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BUBBLE GROWTH BY COALESCENCE  
IN GAS FLUIDIZED BEDS

by

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## ABSTRACT

A study of bubble growth by coalescence in gas fluidized beds has been the object of this research.

Bubble size and distribution of bubble sizes were studied in an air fluidized bed  $11\frac{1}{2}$  inches in diameter and 3 feet high. Motion pictures were taken of the bubbles breaking the top surface of the bed and the size of the bubbles determined from the film. The distribution of bubble volumes at a given bed height was expressed as a gamma distribution with parameters obtained from the observations.

A statistical mechanical method proposed by Hulburt and Katz (1) for studies in agglomeration of particles was used in the mathematical formulation of the problem.

A mechanism defining the rate of bubble coalescence was established. According to this mechanism collisions are binary and the rate of collisions of two species is proportional to the product of the number densities of the colliding species and their average projected area.

A one parameter model based on this mechanism yielded an equation describing the evolution of the distribution with bed height. The parameter was determined by comparison with the experimentally obtained distribution.

## INTRODUCTION

In gas fluidized beds the gas in excess of that required for incipient fluidization passes through the bed as bubbles. These bubbles are gas pockets virtually void of particles. They grow in size as they travel up the bed primarily because of collisions with other bubbles.

In most of the commercial applications of gas fluidized beds, intimate contact between the gas and the fluidized solids is important in the successful operation of the unit. These applications include heat transfer, mass transfer or chemical reactions between gas and solids and gaseous reactions catalyzed by the solids. Presence of bubbles permits some of the gas to move through the bed without contacting the solids, thus reducing the yield of the process.

Information, therefore, on average bubble size and distribution of sizes of bubbles, among other things, is needed in the proper design of gas fluidized beds for these applications (2,3).

Bubble growth has been investigated by various researchers. Experimenting with transparent wall beds, Ohmae and Furukawa (4) and Mathis and Watson (5) observed that bubbles adjacent to the wall grow in size as they travel up the bed, due to coalescence. Morse and Ballou (6), Yasui and Johanson (7), Lanneau (8) and Porter (9) studied

characteristics of bubbles using probes submerged into the bed. Grohse (10) and Baumgarten and Pigford (11) used radiation absorption techniques to measure density fluctuations in the path of a beam through fluidized beds. Romero and Smith (12) used a flash x-ray technique to study internal structure of fluidized beds three inches square. They obtained instantaneous pictures of a part of the bed 11 inches high.

There is some difficulty in interpreting results obtained by these methods. In the submerged probe method there is disturbance of the bubbles by the probes and also there is no way of knowing whether a bubble passed through the probes symmetrically when a diameter is recorded or off-center when a cord is recorded. In the radiation absorption and flash x-ray techniques there is no disturbance of the bubbles, but these methods cannot distinguish two bubbles one behind the other in the path of the rays. In spite of these difficulties, useful information about bubbling fluidized beds was obtained in these investigations, and the results may be summarized as follows:

1. Bubbles grow in size as they travel up the bed, while bubbling frequency decreases.
2. At a given bed height, bubbles are larger at higher flow rates.
3. Larger bubbles travel up the bed faster than smaller ones.

Harrison and Leung (13) investigated the coalescence of bubbles injected one behind the other into an incipiently fluidized bed. They found that the time,  $t_c$ , required for the second bubble to catch up with the first increases by increasing the initial distance of separation,  $\Delta L$ , of the two bubbles. They also found that with the same  $\Delta L$ ,  $t_c$  is smaller for larger bubbles.

In the present work quantitative determination of bubble sizes in gas fluidized beds was attempted by taking motion pictures of the top surface of the bed. Number of bubbles per unit bed height, average bubble volume and variance of bubble volumes were obtained as a function of bed height. These experimental results were compared to the values predicted by a one parameter model based on a proposed mechanism of bubble coalescence, yielding the parameter of the model.

In the comparison of the experimental results with the model, it was assumed that the bubble population at a given elevation in the apparatus is identical (in number, average size and distribution of sizes) whether or not additional bed of any height existed above this elevation.

## MATHEMATICAL MODEL

### Summary of Assumptions

In establishing and solving the differential equations of the model of bubble coalescence in gas fluidized beds, the following assumptions were made explicitly or implicitly:

1. Bubbles are geometrically similar.
2. Bubble volume is conserved.
3. Rise velocity of bubbles is proportional to the one sixth power of bubble volume.
4. The distribution of bubble volumes is described by a gamma distribution.
5. Steady state prevails.
6. The derived equations are solved numerically with initial conditions the experimentally obtained values of the variables at the lowest bed height.

### The Model

The mathematical development follows closely the article "Some Problems in Particle Technology" by Hulburt and Katz (1). Two sets of coordinates describe the bubble, an external one specifying the location of the bubble and which in this case is the vertical distance,  $z$ , from the origin, and an internal one specifying the dimensions of the bubble which is taken here to represent the bubble volume,  $m$ . The number density of the bubbles,  $f(z,m,t)$ , is defined so that

$f(z,m,t) dzdm$  is the number of bubbles at time  $t$  in a slice of bed from  $z - \frac{dz}{2}$  to  $z + \frac{dz}{2}$  having volumes from  $m - \frac{dm}{2}$  to  $m + \frac{dm}{2}$ . A function,  $h(z,m,t)$ , representing the net rate of introduction of bubbles into the system is also defined so that  $h(z,m,t) dzdm$  is the net number of bubbles having volumes from  $m - \frac{dm}{2}$  to  $m + \frac{dm}{2}$  introduced per unit time, at time  $t$ , into a slice of bed from  $z - \frac{dz}{2}$  to  $z + \frac{dz}{2}$  by means other than flow.

The conservation of bubble volume yields

$$(M1) \quad \frac{\partial f}{\partial t} + \frac{\partial (vf)}{\partial z} = h$$

where  $v$  is the bubble velocity.

Collisions between bubbles of volumes  $m_1$  and  $m_2$  are assumed to be proportional to the product of the number densities of the two species and the mean projected area of the two bubbles. Then, the rate of formation of bubbles of volume  $m$  by coalescence is:

$$r_f = \frac{1}{2} B \int f(z,m',t) f(z,m-m',t) \left[ m'^{1/3} + (m-m')^{1/3} \right]^2 dm'$$

and the rate of loss of bubbles of volume  $m$  because of collisions with other bubbles is:

$$r_e = B f(z,m,t) \int f(z,m',t) (m^{1/3} + m'^{1/3})^2 dm'$$

where  $B$  is a proportionality constant. The integration is taken over all possible values of  $m'$  in each case.

Combining these two rates gives:

$$(M2) \quad h(z, m, t) = B \left\{ \frac{1}{2} \int f(z, m', t) f(z, m-m', t) \left[ m'^{1/3} + (m-m')^{1/3} \right]^2 dm' - f(z, m, t) \int f(z, m', t) (m^{1/3} + m'^{1/3})^2 dm' \right\}$$

Substituting (M2) into (M1) yields

$$(M3) \quad \frac{\partial f}{\partial t} + \frac{\partial(vf)}{\partial z} = B \left\{ \frac{1}{2} \int f(z, m', t) f(z, m-m', t) \left[ m'^{1/3} + (m-m')^{1/3} \right]^2 dm' - f(z, m, t) \int f(z, m', t) (m^{1/3} + m'^{1/3})^2 dm' \right\}$$

The velocity may be expressed as a function of bubble volume  $m$  (9, 12, 14, 15, 16).

$$(M4) \quad v = Am^{1/6}$$

where  $A$  is a constant.

Substituting this in (M3) and considering steady state, we obtain

$$(M5) \quad m^{1/6} \frac{df(z, m)}{dz} = b \left\{ \frac{1}{2} \int f(z, m') f(z, m-m') \left[ m'^{1/3} + (m-m')^{1/3} \right]^2 dm' - f(z, m) \int f(z, m') (m^{1/3} + m'^{1/3})^2 dm' \right\}$$

where  $b = B/A$  is a new constant.

Equation (M5) describes the steady state evolution of the number density with bed height. It may be simplified by

applying moment methods on it, thus yielding a set of differential equations for the moments of  $m$ .

The moments of  $m$  are defined as

$$(M6) \quad \mu_j = \int_0^{\infty} m^j f(z, m) dm \quad ; \quad j \geq 0.$$

( $\mu_0$  is therefore the total number of bubbles per unit bed height,  $\mu_1$  their total volume, etc.)

Using moments on (M5) there results:

$$(M7) \quad \frac{d\mu_{n+1/6}}{dx} = \frac{1}{2} \sum_{r=0}^n \binom{n}{r} (\mu_{n-r+2/3} \mu_r + 2\mu_{n-r+1/3} \mu_{r+1/3} + \mu_{n-r} \mu_{r+2/3}) - (\mu_0 \mu_{n+2/3} + 2\mu_{1/3} \mu_{n+2/3} + \mu_{2/3} \mu_n)$$

$$n = 0, 1, 2, \dots ; \quad \binom{n}{r} = \frac{n!}{(n-r)!r!}$$

Here the transformation  $x = bz$  was used.

The first three equations obtained from (M7) for  $n = 0, 1$  and  $2$  respectively are:

$$(M8a) \quad \frac{d\mu_{1/6}}{dx} = - (\mu_0 \mu_{2/3} + \mu_{1/3}^2)$$

$$(M8b) \quad \frac{d\mu_{7/6}}{dx} = 0$$

$$(M8c) \quad \frac{d\mu_{13/6}}{dx} = 2(\mu_1 \mu_{5/3} + \mu_{4/3}^2)$$

These equations contain too many unknowns and they do not close for any  $n$ . Approximate solutions, however, may be sought by expanding  $f(x,m)$  into a Laguerre series:

$$(M9) \quad f(m) = \frac{\lambda}{a} p^{(\lambda)}\left(\frac{\lambda_m}{a}\right) \sum_{i=0}^{\infty} k_i L_i^{(\lambda)}\left(\frac{\lambda_m}{a}\right)$$

where

$$(M10) \quad p^{(\lambda)}(z) = \frac{1}{(\lambda-1)!} z^{\lambda-1} e^{-z}$$

is the gamma distribution and

$$(M11) \quad L_i^{(\lambda)}(z) = \sum_{j=0}^i (-1)^j \frac{i!(i+\lambda-1)!}{j!(i-j)!(i+\lambda-1-j)!} z^{i-j};$$

$$i = 0, 1, 2, \dots$$

are the associated Laguerre polynomials.

This series is developed so that the first term contains three parameters,  $k_0$ ,  $a$  and  $\lambda$ , and the second and third terms drop out.

The three parameters are:

$$(M12a) \quad k_0 = \mu_0$$

$$(M12b) \quad a = \frac{\mu_1}{\mu_0}$$

$$(M12c) \quad \lambda = \frac{a^2}{\mu_2/\mu_1 - a^2}$$

hence  $k_0$  is the total number of bubbles per unit bed height,  $a$  is the mean bubble volume and  $a^2/\lambda$  the variance of bubble volumes.

In this work only the first term of the series was used, i.e.

$$(M13) \quad f(m) = \frac{\lambda k_0}{a} \frac{1}{(\lambda-1)!} \left( \frac{\lambda m}{a} \right)^{\lambda-1} e^{-\frac{\lambda m}{a}}$$

The extent of this approximation is shown in Figures 1 and 2. In these figures the circles represent experimental values of the normalized cumulative number of bubbles plotted against bubble volume. The solid line is the normalized incomplete gamma function:

$$(M14) \quad \frac{G(m)}{k_0} = \int_0^m \frac{f(m')}{k_0} dm' = \int_0^m \frac{\lambda}{a} \frac{1}{(\lambda-1)!} \left( \frac{\lambda m'}{a} \right)^{\lambda-1} e^{-\frac{\lambda m'}{a}}$$

with parameters  $k_0$ ,  $a$ ,  $\lambda$  calculated from the data. The normalized gamma distribution  $f(m)/k_0$  is also shown in the figures.

Using moments (M13) yields

$$(M15) \quad \mu_n = k_0 \left( \frac{a}{\lambda} \right)^n \frac{(n+\lambda-1)!}{(\lambda-1)!} ; \quad n \geq 0$$

With the aid of (M15) moments are expressed in terms of the three parameters of the distribution  $k_0$ ,  $a$ ,  $\lambda$ .

Equations (M8) are transformed now into a set of equations in  $k_0$ ,  $a$ ,  $\lambda$ :

$$(M16a) \quad \frac{dk_0}{dx} = - \frac{k_0^2 a^{1/2}}{36} \left\{ 42R(\lambda) - \lambda Q(\lambda) \left[ P(\lambda) - \frac{\lambda}{1+6\lambda} \right] \right\}$$

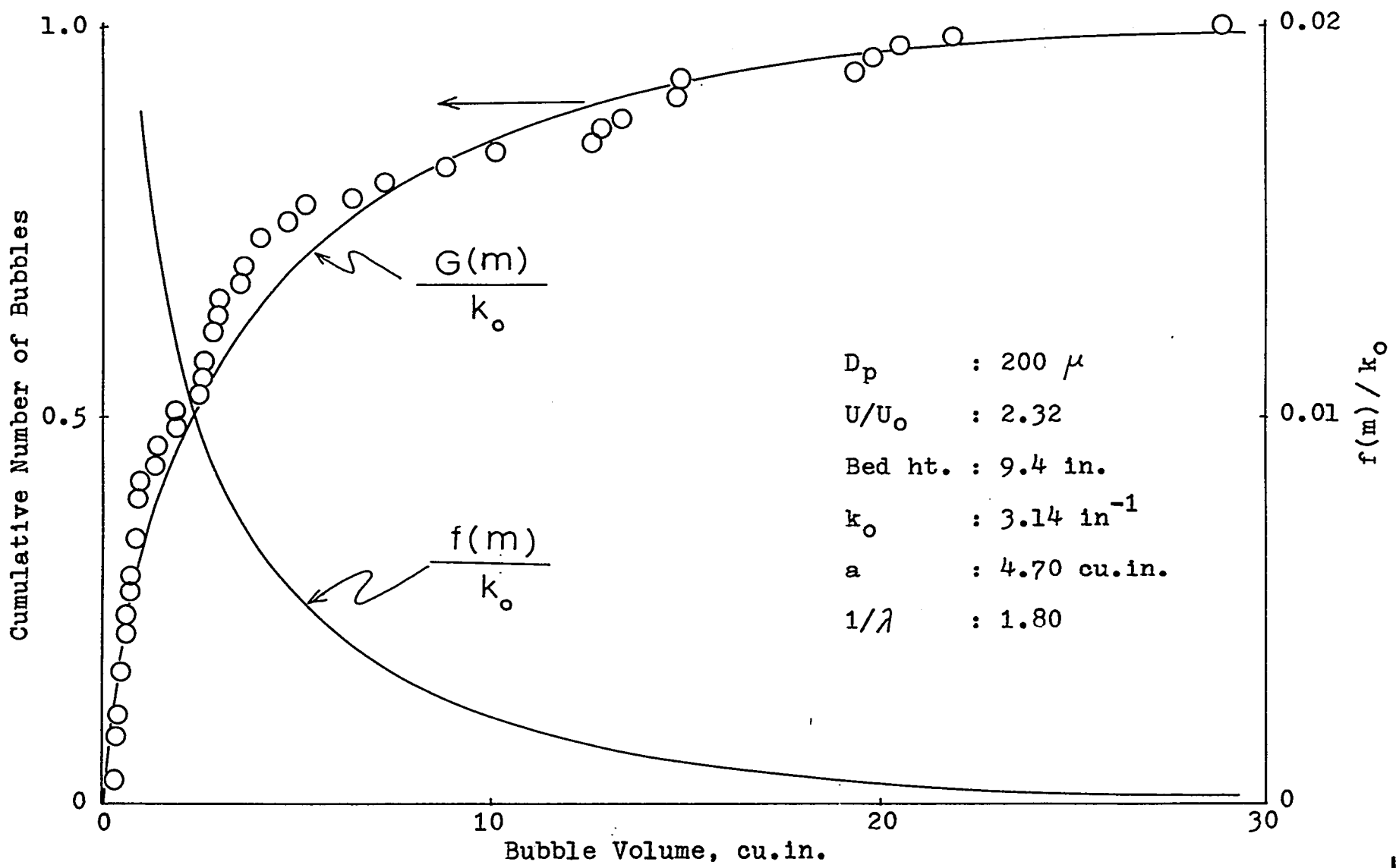


Figure 1. Distribution of Bubble Volumes

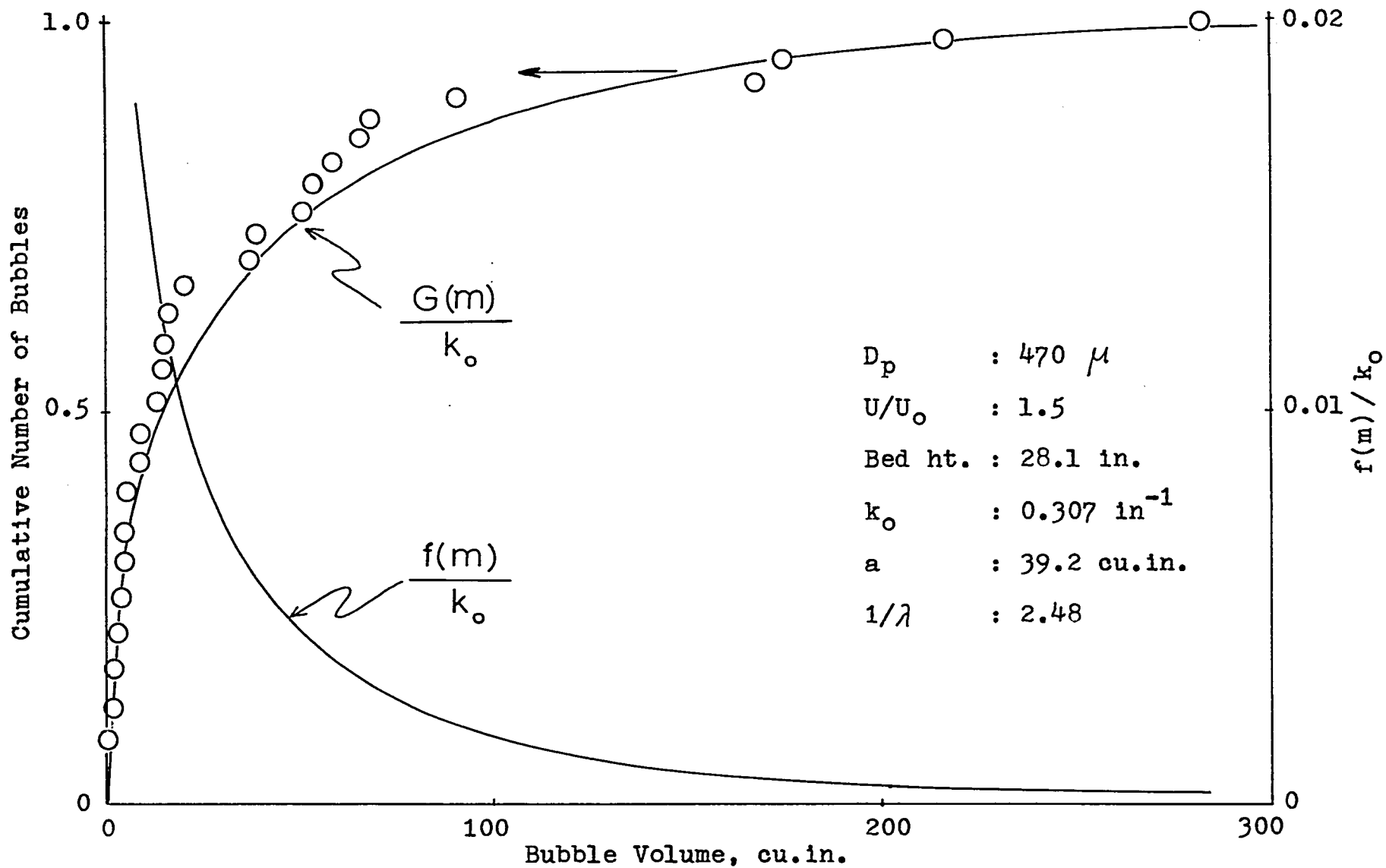


Figure 2. Distribution of Bubble Volumes

$$(M16b) \quad \frac{da}{dx} = \frac{k_o a^{3/2}}{36} \left[ 36 R(\lambda) - \frac{\lambda}{1+6\lambda} Q(\lambda) \right]$$

$$(M16c) \quad \frac{d(1/\lambda)}{dx} = \frac{k_o a^{1/2}}{36} Q(\lambda)$$

where

$$(M17a) \quad R(\lambda) = \frac{1}{\sqrt{\lambda}} \left[ \frac{\Gamma(\lambda + 2/3)}{\Gamma(\lambda + 1/6)} + \frac{\Gamma^2(\lambda + 1/3)}{\Gamma(\lambda)\Gamma(\lambda + 1/6)} \right]$$

$$(M17b) \quad P(\lambda) = \lambda \left[ \psi(\lambda + \frac{1}{6}) - \psi(\lambda) \right]$$

$$(M17c) \quad Q(\lambda) = \frac{1}{\lambda^{5/2}} \left[ \frac{\Gamma^2(\lambda + 1/3)}{\Gamma(\lambda)\Gamma(\lambda + 1/6)} - 7 \frac{\Gamma(\lambda + 2/3)}{\Gamma(\lambda + 1/6)} \right] + 36 R(\lambda)$$

Here  $\Gamma(y) = (y-1)!$  is the gamma function and  $\psi(y) = \frac{d \ln \Gamma(y)}{dy}$  is the digamma function, both tabulated (17).

Equations (M16) constitute a set of coupled ordinary differential equations that, with proper initial conditions, can be solved to yield the profiles  $k_o$ ,  $a$ ,  $1/\lambda$  in  $x$ .

### Initial Conditions

Bubble formation in gas fluidized beds is not well understood as yet. Jackson (18), Pigford and Baron (19) and Porter (9) consider bubbles as the outgrowth of small local disturbances in the distribution of particles and voids of a uniformly fluidized bed. Employing a linearized stability analysis, they found that small local disturbances in the number of particles per unit bed volume propagate both upward and downward in the bed from their point of origin. The downward components are damped out rapidly, while the

upward components increase in amplitude exponentially as they propagate, giving rise to instability. These theories, however, apply only to disturbances of infinitesimal size and may describe the initial rate of growth of small disturbances. Once the disturbances have grown to finite size the non-linearities of the original equations, that were ignored in the analysis, may become important and conclusions may not be drawn on finite size disturbances or "bubbles". Davidson and Harrison (20) suggest that voids of size equal to that of the particles characterize a bed at incipient fluidization. Voids of size ten times the particle size are considered bubbles. Voids of sizes between one and ten define a transition from particulate to aggregative fluidization. Even this simple demarkation does not give a complete set of initial conditions to be used with equations (M16).

Derivation of initial conditions on first principles will have to await until further developments in this area render it possible. For this study the equations were solved using as initial conditions the experimentally obtained values of  $k$ ,  $a$  and  $1/\lambda$  at the lowest bed height.

#### The Parameter of the Model

The mechanism of bubble coalescence in gas fluidized beds proposed in this investigation is an empirical one, in spite of its similarity to the mechanism of molecular colli-

sions employed in the kinetic theory of gases. As a result, the proportionality constant of the mechanism, B, is an empirical constant and no attempt is made to interpret its meaning by attaching physical significance to it. The only requirement for B is that it is independent of m and z.

The following interpretation of the meaning of B was given by Shinnar (24).

B can be interpreted as the relative velocity between two bubbles. If all the bubbles move straight up with no motion imposed on them due to the convective mixing processes in the fluidized bed, then B is given by the difference in rise velocity between bubbles m and m'.

$$B = K A (m^{1/6} - m'^{1/6})\eta(m)$$

Here  $A(m^{1/6} - m'^{1/6})$  is the relative rise velocity,  $\eta(m)$  is the probability of two bubbles coalescing on collision and K a dimensional constant. For bubbles in fluidized beds it is quite reasonable to assume that  $\eta(m)$  is close to unity. When the turbulence in the bed is high, then collision is mainly caused by convective mixing and B will be some unknown function of m. The assumption that B is constant is a first order approximation only, but should cast some light regarding the nature of the collision process.

## EQUIPMENT AND EXPERIMENTS

### Equipment

A diagram of the equipment is shown in Figure 3. The experimental setup consisted of the fluidization unit, devices for measuring flow, pressure and temperature, and the photographic equipment.

The fluidization unit is shown in Figure 4. A transparent wall, methyl methacrylate column, 11.5 inches inside diameter, 0.25 inches wall thickness, contained the particles. Taps along the wall provided for pressure drop measurements. At the lower end, the column was flanged to a 0.25 inches thick, stainless steel, porous support plate. The mean pore opening of the plate was 65 microns. Pressure drop as a function of flow rate through the plate is shown in Figure 6.

Underneath, the plate was flanged to a 14 inches long, cylindrical entrance section.

Air flow rate, pressure and temperature were measured by means of rotameters, pressure gauges and copper-constantan thermocouples, respectively. Pressure drop through the bed was indicated by water manometers. Figure 5 is a photograph of the air control panel.

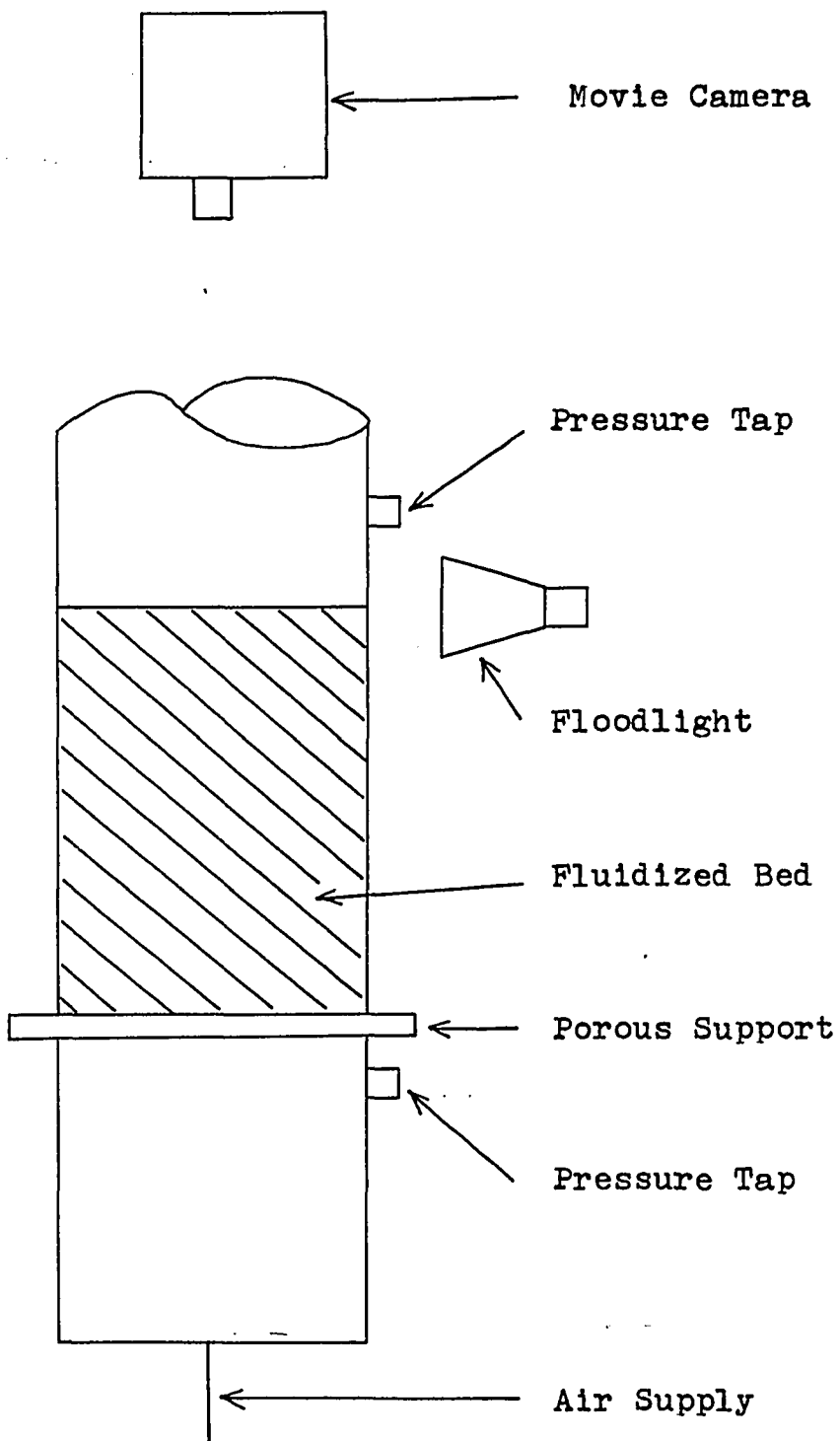


Figure 3.

Diagram of Equipment

FIGURE 4

Fluidization column.

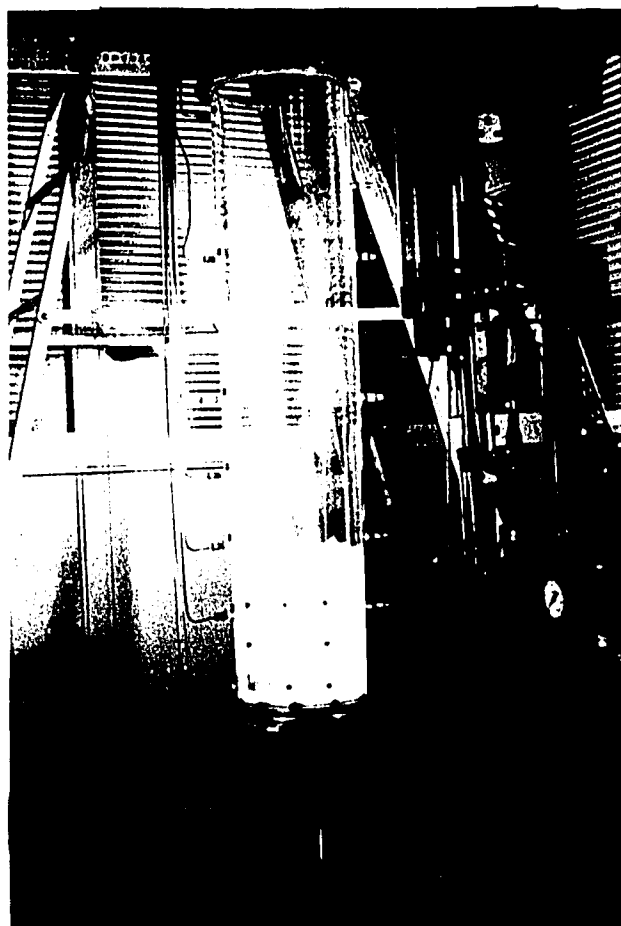


FIGURE 5

Air control panel.

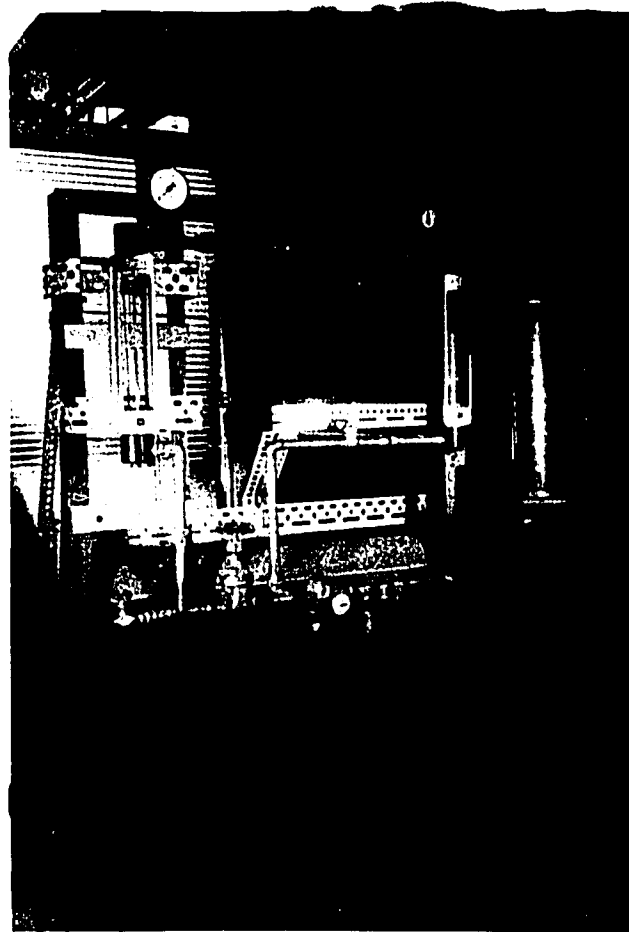
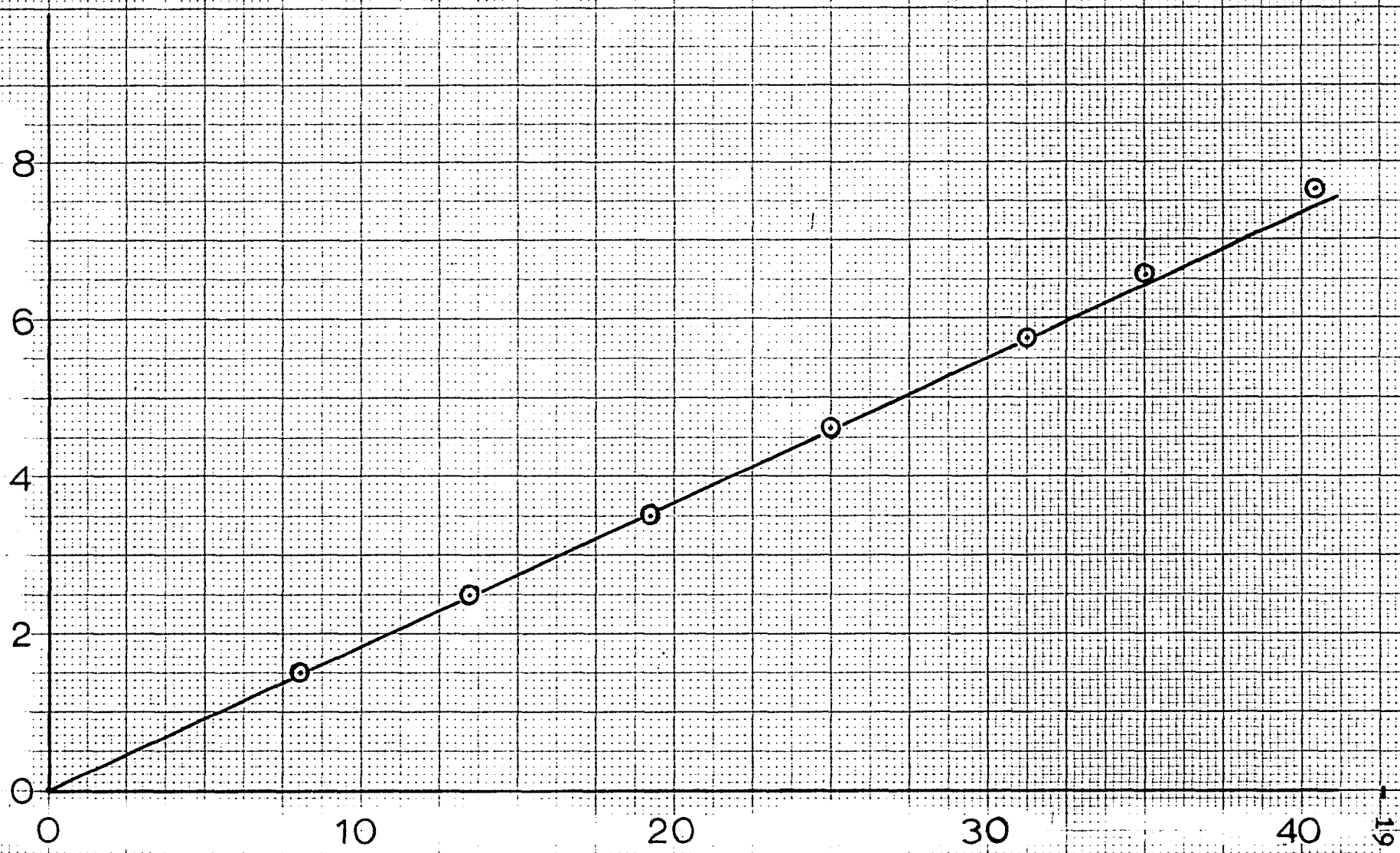


Figure 6. Pressure drop through support plate

Pressure drop , cm. of water



Flow rate , cu.ft./min. at 80 °F. & 1 atm.

A Bell and Howell "200 EE" 18-mm. movie camera was used in some of the experiments. The "200 EE" camera is magazine loaded and operates at various speeds. The shutter open segment of this camera is 0.372. Kodak "Tri-X" 18-mm. black and white movie reversal film was used with this camera.

A Bell and Howell "Eyemo" 35-mm. movie camera was used in the remainder of the experiments. The "Eyemo" camera takes 100-ft. rolls and operates at varying speeds. The shutter open segment of this camera is  $160^{\circ}$ . Kodak "Double X" 35-mm. black and white negative film was used with this camera. Four flood lamps, 300 watts each, were used for illumination. They were placed outside the column, at the level of the top surface of the fluidized bed, two on either side. Light was measured by a Weston light meter.

### Procedure

At any particular run the height of the bed at rest was measured, the bed was fluidized at a high air flow rate, the flow was maintained at this level for several minutes and then was reduced to the desired level. Air flow rate, temperature and pressure were recorded along with pressure drop across the bed. The floodlights were turned on, the camera was adjusted for the right distance and lens opening and the motion pictures were taken for a prescribed time interval. Air flow conditions and pressure drop along the bed were checked again and the run was completed. The frames of the

developed film were numbered consecutively starting with 1 for each run, and these numbers served as the time calibration of the runs. The experimental conditions, listed by run number, are presented in Tables 1 to 5. In the remainder of this thesis experiments will be mentioned by run number, and reference should be made to these tables for the particulars of each run.

The numbered film was projected on coordinate paper and frame number, coordinates of the center and diameter were recorded for each bubble just before bursting. For bubbles that were not round the geometric mean of the maximum,  $d_{\max}$ , and minimum,  $d_{\min}$ , measured dimensions was recorded as the diameter,  $d_1$ .

$$(E1) \quad d_1 = \sqrt{d_{\max} d_{\min}}$$

The inside diameter of the tube was used as a reference for calibrating lengths.

Collected data, ordered by run number, are presented as Parts A and B in Appendix A.

Part A lists the experimental conditions of each run. The characteristics of individual bubbles are presented in Part B. Here bubbles are numbered consecutively in Column 1. Column 2 lists the number of the frame where the bubble was observed breaking the top surface of the bed. Columns 3 and 4 present the coordinates of the center of the bubble in the

Table 1. EXPERIMENTAL CONDITIONS

Particles: Glass beads,  $D_p$ : 200 microns,  $U_0$ : 0.149 ft./sec.

Run No.	U ft./sec.	H in.	$H_0$ in.	Camera Speed fr./sec.	No. of Frames Examined	Duration of Run sec.	Fluidized Bed $\Delta p$ cm. $H_2O$	Air Tem- perature $^{\circ}F$
1	0.209	1.1	1	64	2	0.0214	3.5	82
2	"	2.2	2	64	7	0.0996	4.5	82
3	"	4.4	4	48	13	0.258	15.1	82
4	"	13.0	12	"	192	3.99	44.3	81
5	"	20.4	19	"	220	4.58	71.1	77
6	"	25.8	24	"	203	4.23	89.8	77
7	0.346	1.3	1	64	3	0.037	5.5	82
8	"	2.5	2	64	11	0.162	9.5	82
9	"	4.8	4	48	17	0.341	16.8	82
10	"	9.4	8	"	46	0.945	31.6	82
11	"	13.9	12	"	194	4.03	45.4	81
12	"	21.7	19	"	150	3.11	72.3	77
13	"	27.2	24	"	200	4.15	90.3	77

Table 2. EXPERIMENTAL CONDITIONS

Particles: Glass beads,  $D_p$ : 85 microns,  $U_0$ : 0.0263 ft./sec.

<u>Run No.</u>	<u>U ft./sec.</u>	<u>H in.</u>	<u>H<sub>0</sub> in.</u>	<u>Camera Speed fr./sec.</u>	<u>No. of Frames Examined</u>	<u>Duration of Run sec.</u>	<u>Fluidized Bed <math>\Delta p</math> cm. H<sub>2</sub>O</u>	<u>Air Temperature °F</u>
14	0.0440	4.2	4	48	10	0.197	14.2	91
15	"	8.3	8	"	41	0.843	28.0	93
16	"	12.5	12	"	65	1.34	43.1	87
17	"	25.0	24	"	77	1.58	85.6	90
18	"	37.5	36	"	118	2.46	130.5	91
19	0.0587	1.1	1	"	1	0.00354	3.3	94
20	"	4.4	4	"	17	0.354	14.6	91
21	"	8.6	8	"	49	1.02	28.4	93
22	"	12.8	12	"	202	4.21	43.7	87
23	"	25.4	24	"	77	1.60	86.5	91
24	"	38.0	36	"	145	3.02	131.0	91

Table 3. EXPERIMENTAL CONDITIONS

Particles: Glass beads,  $D_p$ : 85 microns,  $U_0$ : 0.0263 ft./sec.

<u>Run No.</u>	<u>U ft./sec.</u>	<u>H in.</u>	<u>H<sub>0</sub> in.</u>	<u>Camera Speed fr./sec.</u>	<u>No. of Frames Examined</u>	<u>Duration of Run sec.</u>	<u>Fluidized Bed <math>\Delta p</math> cm. H<sub>2</sub>O</u>	<u>Air Temperature °F</u>
25	0.088	0.6	0.5	48	1	0.00221	1.6	94
26	"	1.2	1	"	1	0.00565	3.4	94
27	"	4.5	4	"	10	0.197	14.3	91
28	"	13.1	12	"	52	1.08	44.2	87
29	"	26.0	24	"	64	1.33	86.5	91
30	"	38.8	36	"	119	2.48	129.8	91
31	0.117	8.6	8	"	44	0.917	27.9	93
32	"	12.9	12	"	62	1.29	43.6	88
33	"	24.8	24	"	119	2.48	86.6	91
34	"	38.7	36	"	160	3.33	128.3	91
35	0.147	8.7	8	"	39	0.81	28.0	93
36	"	13.1	12	"	87	1.81	43.2	88
37	"	26.2	24	"	74	1.54	86.4	91
38	"	39.2	36	"	96	2.00	129.1	91

Table 4. EXPERIMENTAL CONDITIONS

Particles: Glass beads,  $D_p$ : 470 microns,  $U_0$ : 0.51 ft./sec.

<u>Run No.</u>	<u>U ft./sec.</u>	<u>H in.</u>	<u>H<sub>0</sub> in.</u>	<u>Camera Speed fr./sec.</u>	<u>No. of Frames Examined</u>	<u>Duration of Run sec.</u>	<u>Fluidized Bed <math>\Delta p</math> cm. H<sub>2</sub>O</u>	<u>Air Temperature °F</u>
41	0.638	1.2	1	64	4	0.0625	4.0	82
42	"	2.4	2	"	31	0.484	7.7	86
43	"	4.6	4	"	58	0.906	15.5	88
44	"	9.1	8	"	160	2.50	30.7	88
45	"	13.5	12	48	237	4.94	46.0	89
46	"	26.7	24	"	179	3.71	92.2	91
47	"	39.8	36	"	168	3.50	138.4	86
48	0.765	1.3	1	64	3	0.0371	4.2	82
49	"	2.6	2	"	19	0.297	8.0	86
50	"	5.0	4	"	64	1.00	15.6	88
51	"	9.7	8	"	125	1.95	30.9	88
52	"	14.4	12	48	301	6.25	46.2	90
53	"	28.1	24	"	191	3.98	92.5	91
54	"	41.6	36	"	350	7.29	138.5	87

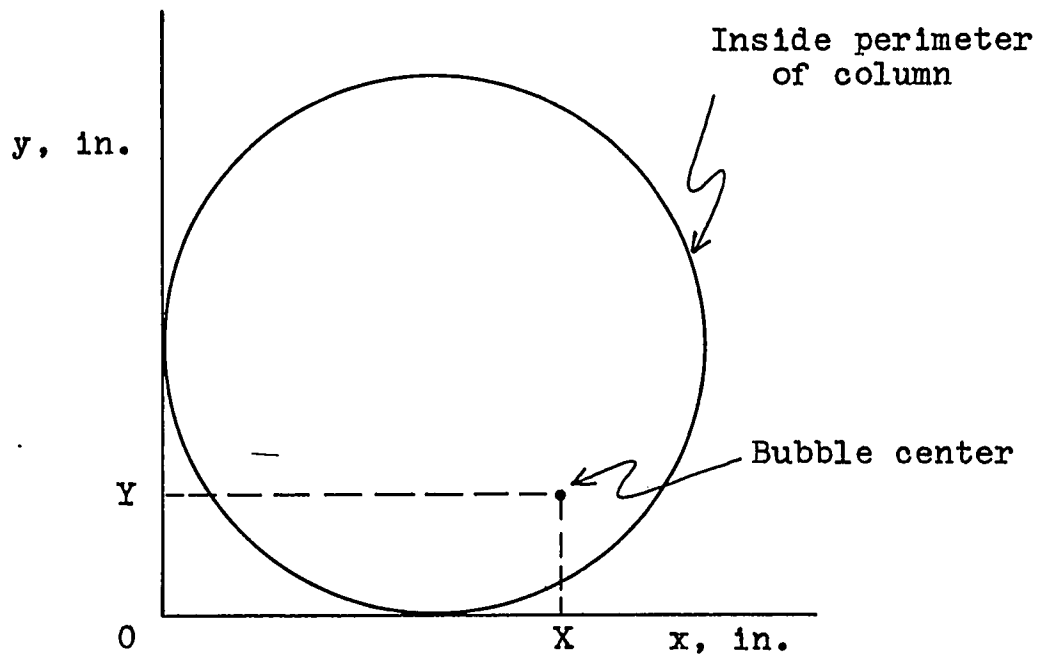
Table 5. EXPERIMENTAL CONDITIONS

Particles: Cracking catalyst,  $D_p$ : 59 microns,  $U_0$ : 0.035 ft./sec.

<u>Run No.</u>	<u>U ft./sec.</u>	<u>H in.</u>	<u>H<sub>0</sub> in.</u>	<u>Camera Speed fr./sec.</u>	<u>No. of Frames Examined</u>	<u>Duration of Run sec.</u>	<u>Fluidized Bed <math>\Delta p</math> cm. H<sub>2</sub>O</u>	<u>Air Temperature °F</u>
56	0.0072	5.0	4.75	64	51	0.797	4.5	87
57	"	10.5	9.75	"	101	1.578	10.0	86
58	"	21.2	20	"	190	2.969	20.9	90
59	"	31.5	30	"	203	3.125	31.4	89

top surface of the bed with reference to a cartesian system of coordinates tangential to the circle bounding the bed surface, Figure 7.

Figure 7  
Reference Coordinates Used in Recording  
Location of Bubble Centers



Column 5 lists the frontal diameter of the bubble, i.e. the diameter recorded as the bubble bursts through the top surface.

Photographs of the top surface of the bed are shown in Figures 8 to 19. These photographs were taken with a 35-mm. still camera at approximately the same shutter speed as that used in taking motion pictures.

Glass beads,

PLATE 1  
 $D_p = 470 \mu.$

$U_o = 0.51 \text{ ft./sec.}$



Figure 8.

$H_o = 1 \text{ in.}$

$$\frac{U}{U_o} = 1.50$$



Figure 9.

$H_o = 2 \text{ in.}$

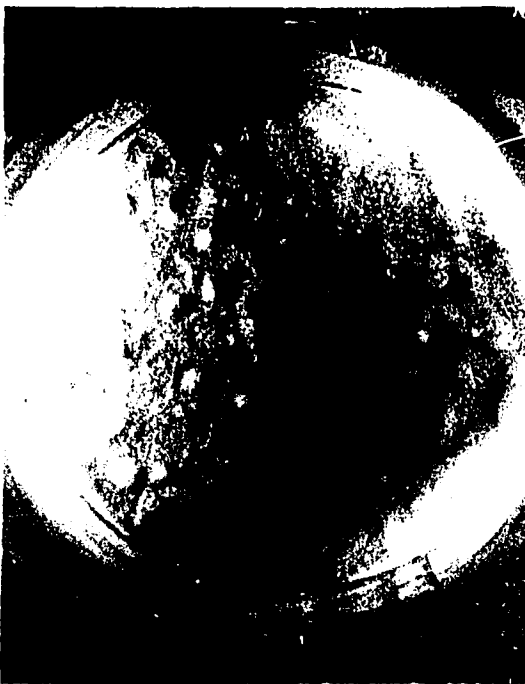


Figure 10.

$$\frac{U}{U_o} = 1.25$$



Figure 11.

Glass beads,

$$D_p = 470 \mu.,$$

$$U_o = 0.51 \text{ ft./sec.}$$



$$\frac{U}{U_o} = 1.50$$



Figure 12.

Figure 13.

$$H_o = 4 \text{ in.}$$

$$H_o = 8 \text{ in.}$$



$$\frac{U}{U_o} = 1.25$$



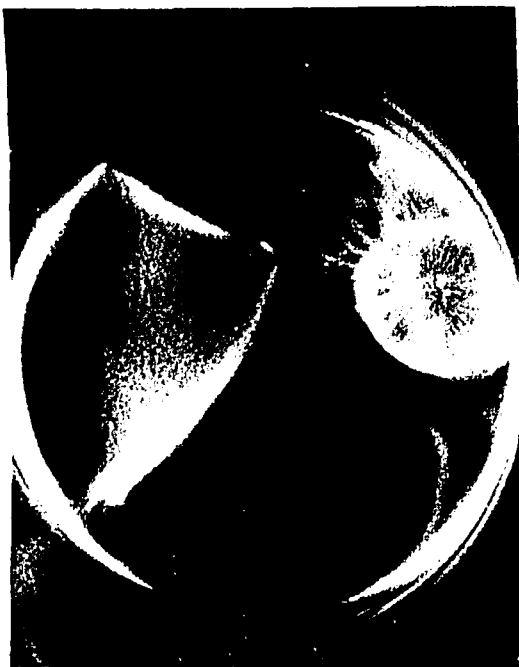
Figure 14.

Figure 15.

Glass beads,

PLATE III  
 $D_p = 470 \mu.$

$U_o = 0.51 \text{ ft./sec.}$



$\frac{U}{U_o} = 1.50$



Figure 16.

$H_o = 12 \text{ in.}$

Figure 17.

$H_o = 24 \text{ in.}$



$\frac{U}{U_o} = 1.25$



Figure 18.

Figure 19.

## Materials

Glass beads of narrow size distribution and cracking catalyst of wide size distribution were fluidized with air. The properties of the glass beads used are given in Table 6. The catalyst, a typical fluid, high-alumina, cracking catalyst, was donated by W. R. Grace and Company. Its properties are listed in Table 7.

The very fine particles of the cracking catalyst formed a cloud of dust when the catalyst was fluidized. The cloud filled the containing column above the surface of the fluidized bed, creating poor visibility conditions, unsuitable for taking motion pictures. This was overcome by fluidizing the catalyst for one hour at 0.54 ft./sec. air velocity and allowing the dust to be carried away. At the end of the hour the catalyst had lost 5% of its original volume. The size distribution of the catalyst used in the experiments, therefore, was somewhat different from the one given in Table 7, with most of the 0 - 20 microns and some of the 20 - 40 microns fractions missing. No size distribution determination of the treated material was made.

Air was taken from the pressurized laboratory supply line. A pressure regulator was used to reduce it from the supplied pressure of 50 - 60 psig to the desired level.

Table 6

PROPERTIES OF FLUIDIZED SOLIDS

Material: Glass

Density: 156 lbs./cu.ft.

Average Diameter, microns	Size Distribution, Percent Retained U.S. Sieves					Bulk Density, lbs./cu.ft.
	U.S. Sieve No.	20	40	50	60	
470	U.S. Sieve No.	20	40	50	60	93.7
	% Retained	0	70	25	5	
200	U.S. Sieve No.	60	70	80	100	94.2
	% Retained	10	40	40	10	
85	U.S. Sieve No.	170	200	230	270	93.6
	% Retained	15	65	15	5	

Table 7

PROPERTIES OF FLUIDIZED SOLIDS

Material: Cracking catalyst

Density: 153 lbs./cu.ft.

Bulk Density: 32.5 lbs./cu.ft. (loosely packed)

Particle Density: 55 lbs./cu.ft.

Size, microns	Size Distribution, Micromesh Analysis				
	0 - 20	0 - 40	0 - 80	0 - 105	0 - 149
Weight, %	2	21	77	92	99

### Interpretation of Data

For any run the following information was available by direct measurement:

- I : The total number of different sizes of bubbles
- $d_i$  : Diameter of bubbles of the  $i$ th size breaking the top surface
- $n_i$  : Number of bubbles having diameter  $d_i$
- T : Duration of observation
- F : Gas flow rate
- $F_0$  : Gas flow rate at incipient fluidization.

From this, a shape factor,  $C'$ , was calculated:

$$(E2) \quad C' = \frac{(F - F_0) T}{\sum_{i=1}^I n_i d_i^3}$$

The shape factors at all bed heights and flow rates used, for the same material, were averaged to give a shape factor,  $C$ , for the material. This shape factor was used in calculating bubbles volumes.

$$(E3) \quad m_i = C d_i^3$$

The implicit assumption here is that bubbles breaking the top surface of the fluidized bed are geometrically similar for a given material. This was verified by Harrison and Leung (14) in experiments with bubbles injected into a bed

at incipient fluidization. They found relation (E3) to hold for bubble diameters up to three-fourths the diameter of the column.

Bubble velocity was calculated by

$$(E4) \quad v_1 = A m_1^{1/6} \text{ in./sec.}$$

where A is a proportionality constant.

This relation was proposed by Davidson et al. (15) and was verified by Davidson et al. (15), Harrison and Leung (14) and Rowe and Partridge (16) in experiments with injected bubbles and by Romero and Smith (12) in naturally bubbling beds. Rowe and Partridge (16) found the constant to depend on particle size and shape. The value of the constant calculated was somewhat different in each of the above investigations. The values given by Rowe and Partridge were used here. For the particles used in this work the total variation in the value of the constant as determined by these investigators would be about 10%, and the average value

$$(E5) \quad A = 14 \text{ in.}^{1/2} / \text{sec.}$$

was used throughout.

Next,  $k_o$ ,  $a$  and  $1/\lambda$  were calculated,

$$(E6) \quad k_o = \sum_{i=1}^I N_i$$

$$(E7) \quad a = \frac{\sum_{i=1}^I N_i m_i}{\sum_{i=1}^I N_i}$$

$$(E8) \quad 1/\lambda = \frac{\sum_{i=1}^I N_i m_i^2}{k_o a^2} - 1$$

where

$$(E9) \quad N_i = \frac{n_i}{v_i T} .$$

is the number of bubbles of the  $i$ th size per unit bed height.

A set of runs consisted of the values of  $k_o$ ,  $a$  and  $1/\lambda$  for the same material and the same flow rate, at various bed heights.

The values of these quantities at the lowest bed height were used as initial conditions with equations (M16). The equations were solved numerically, using the fourth order Runge-Kutta method, on an IBM 7040 digital computer.

The profiles obtained by solving the equations were compared to the set of values obtained from the experimental data using relations (E6) to (E8). The comparison yielded a value of the parameter for each set of runs.

RESULTS

The shape factors obtained from the experimental data with the aid of relations (E2) are presented in Tables 10 to 14.

Shape factors averaged for runs at the same particle size are listed in Table 8. The value obtained by Harrison and Leung is listed in the same table.

Table 8  
SHAPE FACTORS OF BUBBLES BREAKING  
THE SURFACE FOR VARIOUS MATERIALS

Material	<u>Glass Beads</u>			<u>Sand</u>	<u>Cracking Catalyst</u>
Average particle size, microns	470	200	85	160*	59
Average shape factor	.240	.153	.0847	.141*	.125
Standard deviation of shape factors	.082	.017	.0299	--	.0128

\*Values calculated from the data of Harrison and Leung (13)

It is seen from the tabulated values that the shape factor does not vary with bed height or flow rate but it is an increasing function of particle size.

However, the shape factor for the cracking catalyst is not what it should be, judging on size alone.

The cracking catalyst is of wide size distribution as opposed to the narrow size distribution of the other materials listed on Table 8 and also, due to high porosity, its particle density\* is one-third the density of glass or sand. It is possible that different behavior with regard to the shape factor was caused by the different properties of the cracking catalyst.

Experimental values of the distribution of bubble volumes per unit bed height, expressed in the form of parameters of the distribution, are listed in the three last columns of Tables 10 - 14. Here  $k_0$  represents the total number of bubbles per unit bed height,  $a$  the mean bubble volume and  $1/\lambda$  the variance of bubble volumes divided by the square mean. These values were calculated from the experimental data (listed in the appendix) using relations (E6) to (E9). The same quantities  $k_0$ ,  $a$ ,  $1/\lambda$  are plotted as functions of bed height in Figures 20 - 29. In these plots  $k_0$  is represented by the circles,  $a$  by the squares and  $1/\lambda$  by the triangles.

The effect of bed height and fluidizing velocity on bubble volume is clearly seen. The total number of bubbles

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\*Particle density is taken here as the apparent density that would result in dividing the weight of a grain of the material by its volume after the pores of the grain were filled in.

per unit bed height is decreasing very rapidly with increasing bed heights, while the mean bubble volume is increasing equally fast. The variance of the distribution measured in units of squared mean increases with bed height until it reaches a limiting value. The effect of velocity on  $k_0$  and  $a$  is similar to that of bed height. At higher velocities there are fewer larger bubbles per unit bed height. Velocity has no apparent effect on the reduced variance.

Values of  $k_0$ ,  $a$  and  $1/\lambda$  versus  $x$  resulting from the equations are shown as solid lines in Figures 20 to 29. In the same figures, circles, squares and triangles represent the experimentally obtained values of  $k_0$ ,  $a$  and  $1/\lambda$ . The parameter in each case was obtained by minimizing the squared percentage error in  $k_0$  and  $a$ . In Figures 22, 23 and 26 the last point was not included in the least-squares fit.

The points in Figures 27 and 28 were too scattered and no least-squares fit was attempted. An average value of the parameter was used instead.

Values of the parameter  $b$  obtained by the least-squares for each type of material and flow rate used are listed in Table 9.

No trend was observed in the variation of the values of  $b$  with flow rate or particle size.

Table 9

VALUES OF THE PARAMETER OF THE MODEL

Material	$D_p$ microns	$U_o$ ft./sec.	$U/U_o$	$b$ $\text{in.}^{-3/2}$
Glass beads	470	0.510	1.25	0.0200
			1.50	0.0195
	200	0.149	1.40	0.0150
			2.32	0.0190
	85	0.0263	1.67	0.0180
			2.23	0.0165
			3.34	0.0140
			4.46	0.0175
			5.57	0.0175
	Cracking Catalyst	59	0.0035	2.06

Fig 20. Profiles of  $k_o$ ,  $a$  and  $1/\lambda$

Bed height, in.

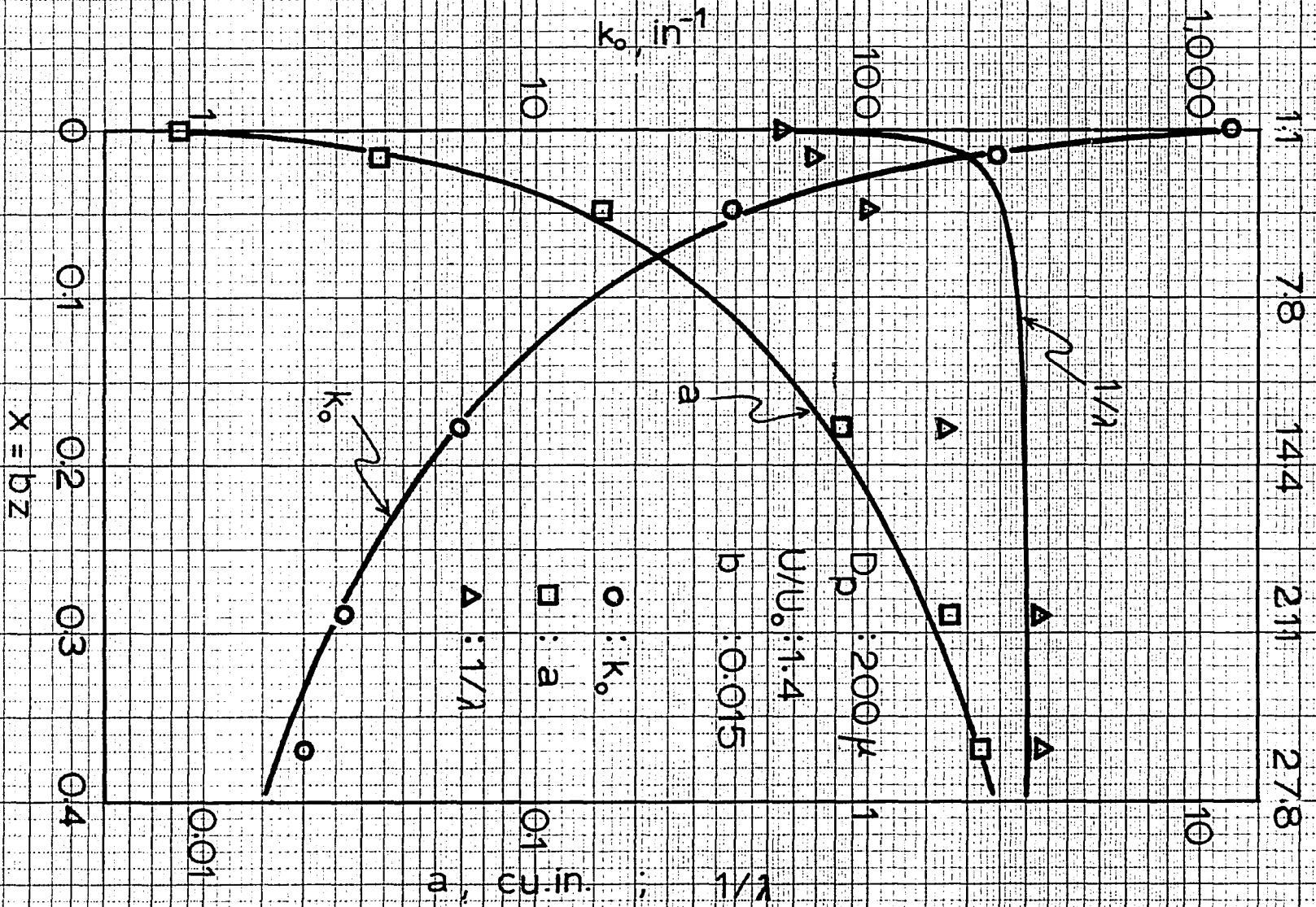
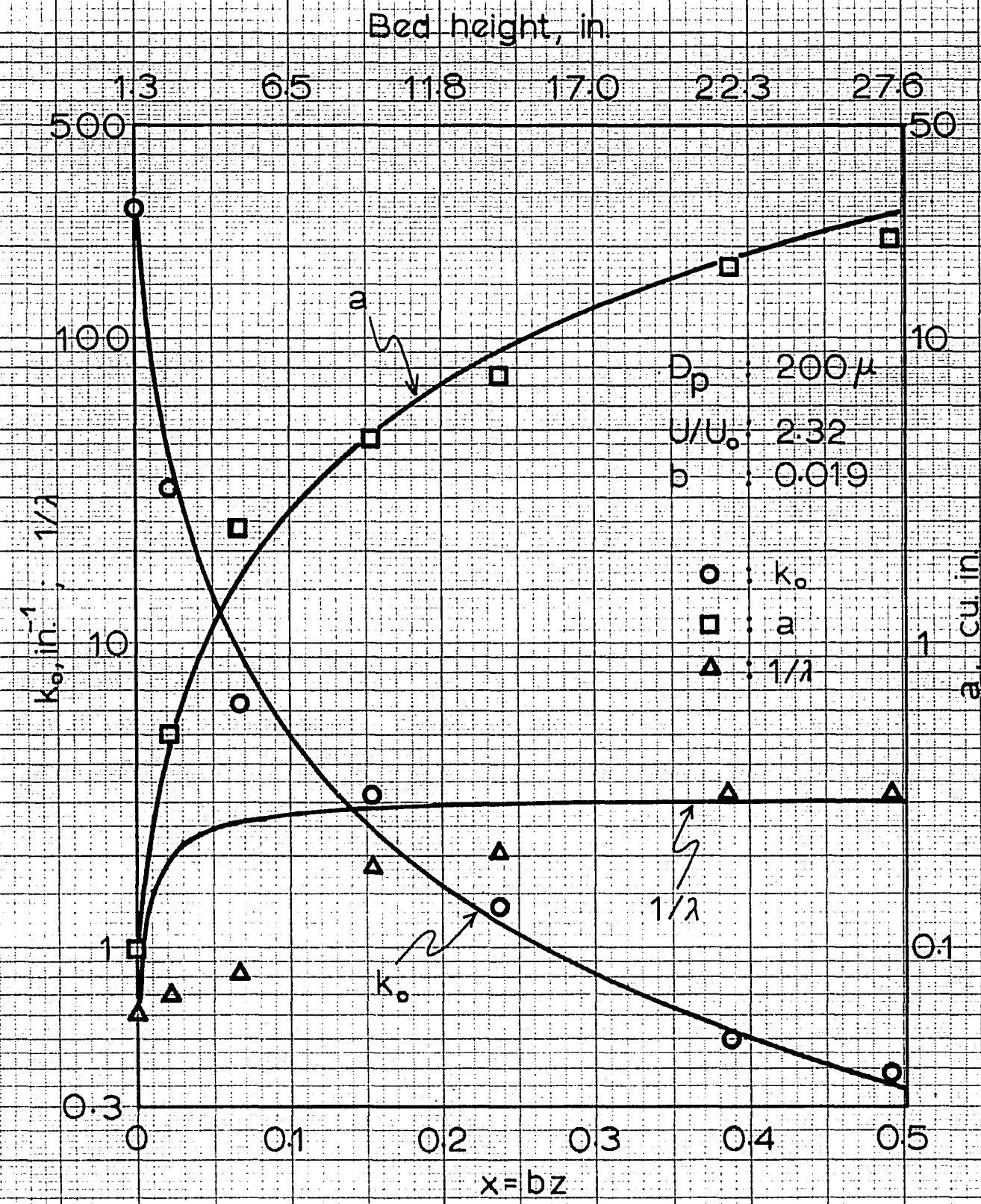


Fig.21. Profiles of  $k_o$ ,  $a$  and  $1/\lambda$



IN 5 CYCLES 7 TO DIVISIONS  
 KEUFFEL & ESSER CO

Fig.22. Profiles of  $k_o$ ,  $a$  and  $1/\lambda$

Bed height, in.

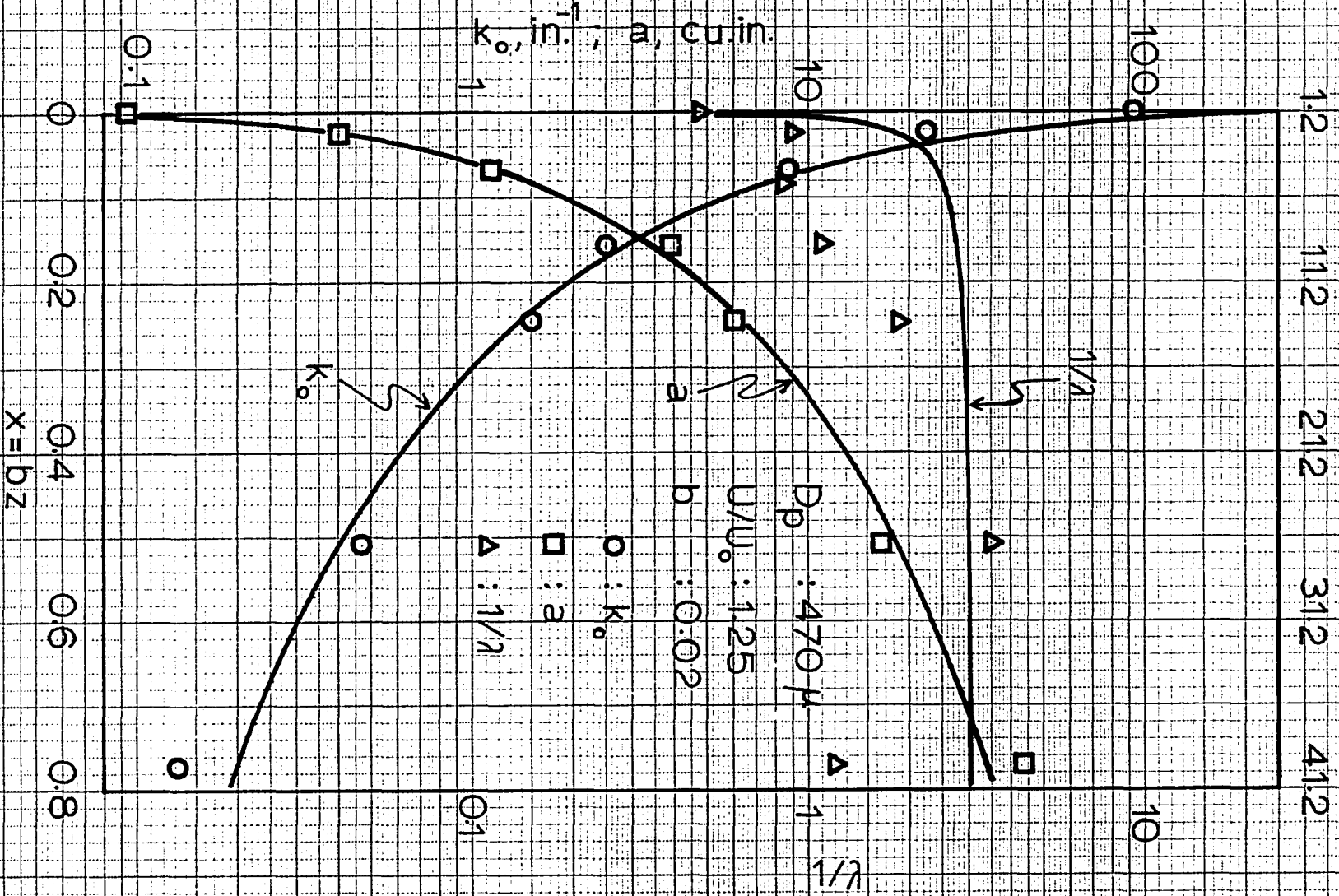


Fig.23. Profiles of  $k_o$ ,  $a$  and  $1/\lambda$

Bed height, in.

1.3      11.6      21.8      32.1      42.3

200  
100

10

1

0.1

0.05

0

0

0.2      0.4      0.6      0.8

$x = b \cdot z$

$D_p : 470 \mu$

$U/U_o : 1.5$

$b : 0.0195$

○ :  $k_o$

□ :  $a$

△ :  $1/\lambda$

$k_o, \text{ in}^{-1}; a, \text{ cu. in.}$

$a$

$k_o$

$1/\lambda$

10

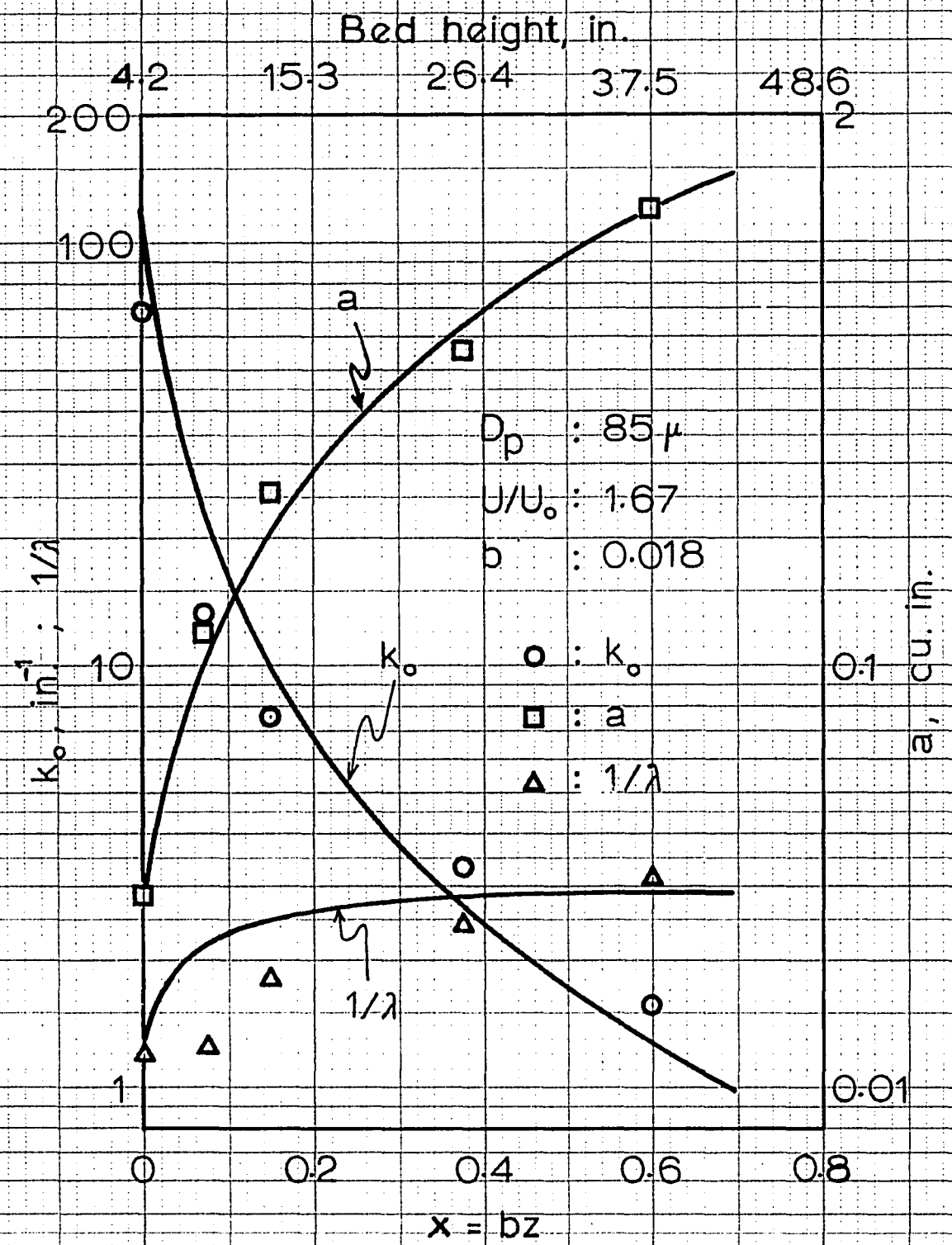
$1/\lambda$

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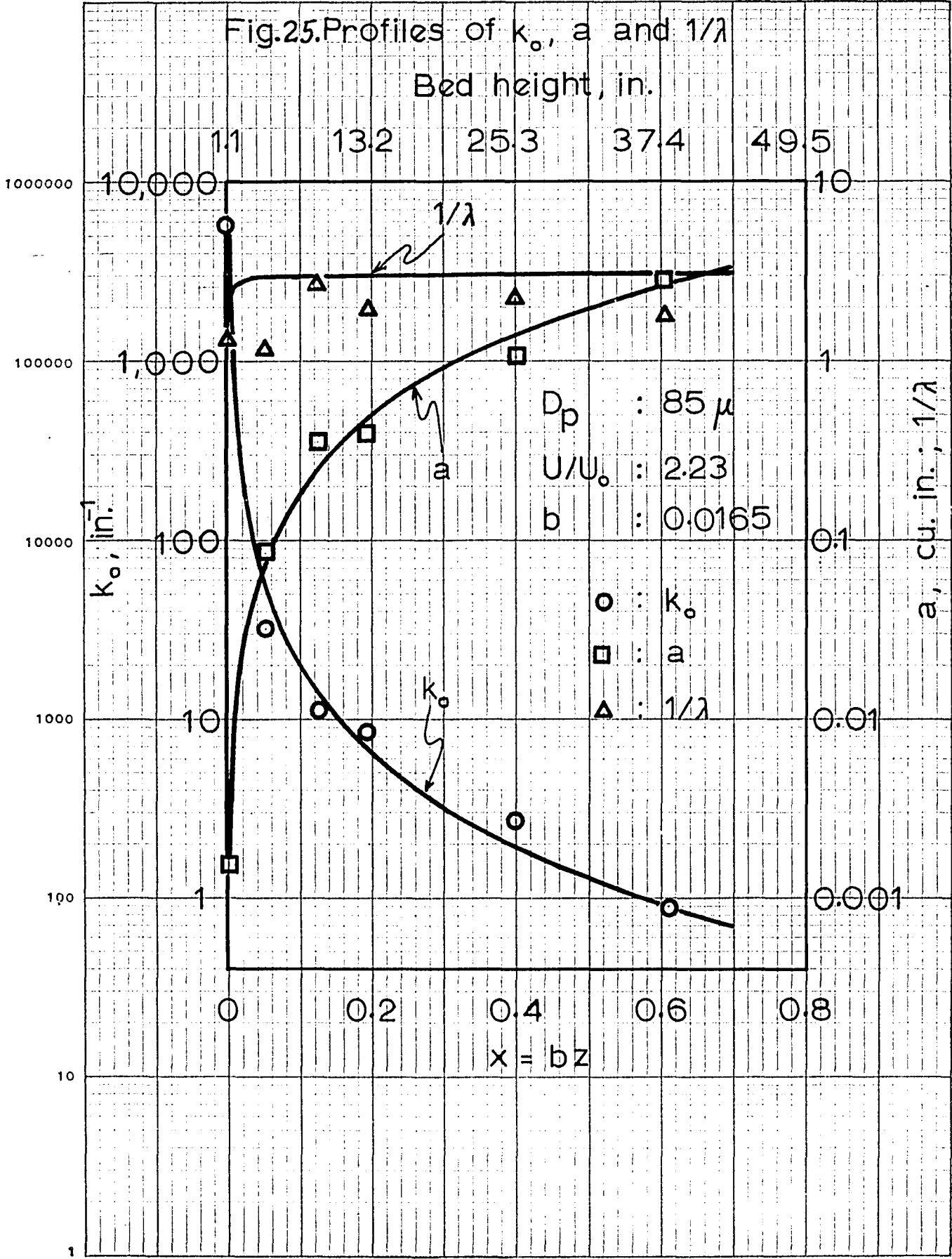
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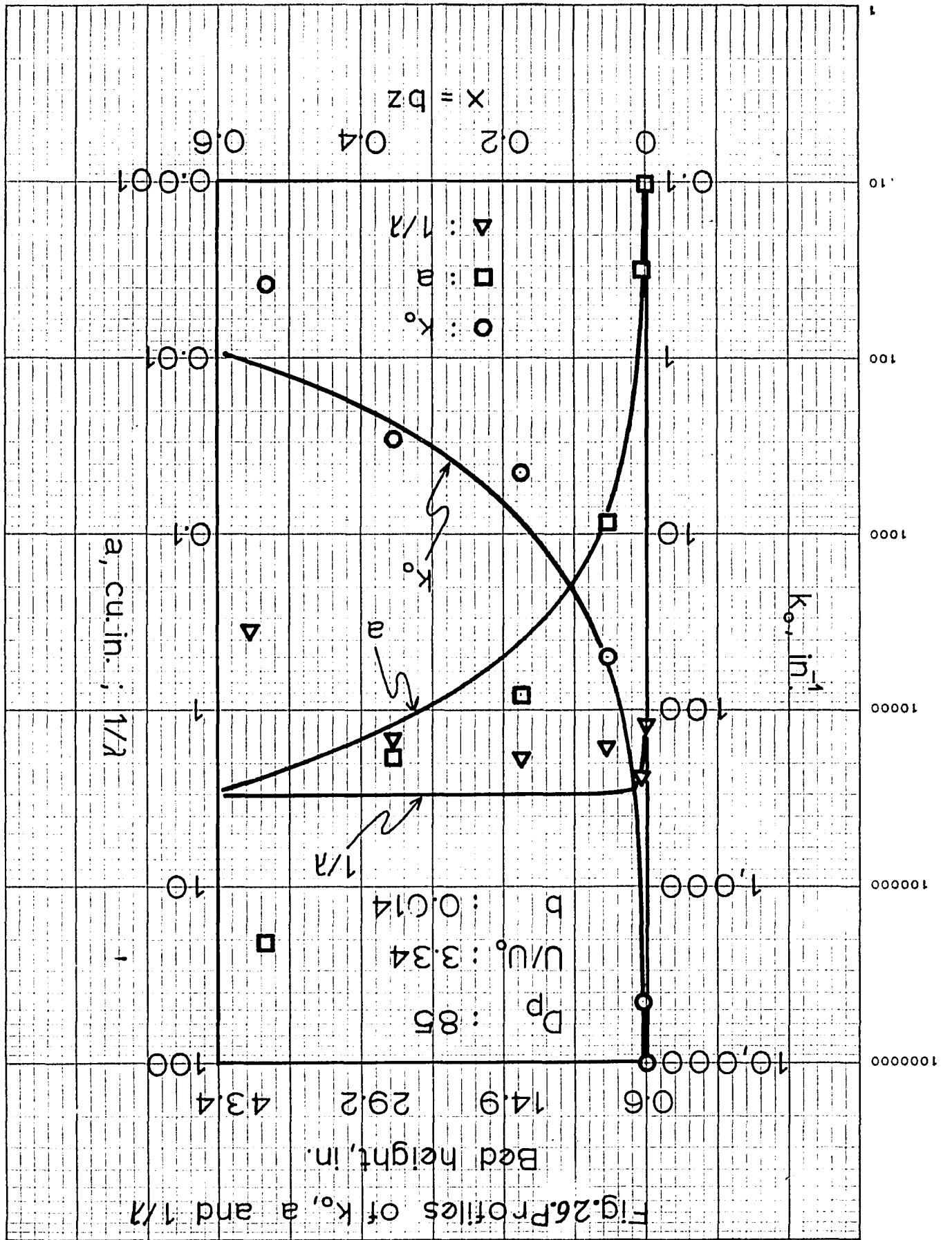
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Fig.24. Profiles of  $k_o$ ,  $a$  and  $1/\lambda$



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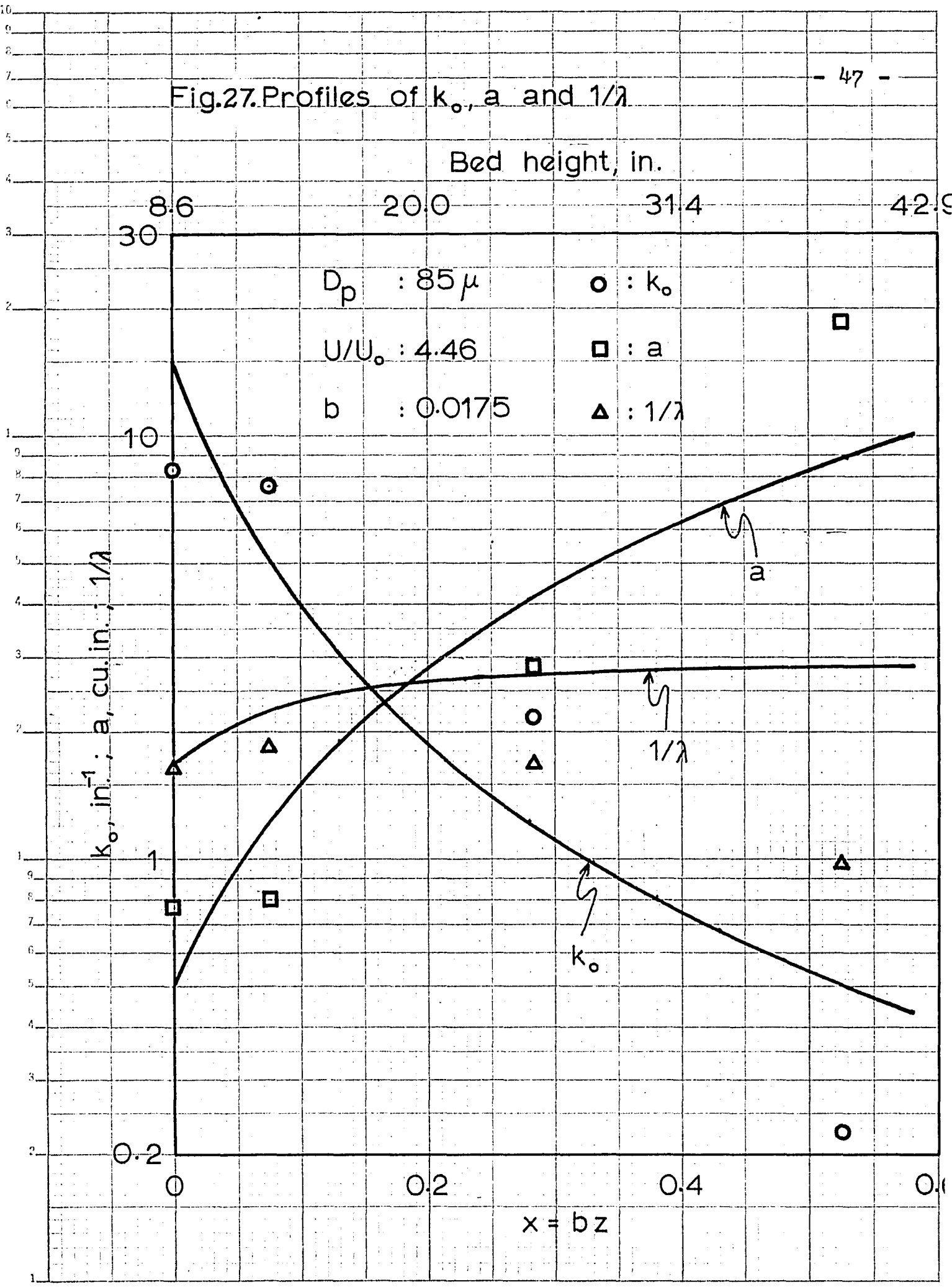




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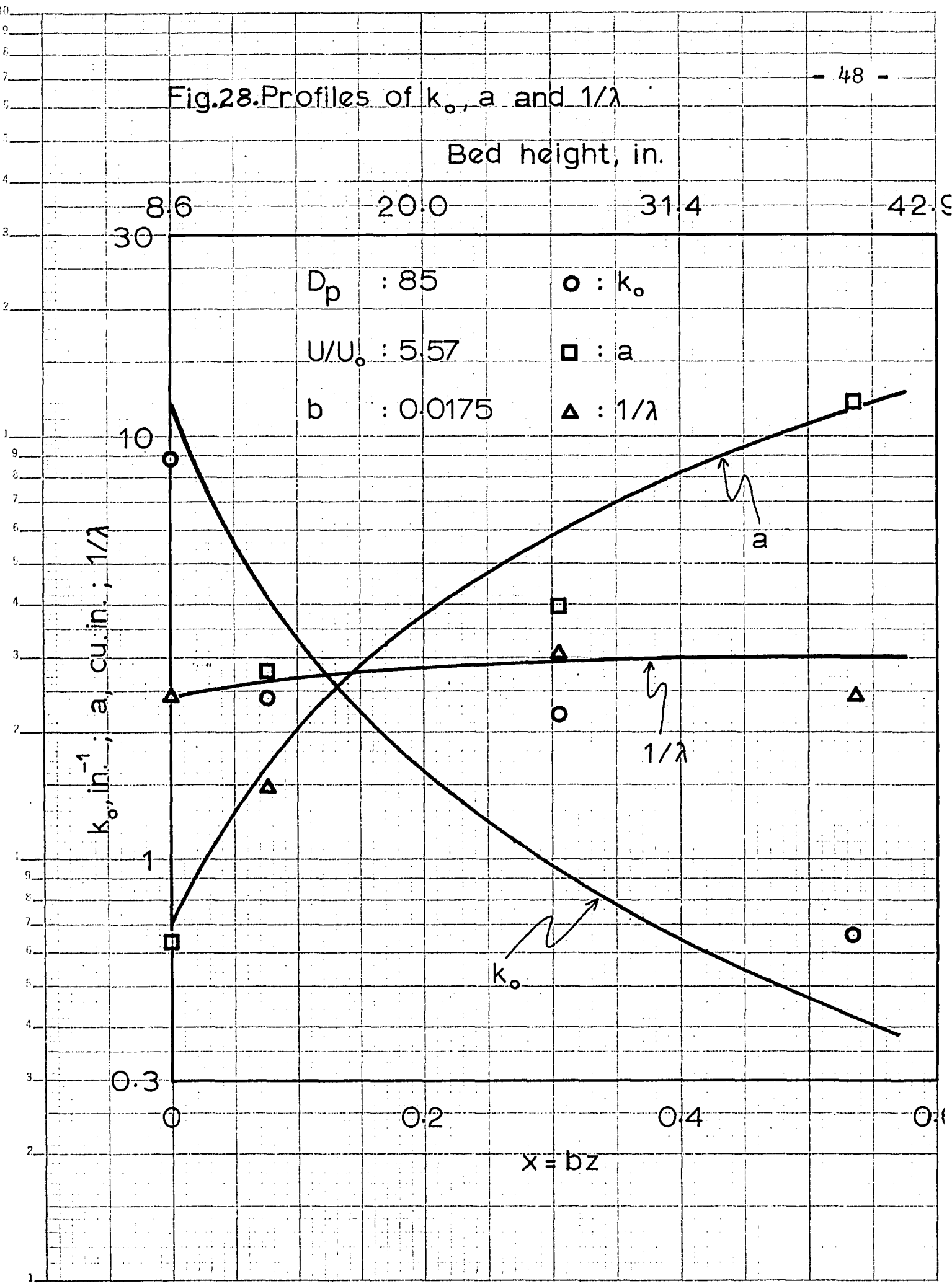
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Fig.27.Profiles of  $k_o$ ,  $a$  and  $1/\lambda$

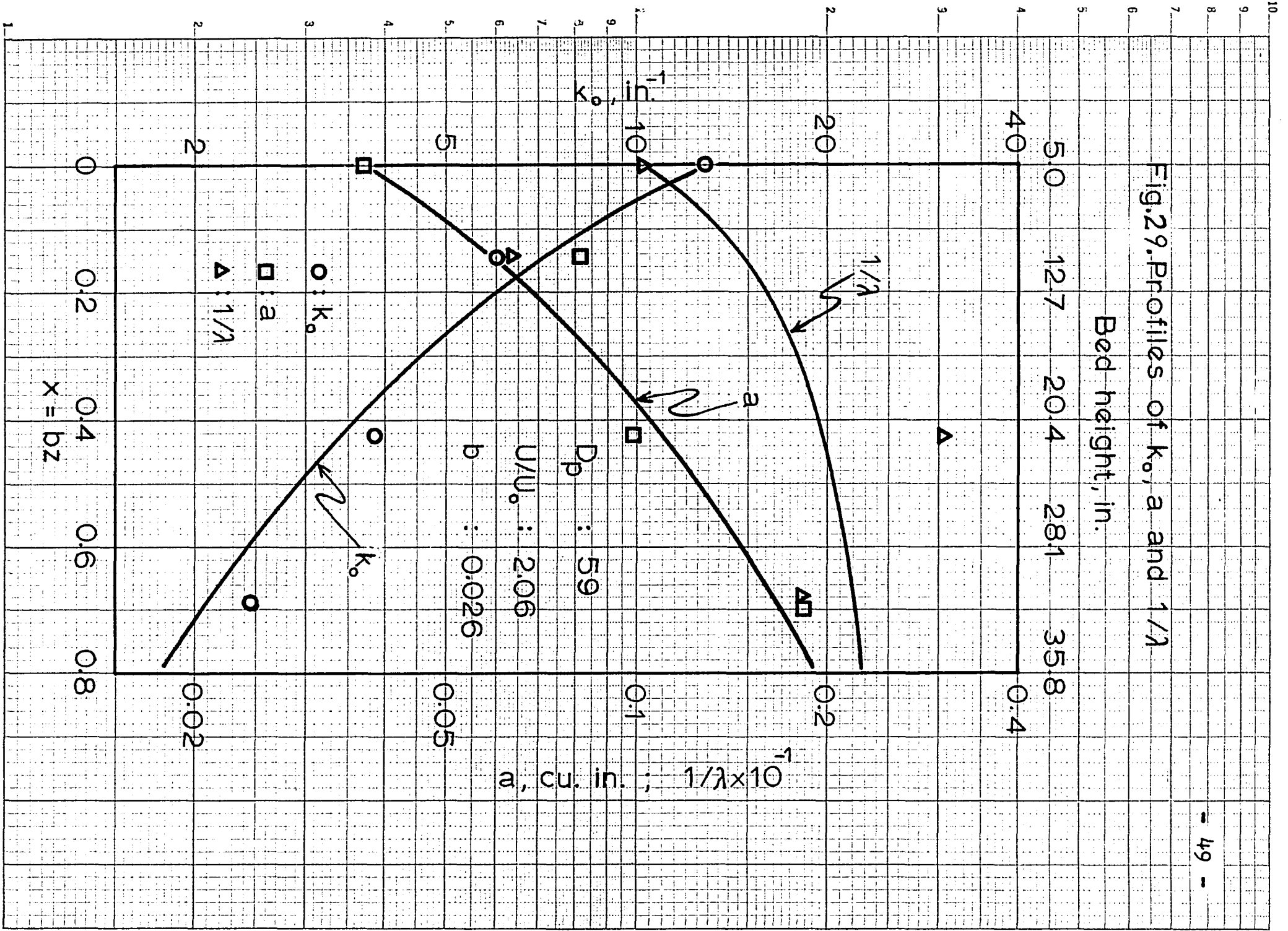


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Fig.28.Profiles of  $k_o$ ,  $a$  and  $1/\lambda$



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According to the interpretation of the proportionality constant B of the collision mechanism given by Shinnar (24), outlined on page b is an estimate of the average value  $m^{1/6} - m',^{1/6}$  multiplied by the collision efficiency . This point, however, needs further investigation and experimental support.

The experimentally obtained values of  $k_0$ , a and  $1/\lambda$  are presented in Tables 10 to 14.

Agreement between experimental and predicted values of  $k_0$  and a was good. The model predicted higher values of  $1/\lambda$  at lower bed heights and a limiting value  $1/\lambda = 3.1$  at higher beds. These limiting value agreed with the experimentally obtained value of  $1/\lambda$  for higher beds. The model appeared to break down at high beds at the higher flow rates. These conditions favor large bubbles where perhaps wall effects become important. This was the reason that in Figures 22, 23 and 26 the points corresponding to the highest bed were not included in the least-squares fit. It was observed that in the experiments with larger particles (200 and 470 microns average particle diameter) bubbles were appearing in randomly distributed locations at the top bed surface. The appearance of a bubble in a certain location was not affected by the location of the other bubbles. However, this was not the case with the smaller size particles (85 microns average particle diameter glass beads and 59

Table 10. EXPERIMENTAL RESULTS

Particles: Glass beads,  $D_p$ : 200 microns,  $U_0$ : 0.149 ft./sec.

<u>Run No.</u>	<u>U</u> <u>ft./sec.</u>	<u>H</u> <u>in.</u>	<u>H<sub>0</sub></u> <u>in.</u>	<u>Shape</u> <u>Factor</u>	<u>k<sub>0</sub></u> <u>in<sup>-1</sup></u>	<u>a</u> <u>cu.in.</u>	<u>1/λ</u>
1	0.209	1.1	1	0.171	1,232	0.0083	0.549
2	"	2.2	2	0.165	245.2	0.034	0.683
3	"	4.4	4	0.170	38.8	0.158	0.978
4	"	13.0	12	0.155	5.93	0.822	1.69
5	"	20.4	19	0.132	2.69	1.77	3.28
6	"	25.8	24	0.133	2.06	2.18	3.32
7	0.346	1.3	1	0.142	268.6	0.0981	0.698
8	"	2.5	2	0.178	32.2	0.500	0.698
9	"	4.8	4	0.146	6.30	2.38	0.807
10	"	9.4	8	0.124	3.14	4.70	1.80
11	"	13.9	12	0.165	1.36	7.49	2.03
12	"	21.7	19	0.163	0.499	17.0	3.16
13	"	27.2	24	0.168	0.385	20.8	3.19

Table 11. EXPERIMENTAL RESULTS

Particles: Glass beads,  $D_p$ : 85 microns,  $U_o$ : 0.0263 ft./sec.

<u>Run No.</u>	<u>U ft./sec.</u>	<u>H in.</u>	<u>Ho in.</u>	<u>Shape Factor</u>	<u><math>k_o</math> in<sup>-1</sup></u>	<u>a cu.in.</u>	<u>1/<math>\lambda</math></u>
14	0.0440	4.2	4	0.1150	69.5	0.0282	1.19
15	"	8.3	8	0.1124	12.5	0.123	1.23
16	"	12.5	12	0.0773	7.49	0.256	1.79
17	"	25.0	24	0.0639	3.65	0.554	2.41
18	"	37.5	36	0.0572	1.58	1.19	3.14
19	0.0587	1.1	1	0.0737	5,823	0.00153	1.29
20	"	4.4	4	0.1174	33.3	0.086	1.12
21	"	8.6	8	0.0634	11.2	0.349	2.68
22	"	12.8	12	0.0751	8.49	0.393	1.95
23	"	25.4	24	0.0751	2.72	1.03	2.17
24	"	38.0	36	0.0719	0.879	2.85	1.72

Table 12. EXPERIMENTAL RESULTS

Particles: Glass beads,  $D_p$ : 85 microns,  $U_0$ : 0.263 ft./sec.

<u>Run No.</u>	<u>U</u> <u>ft./sec.</u>	<u>H</u> <u>in.</u>	<u>H<sub>0</sub></u> <u>in.</u>	<u>Shape</u> <u>Factor</u>	<u>k<sub>0</sub></u> <u>in<sup>-1</sup></u>	<u>a</u> <u>cu.in.</u>	<u>1/λ</u>
25	0.088	0.6	0.5	0.1346	10,021	0.00100	1.28
26	"	1.2	1	0.0746	4,448	0.00316	2.38
27	"	4.5	4	0.1581	50	0.0811	1.51
28	"	13.1	12	0.1243	4.34	0.807	1.83
29	"	26.0	24	0.0681	2.99	1.85	1.42
30	"	38.8	36	0.0489	0.27	20.7	0.34
31	0.117	8.6	8	0.1011	8.27	0.769	1.63
32	"	12.9	12	0.1057	7.60	0.798	1.84
33	"	24.8	24	0.0843	2.15	2.82	1.66
34	"	38.7	36	0.0937	0.224	18.4	0.973
35	0.147	8.7	8	0.1516	8.80	0.634	2.41
36	"	13.1	12	0.1048	2.39	2.76	1.48
37	"	26.2	24	0.0716	2.18	3.95	3.04
38	"	39.2	36	0.0645	0.659	12.0	2.41

Table 13. EXPERIMENTAL RESULTS

Particles: Glass beads,  $D_p$ : 470 microns,  $U_0$ : 0.51 ft./sec.

<u>Run No.</u>	<u>U</u> <u>ft./sec.</u>	<u>H</u> <u>in.</u>	<u>H<sub>0</sub></u> <u>in.</u>	<u>Shape</u> <u>Factor</u>	<u>k<sub>0</sub></u> <u>in<sup>-1</sup></u>	<u>a</u> <u>cu.in.</u>	<u>1/λ</u>
41	0.638	1.2	1	0.474	91.7	0.0934	0.469
42	"	2.4	2	0.345	22.2	0.401	0.896
43	"	4.6	4	0.265	8.70	1.13	0.841
44	"	9.1	8	0.216	2.49	3.87	1.10
45	"	13.5	12	0.204	1.51	6.05	1.84
46	"	26.7	24	0.192	0.467	16.5	3.49
47	"	39.8	36	0.243	0.131	43.2	1.20
48	0.765	1.3	1	0.243	143	0.195	0.687
49	"	2.6	2	0.372	29.7	0.519	0.771
50	"	5.0	4	0.231	7.98	2.31	1.85
51	"	9.7	8	0.185	2.32	7.78	2.31
52	"	14.4	12	0.216	0.781	17.6	1.91
53	"	28.1	24	0.210	0.307	39.2	2.48
54	"	41.6	36	0.272	0.058	140.8	0.751

Table 14. EXPERIMENTAL RESULTS

Particles: Cracking catalyst,  $D_p$ : 59 microns,  $U_0$ : 0.0035 ft./sec.

<u>Run No.</u>	<u>U ft./sec.</u>	<u>H in.</u>	<u>H<sub>0</sub> in.</u>	<u>Shape Factor</u>	<u>k<sub>0</sub> in<sup>-1</sup></u>	<u>a cu.in.</u>	<u>1/λ</u>
56	0.0072	5.0	4.75	0.1380	12.9	0.0369	1.02
57	"	10.5	9.75	0.1215	6.0	0.0812	0.633
58	"	21.2	20.0	0.1355	3.84	0.0982	3.05
59	"	31.5	30.0	0.1060	2.44	0.1843	1.83

microns average particle diameter cracking catalyst). With these two materials bubbles were appearing preferentially in some locations and not in others. This was extremely pronounced in the case of the cracking catalyst. Here the bubbles were appearing in a few locations, always the same, during any one run.

Location of bubbles breaking the top surface of the bed during the run is shown in Figures 30 to 33. In these figures the large circle represents the inside wall of the column and the small circles inside it the locations of the bubble centers. All bubbles counted in each run were included in the corresponding figure. More than one bubbles appearing in the same location are represented by one point in the plot.

Randomness of bubble position at the top bed surface was formally tested by applying the shortest distance test developed by Shinnar and Naor (21). The results of the test are presented in Tables 15 to 18. It is seen that while in all runs with particle size 470 and 200 microns the distribution of bubbles is random, in most of the runs with the 85 microns particles and in the runs with cracking catalyst the distribution of bubbles is not random.

A test of randomness applied to the larger third as well as to the smaller third of the bubbles of a run is shown in Table 19. No preference in location was observed

Figure 30

Run 4. Plot of Bubble Centers  
in the Plane of the Top Bed Surface

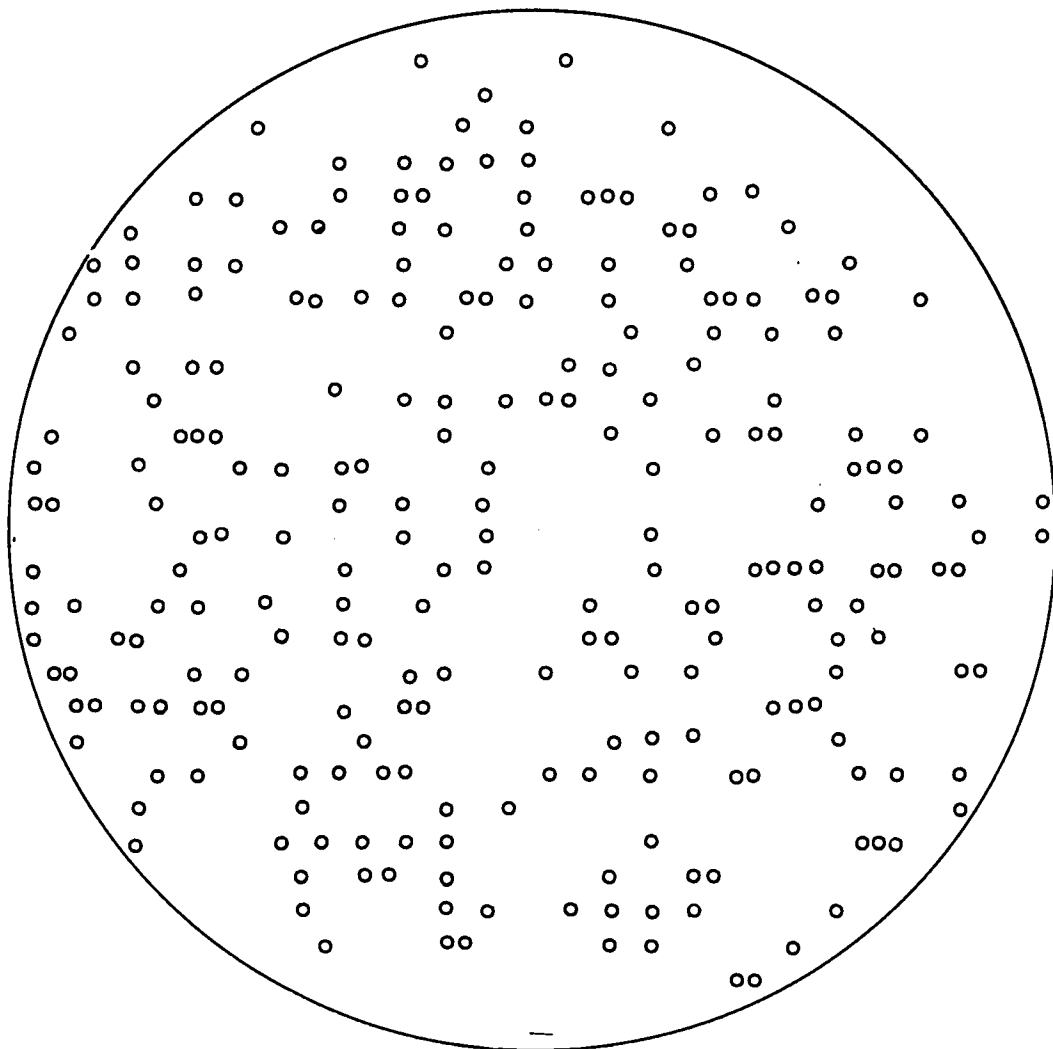


Figure 31

Run 22. Plot of Bubble Centers  
in the Plane of the Top Bed Surface

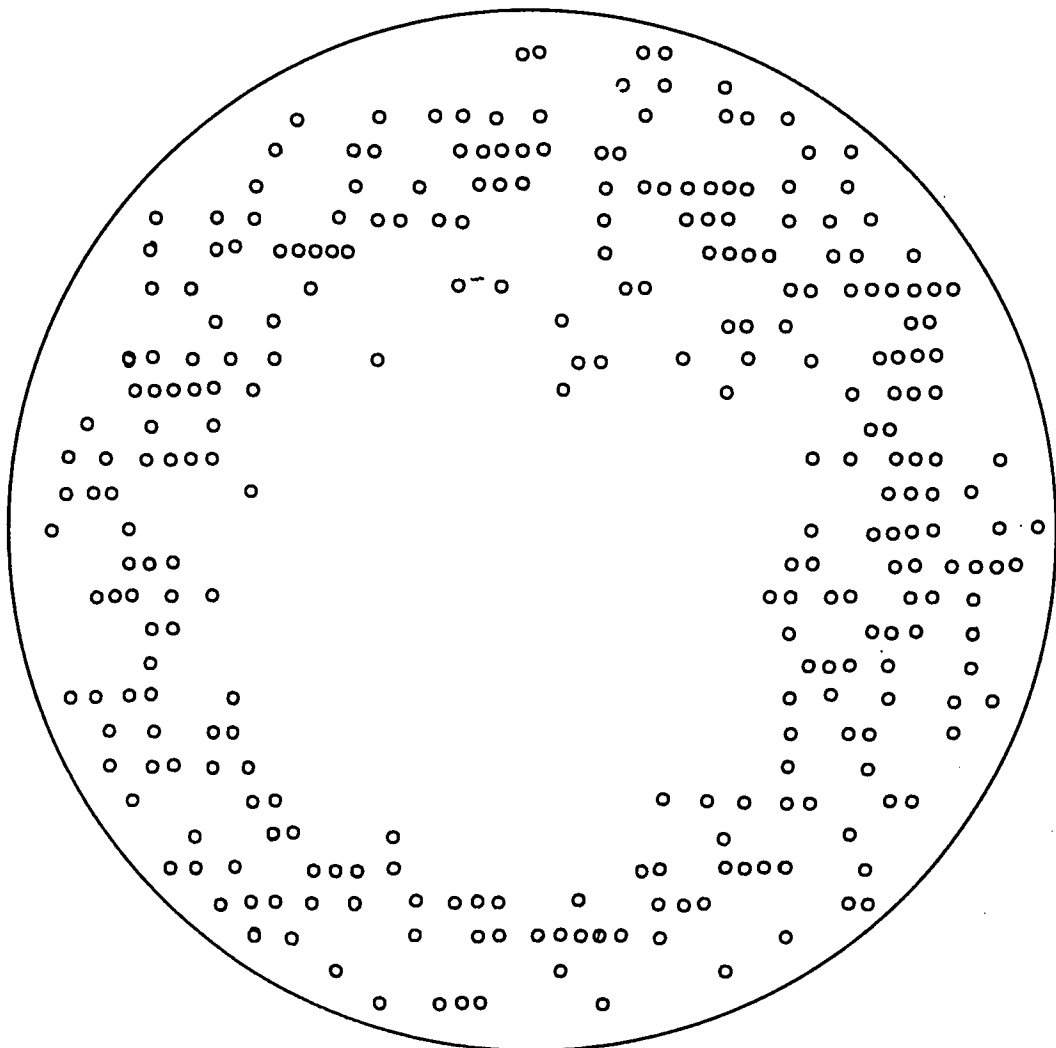


Figure 32

Run 52. Plot of Bubble Centers  
in the Plane of the Top Bed Surface

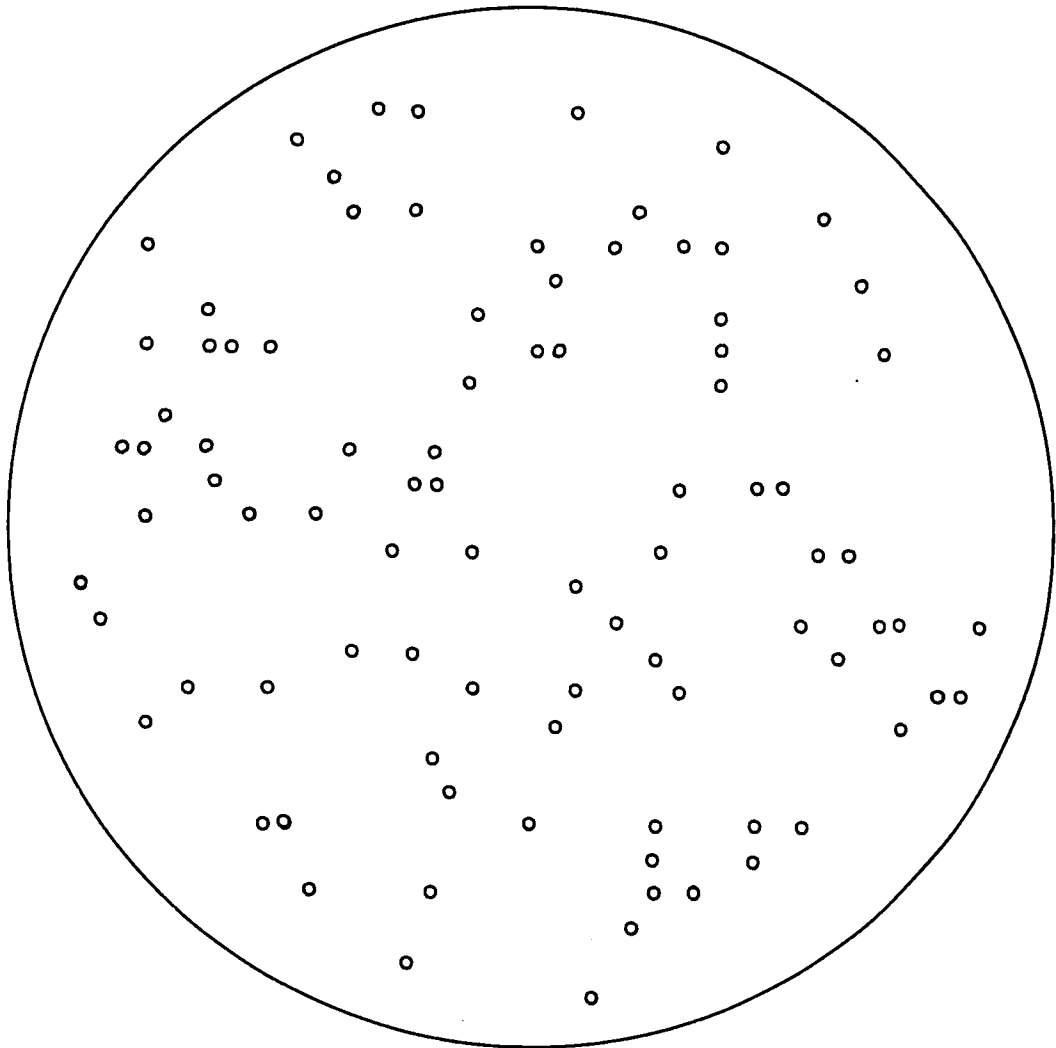


Figure 33

Run 57. Plot of Bubble Centers  
in the Plane of the Top Bed Surface

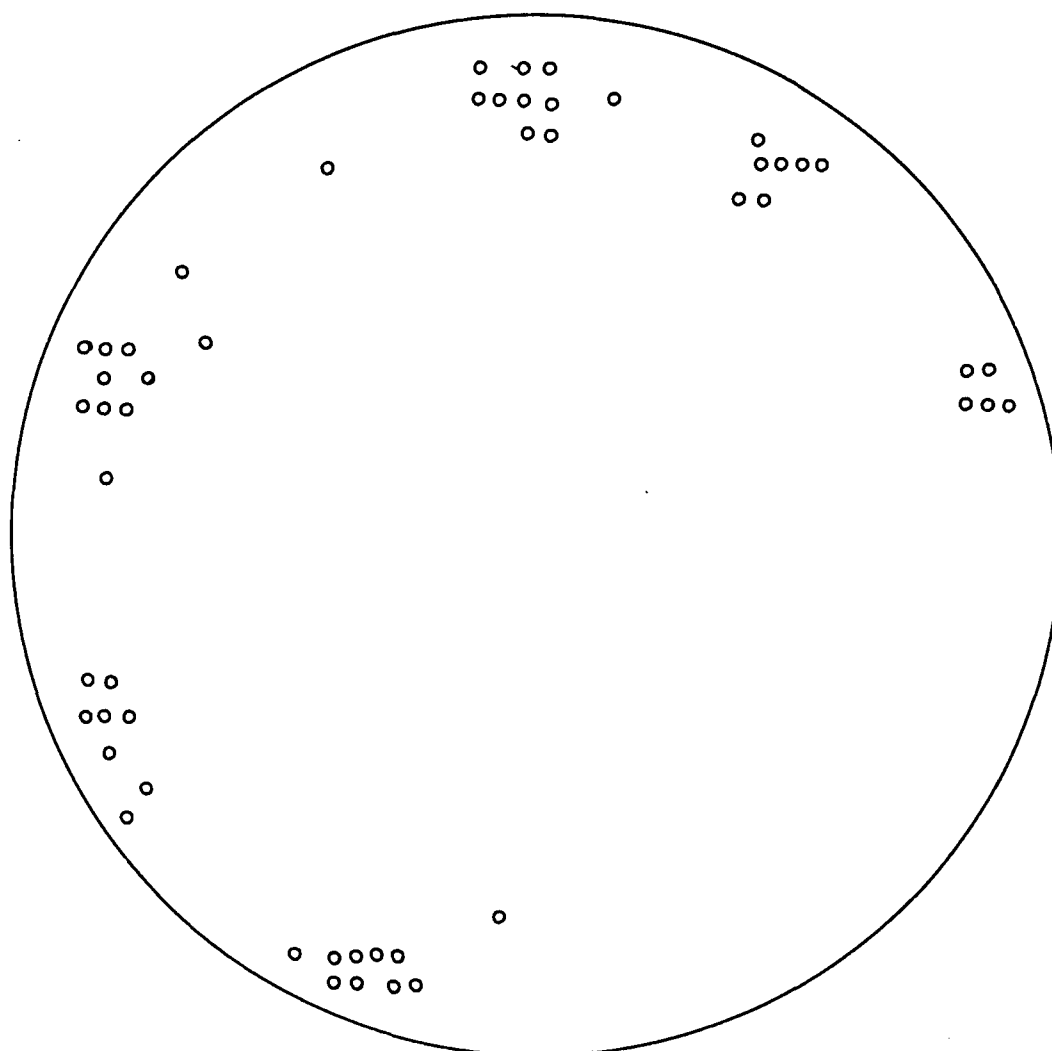


Table 15

SHORTEST DISTANCE TEST OF RANDOMNESS

Particle Size: 200 microns

<u>Run No.</u>	<u>P</u>	<u><math>P^2</math></u>	<u><math>\chi^2_{0.05,2P}</math></u>	<u>Distribution</u>
1	160	292	280	Random
2	186	443	376	"
3	96	240	162	"
4	281	561	500	"
5	162	287	285	"
6	114	119	195	Not random
7	90	232	150	Random
8	62	182	100	Random
9	33	66	47	"
10	48	105	75	"
11	96	188	162	"
12	29	66	40	"
13	31	66	43	"

Table 16

SHORTEST DISTANCE TEST OF RANDOMNESS

Particle Size: 85 microns

<u>Run No.</u>	<u>P</u>	<u><math>\rho^2</math></u>	<u><math>\chi^2_{0.05, 2P}</math></u>	<u>Distribution</u>
14	96	116	162	Not random
15	93	192	157	Random
16	98	172	165	"
17	65	64	105	Not random
18	44	74	67	Random
19	90	100	152	Not random
20	100	175	170	Random
21	114	117	196	Not random
22	374	611	650	" "
23	53	72	85	" "
24	37	57	47	Random
25	90	100	152	Not random
26	116	360	198	Random
27	82	120	137	Not random
28	58	70	93	" "
29	55	80	88	" "
30	15	9.43	20	" "
31	91	142	153	Not random
32	120	223	205	Random
33	76	140	125	"
34	15	24	20	"
35	78	157	130	Random
36	65	102	105	"
37	51	101	80	"
38	24	50	30	"

Table 17

SHORTEST DISTANCE TEST OF RANDOMNESS

Particle Size: 470 microns

<u>Run No.</u>	<u>P</u>	<u><math>\rho^2</math></u>	<u><math>\chi^2_{0.05, 2P}</math></u>	<u>Distribution</u>
41	52	103	82	Random
42	120	264	205	"
43	106	180	182	"
44	99	157	167	"
45	124	203	213	"
46	32	54	45	"
47	11	19	10	"
48	54	158	85	Random
49	105	264	180	"
50	116	212	198	"
51	75	172	123	"
52	94	162	159	"
53	27	68	37	"
54	12	13	10	"

Table 18

## SHORTEST DISTANCE TEST OF RANDOMNESS

Particle Size: 59 microns

<u>Run No.</u>	<u>P</u>	<u><math>\rho^2</math></u>	<u><math>\chi^2_{0.05, 2P}</math></u>	<u>Distribution</u>
56	76	76	125	Not random
57	82	48	137	" "
58	93	43	155	" "
59	71	79	116	" "

for the larger or the smaller bubbles as compared to all the bubbles of the run.

Table 20 summarizes the flow rates employed in the experiments in order of increasing fluidizing velocity. It is clear that randomness of location is more pronounced at higher fluidizing velocities. Perhaps the pressure drop through the support or the ratio of this pressure drop to the the total pressure drop through the bed is related to randomness of bubble locations. However, the data of the present research do not allow firm conclusions with regard to cause of randomness—non-randomness, and this could be a worthwhile area for future work.

The fifth column of Table 20 lists the ratio of flow rate passing through the bed in the form of bubbles to the

Table 19

SHORTEST DISTANCE TEST OF RANDOMNESS  
ON LARGEST AND SMALLEST BUBBLES

$D_p = 200$  microns

<u>Run No.</u>	<u>Fraction Examined</u>	<u>P</u>	<u><math>P^2</math></u>	<u><math>\chi^2_{0.05, 2P}</math></u>	<u>Distribution</u>
4	All bubbles	281	561	500	Random
	1/3 largest	93	170	155	"
	1/3 smallest	84	208	139	"
11	All bubbles	96	188	162	Random
	1/3 largest	28	28	40	Not random
	1/3 smallest	28	57	40	Random

Table 20

DEPENDANCE OF LOCATION ON PARTICLE SIZE AND FLOW RATE

<u>Particle Size microns</u>	<u>Flow Rate cu.ft./sec.</u>		<u><math>F_b/F</math></u>	<u>Number of Runs</u>	
	<u><math>F_0</math></u>	<u>F</u>		<u>Random Distrib.</u>	<u>Non-random Distribution</u>
59	0.0025	0.0052	0.51	0	4
85	0.019	0.0318	0.41	3	2
		0.0425	0.56	2	4
		0.0635	0.71	1	5
		0.0865	0.78	3	1
		0.108	0.83	4	0
200	0.107	0.151	0.287	5	1
		0.250	0.570	7	0
400	0.368	0.460	0.20	7	0
		0.552	0.33	7	0

total flow rate. It is seen that randomness is independent of this ratio, i.e. randomness in the distributions of bubbles in the top surface of the bed occurs at high as well as at low values of this ratio. This in turn indicates that maldistribution of pore sizes of the support plate alone could not explain the observed cases of randomness and non-randomness.

Bubbling frequency was found to decrease at higher flow rates and at higher beds. This was noticed by observing the fluidized bed. It may also be seen by studying the data presented as Part B in Appendix A. For comparable time intervals the number of bubbles counted at higher beds and at higher flow rates is much smaller than the corresponding numbers at lower beds at lower flow rates.

Bubbling frequency has a strong effect on the flow rate of the gas exiting the fluidized bed and on the ratio of flow rate due to bubbles to that due to particulate fluidization. The relative effects may be seen by examining beds of various heights.

Figures 34 to 39 are plots of air flow rate exiting the bed in form of bubbles, as a function of time in fluidized beds of 4, 12, and 36 inches settled bed height, at two fluidization velocities. Fluidized particles were the same in all cases. It is seen that as the bed height is increasing the fluctuations of bubble flow rate about the mean

Fig.34. Time dependent bubble flow rate

Run 43,  $D_p : 470 \mu$ ,  $H : 4.6 \text{ in.}$ ,  $U : 0.638 \text{ ft./sec.}$

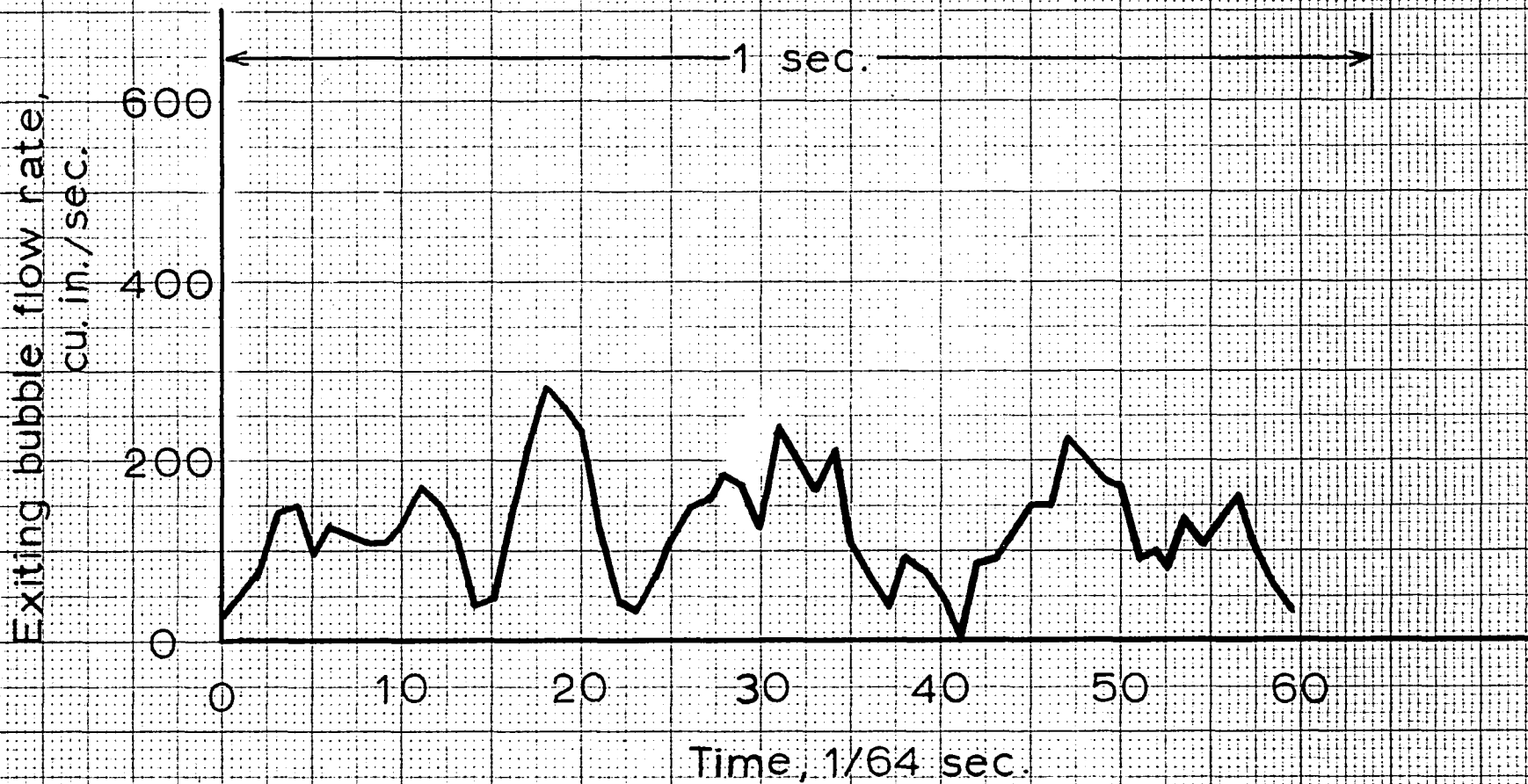
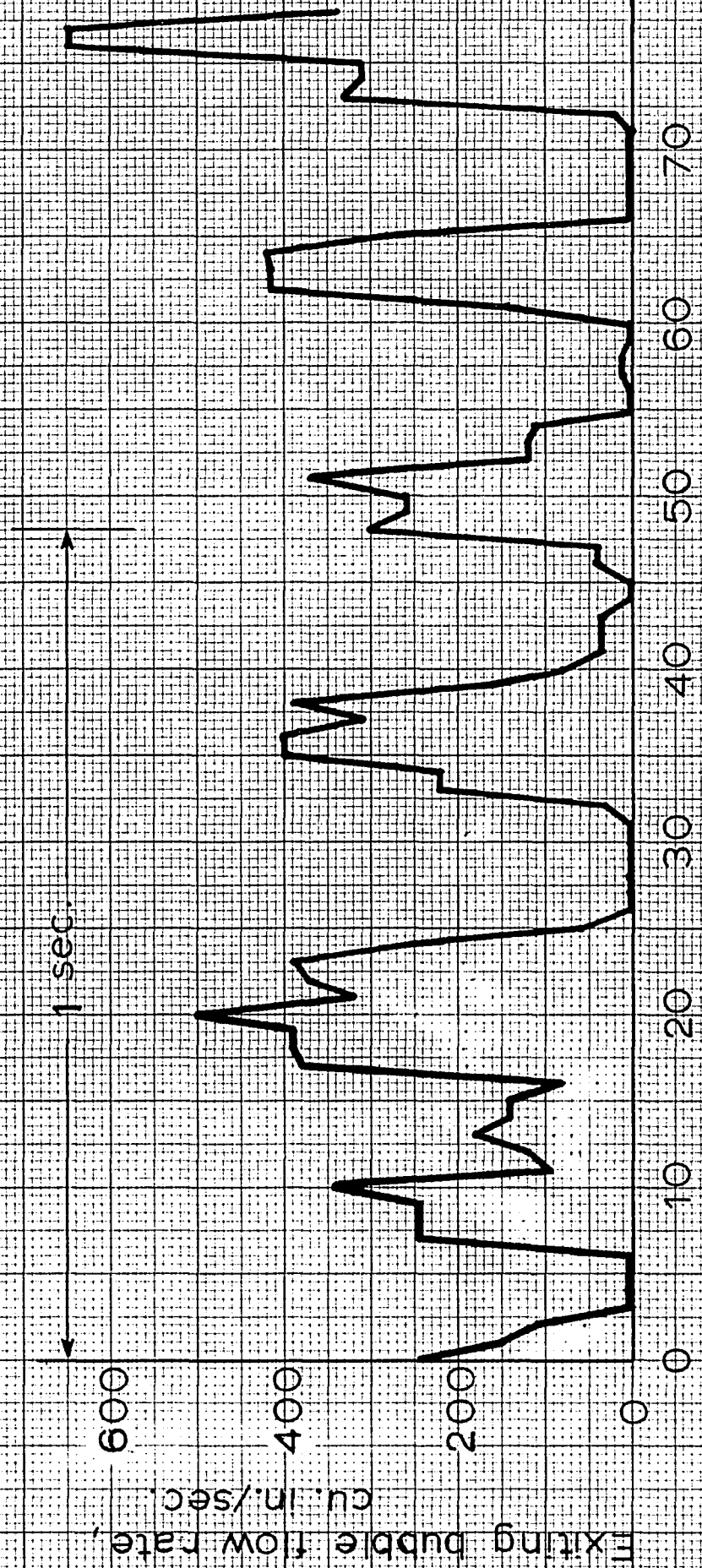


Fig.35. Time dependent bubble flow rate

Run 45,  $D_p$ : 470  $\mu$ ., H: 13.5 in., U: 0.638 ft./sec.



Time, 1/48 sec.

Fig.36. Time dependent bubble flow rate

Run 47, D : 470  $\mu$ , H : 39.8 in., U : 0.638 ft./sec.

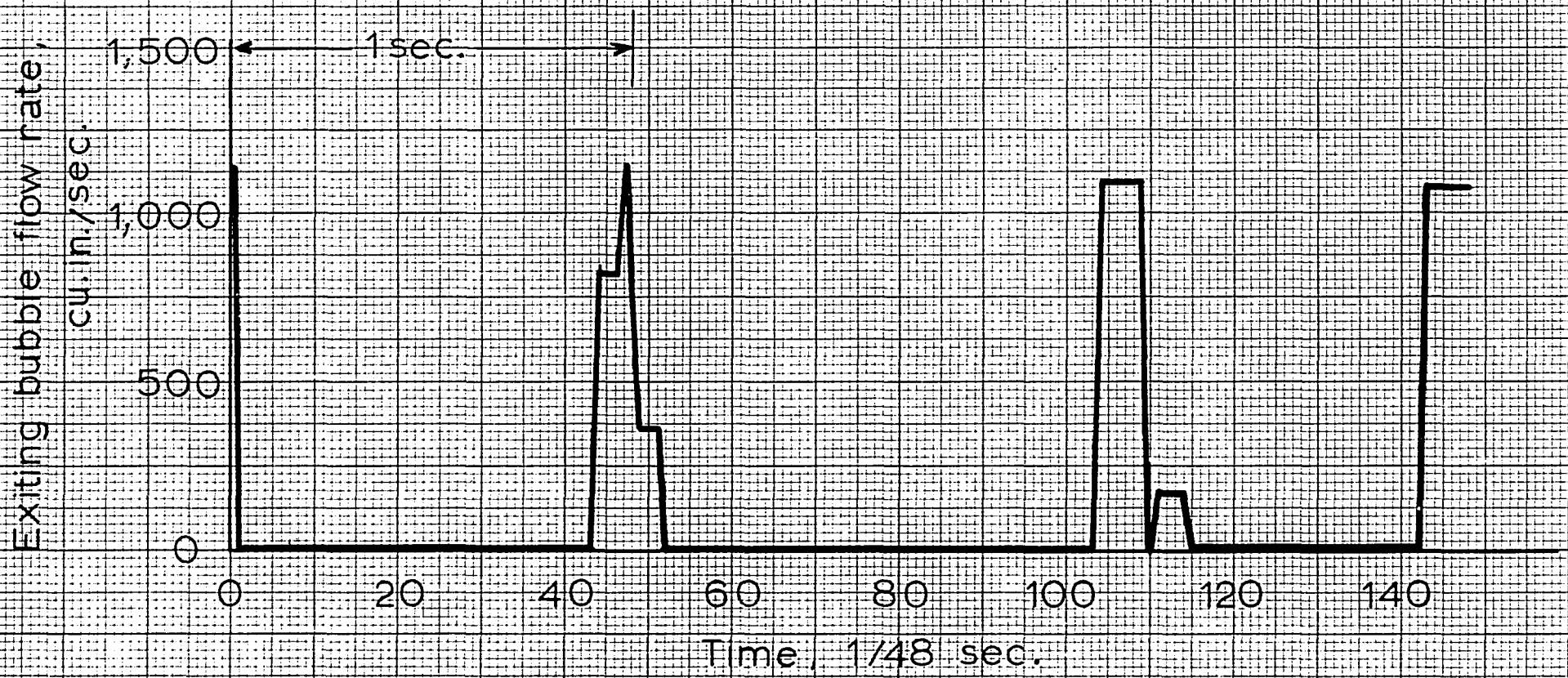


Fig.37. Time dependent bubble flow rate

Run 50,  $D_p : 470 \mu.$ ,  $H : 5.0 \text{ in.}$ ,  $U : 0.765 \text{ ft./sec.}$

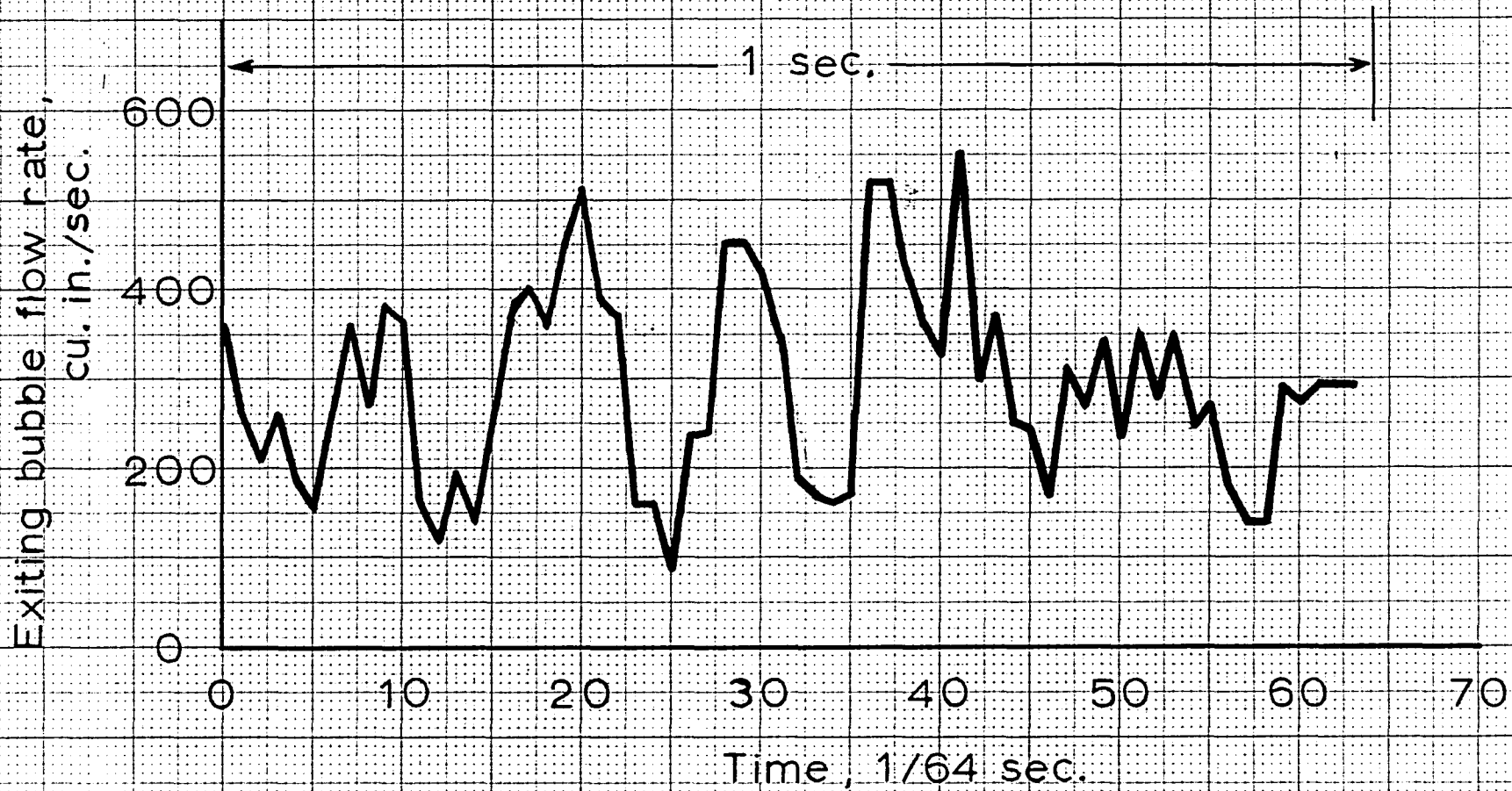


Fig.38. Time dependent bubble flow rate

Run 52,  $D_p$  : 470  $\mu$ , H : 14.4 in., U : 0.765 ft./sec.

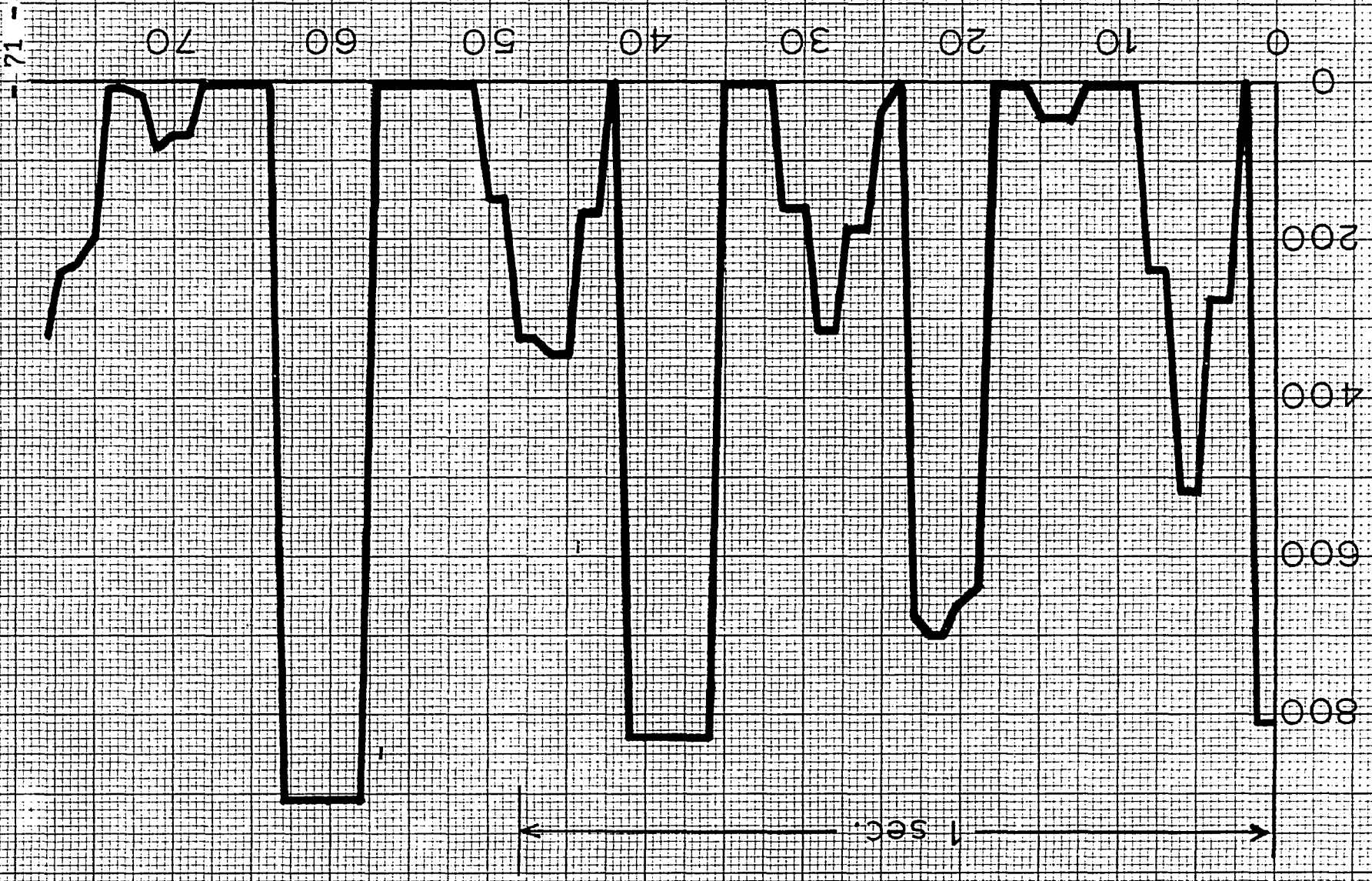
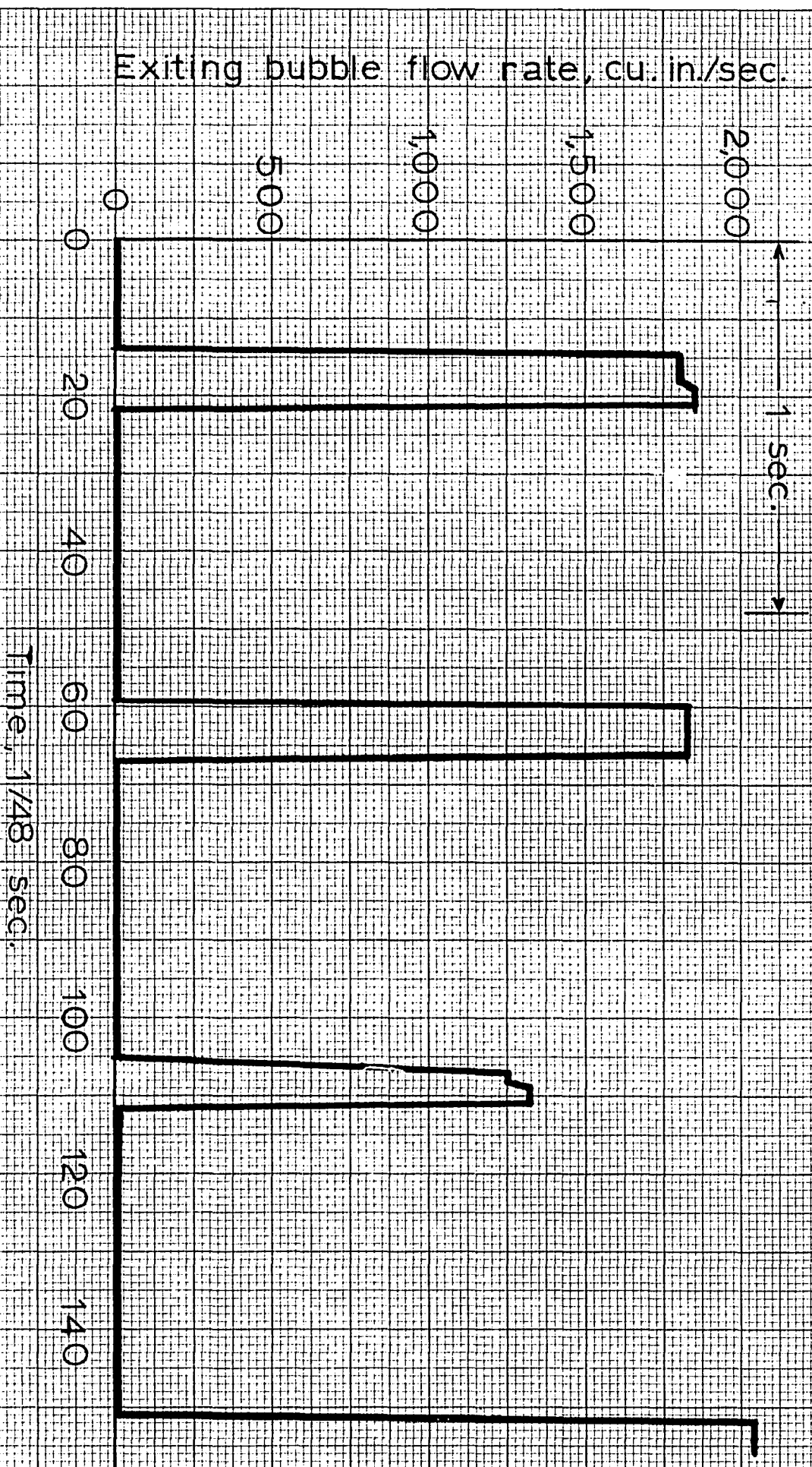


Fig.39. Time dependent bubble flow rate

Run 54,  $D_p$  : 470  $\mu$ , H : 41.6 in., U : 0.765 ft./sec.



become stronger and less frequent and at the higher beds the bubble flow rate is intermittent.

In Figures 34 to 39 the instantaneous value of the exiting gas flow rate contributed by bubbles was calculated by assuming the bubbles to be cylinders of volume equal to the bubble volume  $V$  with their axis of symmetry in the vertical direction. The diameter of the cylinder was taken equal to the diameter of a sphere of volume  $V$ .

This assumption was made because the exact shape of bubbles exiting the bed is not known. The results of Table 6 indicate that a bubble exiting the bed is flattened in comparison to the same bubble within the bed. That would put the above calculations on the conservative side and most likely the actual flow rate fluctuates stronger about the mean than what is shown in the plots of Figures 34 to 39.

## CONCLUSIONS

The method of determining bubble volume by taking motion pictures of the top surface of the bed and measuring the diameter of the bubble breaking the surface is a convenient way of studying bubble growth in gas fluidized beds. However, determination of a shape factor for the material used, relating the diameter of the bubbles breaking surface to the bubble volume, is necessary.

Experiments conducted under varying conditions of bed height, fluidizing velocity and particle size yielded valuable information on bubble size and the distribution of sizes of bubbles. It was observed that the total number of bubbles per unit bed height was rapidly decreasing at increasing bed heights, while the mean bubble volume was increasing at a correspondingly fast pace.

The experimentally obtained distributions of bubble volumes at any given set of conditions were expressed in the form of a gamma distribution. This was proved to be a suitable way of representing the experimental distributions. The three parameters of the distribution represent the total number of bubbles per unit bed height, the mean bubble volume and the variance of bubble volumes divided by the squared mean. Experimentally the effect of bed height on

the distribution was examined by observing the profiles of the three parameters as they evolved with bed height.

Distribution of location of bubbles appearing at the top bed surface was different for the larger and smaller particles. No satisfactory explanation was found. The argument that either non-uniform distribution of sizes of pores in the support plate or low pressure drops through the support plate causes this behavior was rejected. Jackson's (18) stability analysis of the state of uniform fluidization agrees with the observations at least qualitatively.

The mechanism of molecular collisions employed in the kinetic theory of gases (22) was used to establish a model of bubble growth by coalescence in gas fluidized beds. With the assumption that the parameters which describe the bubble population at a given elevation in the apparatus are independent of the fact whether or not a bed exists above this elevation, the model successfully predicted the average bubble size and the number of bubbles per unit bed height for small to moderate bubble sizes. The model did not hold for large bubbles where the bubble diameter was approaching that of the column.

The model predicted that  $1/\lambda$  approaches a limiting value very fast, i.e. after a short distance from the support plate the distribution of bubble sizes should remain constant. The experiments, however, indicated that even though

$1/\lambda$  tends to the limiting value predicted by the model, the approach is more gradual. This may be attributed to the difference between collisions in the sense of the kinetic theory of gases on the one hand, and the more complex and not yet well understood process of bubble coalescence.

In the cases studied, the proportionality constant B of the bubble coalescence mechanism appears to be independent of gas flow rate, of particle size and of bubble size. This is a striking result, for one might have reasonably expected the "influence" of a bubble upon its neighbors to extend for a distance which depends upon one or more of these factors. Apparently, however, the rate of coalescence of two bubbles depends only upon geometric factors.

The oscillating nature of the bubble flow rate exiting the bed should be taken into account in experimental studies of mixing in fluidized beds. "Frequency response" and "residence time distribution" techniques should be used with caution and with understanding of the effect that fluctuations in bubble flow rate might have on the outcome of the experiments.

A striking feature of a bubbling, gas-fluidized bed observed in this investigation was the fast rate of bubble growth. The number of bubbles per unit bed height was found to decrease by three or more orders of magnitude over three

feet of bed height, while the average bubble volume increased by an equivalent amount.

Growth by coalescence therefore is an important process in the "life" of a bubble as it moves up the bed. This should be kept in mind in setting up models of bubbling gas fluidized beds for purposes of mass or heat transfer, or chemical reaction between gas and fluidized particles, instead of the present trend of considering the bubbles all of the same size, uniformly distributed throughout the bed.

## RECOMMENDATIONS

In order to develop a more sophisticated mechanism of bubble growth by coalescence, more information is needed on the nature of bubble coalescence, along the lines followed by Harrison and Leung (13) and Botterill and George (22). With this at hand a mechanism of coalescence could be set up on first principles which in turn would cast light on the physical significance of the proportionality constant, B.

A theory on bubble formation extending beyond the infinitesimal disturbance stage is needed in setting up initial conditions to be used with the model equations.

This work should be extended to cover a range of particle properties, especially density, and gas properties such as density and viscosity.

The influence of the support plate on randomness of bubble locations and in general the causes of non-randomness should be investigated by appropriate experimentation.

NOMENCLATURE

- a : Mean bubble volume, cu.in.
- A : Constant in the velocity expression (E4), in.<sup>1/2</sup>/sec.
- B : Proportionality constant in the collision mechanism,  
in.<sup>-1</sup>sec.<sup>-1</sup>
- b : Parameter of the model, in.<sup>-3/2</sup>
- C' : Shape factor relating bubble volume to the diameter  
of the bubble breaking surface
- C : Shape factor averaged for the material
- d : Diameter of bubble breaking the top surface of the  
bed, in.
- D<sub>p</sub> : Average particle diameter, microns
- f : Number density of bubbles, in.<sup>-4</sup>
- F : Gas flow rate, cu.in./sec.
- F<sub>0</sub> : Gas flow rate at incipient fluidization, cu.in./sec.
- G : Incomplete gamma function
- h : Source function, in.<sup>-4</sup>sec.<sup>-1</sup>
- H : Bed height, in.
- H<sub>0</sub> : Settled bed height, in.
- I : Total number of different bubble sizes in a run
- k<sub>0</sub> : Number of bubbles per unit bed height, in.<sup>-1</sup>
- L : Associate Laguerre polynomials
- m : Bubble volume, cu.in.
- n<sub>1</sub> : Number of bubbles of diameter d<sub>1</sub>
- N<sub>1</sub> : Number of bubbles of diameter d<sub>1</sub> per unit bed height, in.<sup>-1</sup>
- P : Total number of bubbles counted in a run

- $p$  : Gamma distribution  
 $r_f$  : Rate of bubble formation by coalescence,  $\text{in.}^{-4}\text{sec.}^{-1}$   
 $r_e$  : Rate of disappearance of bubbles because of collisions,  $\text{in.}^{-4}\text{sec.}^{-1}$   
 $t$  : Time coordinate, sec.  
 $T$  : Time interval of a run, sec.  
 $U$  : Superficial air velocity, ft./sec.  
 $U_0$  : Superficial air velocity at incipient fluidization, ft./sec.  
 $V$  : Bubble velocity, in./sec.  
 $x$  : Transformed space coordinate ( $=bz$ ),  $\text{in.}^{-5/2}$   
 $z$  : Space coordinate, in.  
 $r_i$  : Center-to-center distance of the  $i$ th bubble to its nearest neighbor, in.

Greek Letters

- $\Gamma$  : Gamma function  
 $\lambda$  : Dependent variable, related to the variance of bubble volumes, defined by equation (M12c)  
 $\mu_j$  :  $J$ th moment of  $m$ , defined by equation (M6)  
 $\rho^2$  :  $2\pi \frac{P}{104} \sum_{i=0}^P r_i^2$   
 $\chi^2_{1-\alpha, n}$  : Value of the  $\chi^2$  distribution with  $n$  degrees of freedom, exceeded with probability  $\alpha$ .  
 $\Psi$  : Digamma function

APPENDIX A

EXPERIMENTAL DATA

RUN 1 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	200	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.149	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.209	FT./SEC.
BED HEIGHT	1.1	IN.
SETTLED BED HEIGHT	1.0	IN.
PRESSURE DROP THROUGH BED	3.5	CM. OF WATER
AIR TEMPERATURE	82	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	64	FRAMES/SEC.
DURATION OF RUN	0.021	SEC.

RUN 1 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	8.7	8.4	0.26
2	1	8.7	7.9	0.26
3	1	9.6	7.1	0.19
4	1	9.7	7.4	0.19
5	1	9.5	7.3	0.19
6	1	8.6	8.4	0.26
7	1	8.6	8.1	0.26
8	1	8.3	8.3	0.26
9	1	8.3	7.8	0.26
10	1	10.2	6.4	0.26
11	1	10.4	5.8	0.38
12	1	10.0	5.9	0.44
13	1	9.7	6.3	0.31
14	1	9.8	5.6	0.38
15	1	10.7	5.4	0.38
16	1	10.0	5.2	0.38
17	1	9.5	5.3	0.38
18	1	10.4	5.0	0.38
19	1	8.0	6.2	0.38
20	1	8.3	5.5	0.26
21	1	8.1	5.8	0.31
22	1	7.9	5.5	0.31
23	1	8.1	4.9	0.45
24	1	9.7	2.8	0.51
25	1	8.0	2.6	0.41
26	1	8.6	2.1	0.38
27	1	8.7	1.7	0.38
28	1	9.1	1.3	0.38
29	1	7.7	1.1	0.38
30	1	6.1	9.1	0.45
31	1	6.5	8.1	0.35
32	1	6.3	7.5	0.45
33	1	7.7	5.2	0.31
34	1	7.5	4.3	0.32
35	1	6.4	4.2	0.32
36	1	7.3	2.4	0.38
37	1	5.9	3.7	0.51
38	1	5.5	3.5	0.51
39	1	5.3	3.2	0.44
40	1	6.3	2.4	0.51

RUN 1 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	1	5.8	3.6	0.58
42	1	7.7	2.2	0.31
43	1	7.2	2.0	0.38
44	1	6.4	1.7	0.26
45	1	6.0	1.8	0.48
46	1	6.6	0.5	0.26
47	1	5.2	1.3	0.38
48	1	5.6	1.0	0.38
49	1	5.4	0.4	0.38
50	1	3.7	3.9	0.31
51	1	4.9	3.9	0.29
52	1	4.3	3.5	0.31
53	1	4.5	3.1	0.45
54	1	4.9	2.7	0.38
55	1	3.2	3.2	0.26
56	1	3.2	2.7	0.29
57	1	2.6	1.4	0.32
58	1	0.8	6.6	0.32
59	1	0.6	6.1	0.26
60	1	0.3	6.2	0.38
61	1	1.7	7.2	0.26
62	1	0.6	4.9	0.32
63	1	0.9	7.4	0.51
64	1	1.3	6.4	0.51
65	1	1.8	6.0	0.45
66	1	2.2	5.7	0.38
67	1	0.3	5.2	0.36
68	1	2.4	4.4	0.45
69	1	1.8	3.7	0.26
70	1	1.8	3.3	0.26
71	1	0.8	4.4	0.38
72	1	0.8	3.1	0.26
73	1	1.8	2.7	0.32
74	1	1.3	2.9	0.32
75	2	9.9	4.8	0.38
76	2	11.3	6.1	0.44
77	2	9.3	6.8	0.45
78	2	11.2	5.2	0.38
79	2	9.3	6.3	0.38
80	2	9.5	4.9	0.26

## RUN 1 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	2	8.9	4.7	0.38
82	2	8.1	3.6	0.32
83	2	8.5	3.5	0.38
84	2	9.1	2.7	0.36
85	2	8.7	2.7	0.40
86	2	8.9	1.3	0.31
87	2	7.9	3.4	0.38
88	2	8.9	1.7	0.26
89	2	8.2	1.7	0.44
90	2	8.2	1.0	0.38
91	2	6.8	2.4	0.38
92	2	6.6	9.1	0.45
93	2	7.2	7.7	0.31
94	2	6.9	7.7	0.26
95	2	6.5	7.0	0.38
96	2	6.7	5.9	0.26
97	2	6.8	5.4	0.26
98	2	6.9	5.6	0.36
99	2	6.8	4.8	0.38
100	2	7.2	5.1	0.26
101	2	6.0	6.4	0.63
102	2	6.1	7.1	0.38
103	2	5.3	6.2	0.49
104	2	5.3	5.8	0.44
105	2	5.4	5.4	0.51
106	2	5.4	4.9	0.36
107	2	5.8	4.2	0.32
108	2	5.6	4.3	0.38
109	2	5.2	3.9	0.38
110	2	6.4	3.6	0.41
111	2	7.2	3.2	0.44
112	2	5.9	1.4	0.51
113	2	6.3	1.3	0.51
114	2	5.5	2.2	0.44
115	2	4.5	9.4	0.31
116	2	4.7	9.1	0.45
117	2	3.0	7.7	0.41
118	2	2.9	7.3	0.45
119	2	3.3	6.5	0.38
120	2	3.1	6.6	0.51

RUN 1 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
121	2	4.2	6.4	0.51
122	2	3.0	5.3	0.38
123	2	3.1	5.6	0.44
124	2	3.7	5.4	0.26
125	2	4.7	5.1	0.27
126	2	4.0	4.2	0.31
127	2	3.1	5.6	0.38
128	2	3.1	5.9	0.38
129	2	3.3	5.0	0.32
130	2	2.9	5.1	0.51
131	2	3.6	6.1	0.64
132	2	2.7	4.4	0.38
133	2	2.7	3.8	0.38
134	2	2.7	3.3	0.31
135	2	5.1	2.1	0.35
136	2	3.3	1.2	0.26
137	2	2.9	1.2	0.32
138	2	3.6	1.9	0.26
139	2	2.9	1.5	0.26
140	2	2.8	2.2	0.26
141	2	2.7	2.6	0.31
142	2	3.2	3.6	0.26
143	2	3.8	3.1	0.31
144	2	4.2	3.2	0.26
145	2	4.3	2.9	0.31
146	2	1.5	8.1	0.32
147	2	1.1	8.5	0.38
148	2	1.1	7.9	0.45
149	2	2.4	7.5	0.45
150	2	1.5	7.6	0.45
151	2	1.9	4.5	0.31
152	2	1.5	4.5	0.32
153	2	2.2	1.5	0.38
154	2	1.8	9.1	0.38
155	2	1.4	8.7	0.51
156	2	0.4	6.6	0.45
157	2	2.3	6.9	0.51
158	2	1.7	6.8	0.44
159	2	2.2	6.3	0.49
160	2	2.1	4.9	0.38

RUN 2 PART A

PARTICLES

GLASS BEADS

AVERAGE PARTICLE DIAMETER

200

MICRONS

INCIPIENT FLUIDIZATION VELOCITY,  
SUPERFICIAL

0.149

FT./SEC.

FLUIDIZATION VELOCITY, SUPERFICIAL

0.209

FT./SEC.

BED HEIGHT

2.2

IN.

SETTLED BED HEIGHT

2.0

IN.

PRESSURE DROP THROUGH BED

4.5

CM. OF WATER

AIR TEMPERATURE

82

DEGREES F.

CAMERA

200 EE

CAMERA SPEED

64

FRAMES/SEC.

DURATION OF RUN

0.100

SEC.

RUN 2 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	2	7.9	10.4	0.70
2	2	10.5	6.6	0.44
3	2	9.3	6.1	0.64
4	2	9.7	3.8	0.57
5	2	5.5	10.4	0.51
6	2	5.2	8.9	0.66
7	2	5.9	3.1	0.51
8	2	6.9	7.8	0.76
9	2	4.5	9.1	0.64
10	2	3.8	8.7	0.54
11	2	4.0	9.3	0.49
12	2	2.9	8.2	0.70
13	2	4.5	6.3	0.64
14	2	4.0	6.4	0.38
15	2	5.0	2.4	0.51
16	2	4.5	1.7	0.89
17	2	0.8	6.8	0.44
18	2	1.8	5.8	0.51
19	2	0.4	6.0	0.70
20	2	0.9	5.8	0.64
21	2	1.5	8.7	0.64
22	3	8.7	10.5	0.51
23	3	9.1	9.5	0.38
24	3	8.8	9.8	0.45
25	3	8.3	8.6	0.51
26	3	9.3	7.8	0.38
27	3	8.6	6.4	0.49
28	3	7.9	6.4	0.38
29	3	10.7	4.3	0.38
30	3	10.5	3.6	0.51
31	3	9.6	2.9	0.76
32	3	8.1	3.8	0.38
33	3	7.8	2.7	0.70
34	3	9.7	2.2	0.89
35	3	8.6	1.5	0.70
36	3	8.3	0.9	0.70
37	3	6.0	9.8	0.77
38	3	6.5	10.1	0.26
39	3	7.0	9.6	0.51
40	3	7.2	8.8	0.51

RUN 2 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	3	6.1	8.7	0.38
42	3	5.2	9.6	0.51
43	3	5.6	8.2	0.26
44	3	7.2	7.0	0.51
45	3	7.5	6.4	0.51
46	3	6.0	6.3	0.45
47	3	7.0	5.1	0.58
48	3	2.8	9.6	0.51
49	3	5.0	1.2	0.64
50	3	4.2	10.2	0.83
51	3	2.8	2.9	0.64
52	3	3.6	1.8	0.51
53	3	1.2	7.9	0.49
54	3	2.3	2.4	0.38
55	3	2.0	3.1	0.51
56	3	0.5	4.9	0.51
57	3	0.9	3.2	0.57
58	3	1.3	7.7	0.51
59	4	9.1	8.9	0.89
60	4	7.9	9.5	0.38
61	4	8.9	7.9	0.51
62	4	9.3	6.1	0.26
63	4	9.7	4.0	0.38
64	4	5.5	6.5	0.57
65	4	6.3	6.8	0.51
66	4	7.0	10.5	0.44
67	4	6.9	5.6	0.51
68	4	6.6	6.4	0.38
69	4	7.4	4.7	0.51
70	4	5.5	4.2	0.57
71	4	5.8	3.2	0.77
72	4	6.8	2.9	0.51
73	4	6.3	1.3	0.89
74	4	2.9	1.9	0.70
75	4	2.9	8.2	0.58
76	4	2.7	6.1	0.51
77	4	3.7	5.5	0.76
78	4	2.9	5.6	0.59
79	4	4.7	5.4	0.51
80	4	1.3	3.8	0.89

RUN 2 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	4	2.4	8.7	0.38
82	4	0.8	4.1	0.83
83	5	10.5	8.7	0.63
84	5	8.0	8.4	0.31
85	5	9.3	7.8	0.38
86	5	11.1	6.4	0.44
87	5	8.9	6.1	0.51
88	5	9.2	5.6	0.57
89	5	11.0	4.9	0.44
90	5	8.7	4.2	0.45
91	5	8.6	3.1	0.64
92	5	8.1	3.7	0.76
93	5	9.2	2.4	0.51
94	5	10.4	8.3	0.76
95	5	9.7	8.6	0.44
96	5	5.4	5.2	0.51
97	5	7.7	10.7	0.77
98	5	6.6	10.0	0.51
99	5	5.4	7.3	0.51
100	5	6.8	6.4	0.70
101	5	7.5	1.8	0.68
102	5	6.5	0.8	0.70
103	5	7.0	0.9	0.57
104	5	4.1	7.5	0.77
105	5	3.5	6.6	0.51
106	5	2.8	4.9	0.51
107	5	5.0	2.4	0.83
108	5	4.2	4.5	0.96
109	5	4.5	10.0	0.51
110	5	2.6	6.8	0.83
111	5	1.0	4.6	0.51
112	5	2.0	4.1	0.77
113	5	1.7	5.8	0.64
114	6	7.9	9.8	0.38
115	6	8.7	6.9	0.57
116	6	10.1	8.9	0.45
117	6	10.9	7.8	0.38
118	6	8.3	6.1	0.44
119	6	7.7	7.0	0.58
120	6	10.5	3.6	0.77

RUN 2 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
121	6	9.6	8.8	0.38
122	6	6.3	5.8	0.51
123	6	6.8	4.7	0.51
124	6	6.3	3.8	0.51
125	6	6.6	3.1	0.70
126	6	6.3	2.4	0.63
127	6	6.3	1.3	0.58
128	6	5.8	0.6	0.89
129	6	5.9	7.3	0.51
130	6	4.7	8.9	0.64
131	6	4.7	3.5	0.63
132	6	4.0	2.4	0.51
133	6	4.7	11.1	0.38
134	6	5.0	10.5	0.70
135	6	3.5	7.3	0.64
136	6	3.8	2.9	0.64
137	6	1.7	7.0	0.57
138	6	1.9	9.6	0.51
139	6	1.5	9.2	0.64
140	6	0.5	7.2	0.38
141	6	0.4	6.6	0.51
142	6	2.6	1.3	0.51
143	7	10.1	6.6	0.45
144	7	8.8	8.9	0.64
145	7	9.1	8.2	0.38
146	7	8.3	7.4	0.64
147	7	9.1	2.6	0.51
148	7	8.6	5.4	0.51
149	7	7.9	5.5	0.64
150	7	9.2	1.4	0.51
151	7	11.2	5.6	0.45
152	7	5.4	2.7	0.63
153	7	6.1	8.1	0.51
154	7	6.4	7.5	0.58
155	7	5.6	11.0	0.70
156	7	6.0	6.5	0.57
157	7	3.2	9.1	0.77
158	7	4.7	6.5	0.83
159	7	2.7	1.9	0.57
160	7	4.9	8.1	0.77

RUN 2 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
161	7	4.2	1.9	0.64
162	7	3.8	0.9	0.64
163	7	4.3	10.9	0.51
164	7	4.7	1.0	0.51
165	7	5.1	1.3	0.89
166	7	2.4	4.9	0.77
167	7	1.2	8.3	0.76
168	7	1.3	6.4	0.83
169	8	9.8	2.3	0.77
170	8	10.1	7.4	0.64
171	8	8.9	5.1	0.57
172	8	8.7	4.3	0.77
173	8	7.0	10.1	0.58
174	8	7.5	8.4	0.51
175	8	6.6	4.0	0.57
176	8	5.4	3.5	0.64
177	8	3.6	10.6	0.70
178	8	3.6	10.0	0.64
179	8	4.7	5.5	1.01
180	8	4.2	4.5	0.99
181	8	3.8	5.6	1.01
182	8	1.3	3.6	0.83
183	8	1.9	6.1	0.70
184	8	1.2	4.9	0.51
185	8	0.4	5.1	0.51
186	8	2.4	2.7	0.49

RUN 3 PART A.

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	200	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.149	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.209	FT./SEC.
BED HEIGHT	4.4	IN.
SETTLED BED HEIGHT	4.0	IN.
PRESSURE DROP THROUGH BED	15.1	CM. OF WATER
AIR TEMPERATURE	82	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	0.258	SEC.

RUN 3 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	78	9.3	6.3	0.89
2	78	2.2	5.5	0.94
3	78	1.7	6.5	0.89
4	79	11.1	4.1	1.70
5	79	11.0	7.0	1.34
6	79	7.0	0.8	0.77
7	79	6.0	0.6	0.83
8	79	6.4	10.5	0.64
9	79	3.6	10.5	0.89
10	79	3.2	10.2	0.44
11	79	4.6	5.2	0.51
12	79	4.9	4.5	0.89
13	79	2.9	6.8	1.12
14	79	1.5	8.8	1.40
15	80	7.7	2.9	0.77
16	80	8.8	4.7	0.76
17	80	6.8	2.3	1.40
18	80	5.5	6.4	0.77
19	80	7.2	6.1	0.64
20	80	6.3	5.5	0.89
21	80	4.9	8.3	1.14
22	80	3.6	5.1	1.07
23	81	10.0	8.1	1.56
24	81	10.1	3.1	0.51
25	81	7.4	5.0	0.83
26	81	6.8	1.5	0.96
27	81	5.4	3.8	1.21
28	81	5.9	2.6	1.03
29	81	5.0	1.3	1.28
30	81	4.1	2.9	1.04
31	81	1.2	4.7	0.51
32	81	2.3	3.8	1.02
33	82	5.2	10.2	1.27
34	82	4.9	5.4	0.96
35	82	3.8	10.6	1.09
36	83	6.9	10.0	1.01
37	83	7.2	4.0	0.64
38	83	6.1	7.8	1.08
39	83	5.0	8.3	0.99
40	83	2.4	8.4	1.20

RUN 3 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	83	2.4	2.4	1.02
42	83	1.3	2.9	1.15
43	84	9.8	8.1	1.02
44	84	5.9	7.5	0.83
45	84	5.2	5.5	0.89
46	85	8.6	3.7	0.63
47	85	7.0	4.2	0.83
48	85	6.3	4.2	0.89
49	85	5.5	1.9	0.44
50	85	4.7	9.6	0.49
51	85	4.1	7.2	0.77
52	85	2.9	8.9	1.84
53	85	2.0	9.5	0.68
54	85	0.9	6.8	0.96
55	86	7.9	10.1	0.99
56	86	9.7	5.0	0.26
57	86	7.5	9.5	0.89
58	86	7.0	4.3	0.26
59	86	5.6	7.0	0.77
60	86	2.8	5.2	0.77
61	86	5.1	3.8	1.40
62	86	5.0	0.6	0.81
63	87	9.2	2.8	1.14
64	87	8.2	7.2	1.12
65	87	8.6	3.5	0.83
66	87	8.9	1.8	0.83
67	87	7.4	6.9	1.07
68	87	6.8	9.3	1.15
69	87	6.3	6.9	1.02
70	87	7.2	0.5	1.28
71	87	6.1	2.2	0.68
72	87	5.0	9.3	0.89
73	87	4.6	2.2	1.07
74	87	3.7	9.6	1.53
75	87	3.7	2.0	1.15
76	87	1.0	5.5	1.12
77	87	1.5	5.4	1.53
78	88	10.5	7.7	0.76
79	88	10.0	6.8	1.21
80	88	8.8	6.0	1.15

RUN 3 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	88	8.3	1.0	0.83
82	88	5.8	9.3	0.83
83	88	6.5	11.0	0.51
84	88	5.2	10.9	0.83
85	88	5.9	2.0	0.96
86	88	3.3	6.6	1.28
87	88	4.7	4.2	1.20
88	88	2.3	7.0	0.77
89	88	1.8	3.2	1.15
90	88	0.6	4.5	0.77
91	89	9.5	8.9	0.63
92	89	8.9	2.8	1.59
93	89	7.3	3.8	0.83
94	89	6.4	3.5	1.53
95	89	4.9	1.0	0.89
96	90	3.3	7.9	1.46

RUN 4 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	200	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.149	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.209	FT./SEC.
BED HEIGHT	13.0	IN.
SETTLED BED HEIGHT	12.0	IN.
PRESSURE DROP THROUGH BED	44.3	CM. OF WATER
AIR TEMPERATURE	81	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	3.990	SEC.

RUN 4 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	0.5	7.0	0.34
2	1	5.4	9.9	1.03
3	1	1.4	9.1	1.15
4	2	9.5	2.4	1.03
5	3	3.6	2.9	1.72
6	3	1.7	7.2	2.30
7	4	2.5	9.0	1.95
8	5	4.5	9.0	0.57
9	9	3.8	6.6	1.95
10	9	4.3	9.1	0.69
11	11	11.0	4.0	1.03
12	11	4.9	7.0	2.18
13	11	4.3	7.4	1.49
14	13	2.0	7.0	1.49
15	13	6.6	3.2	1.49
16	13	6.6	4.6	2.53
17	15	5.4	5.7	2.53
18	15	4.6	4.9	1.03
19	15	9.5	3.0	1.15
20	15	9.3	3.4	0.34
21	15	9.3	4.3	0.46
22	15	3.4	2.2	0.92
23	16	1.7	3.2	2.64
24	17	0.5	4.0	1.26
25	17	2.0	4.3	1.15
26	17	3.7	3.9	1.95
27	17	8.4	6.9	0.80
28	17	8.0	8.0	1.15
29	17	6.7	9.5	1.61
30	18	8.5	3.6	2.53
31	18	10.5	5.3	2.41
32	19	2.3	7.0	2.53
33	19	3.0	6.7	0.46
34	19	2.0	5.7	0.57
35	20	5.2	10.6	2.18
36	20	4.5	9.8	1.15
37	20	4.5	8.9	1.03
38	20	3.4	9.4	1.38
39	21	2.0	3.7	1.15
40	21	8.5	3.8	1.72

RUN 4 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	22	6.1	8.7	1.61
42	22	7.0	8.0	0.80
43	23	4.0	4.5	1.03
44	24	6.8	1.0	1.95
45	25	4.8	5.2	1.95
46	26	0.3	4.4	1.95
47	27	10.9	5.7	0.92
48	27	10.7	4.3	1.03
49	28	7.6	9.1	0.92
50	28	7.0	8.2	0.80
51	28	6.3	7.2	0.57
52	29	5.1	8.5	1.03
53	29	5.7	9.3	1.03
54	29	4.5	9.0	1.49
55	30	8.2	0.7	0.80
56	32	10.2	7.1	0.57
57	32	9.5	6.4	0.69
58	32	9.3	8.0	1.03
59	32	8.5	7.5	2.30
60	32	5.6	2.5	1.95
61	32	5.1	0.9	1.15
62	33	4.3	2.4	1.49
63	34	9.3	1.6	2.30
64	35	0.3	6.6	2.18
65	36	1.6	3.7	1.49
66	36	2.5	6.6	3.10
67	38	4.7	9.5	0.46
68	38	4.8	4.3	2.99
69	39	1.5	3.9	1.49
70	39	10.1	6.6	2.07
71	39	3.9	4.6	1.49
72	40	3.4	1.1	1.61
73	43	6.8	7.0	1.03
74	43	9.8	6.7	1.95
75	44	5.3	6.7	1.03
76	44	4.0	6.4	1.61
77	45	2.5	4.0	1.84
78	45	3.1	4.4	0.92
79	45	1.5	7.8	1.03
80	46	6.7	1.3	2.87

## RUN 4 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	48	8.2	8.3	2.64
82	48	0.3	4.8	1.49
83	49	7.2	3.4	0.92
84	49	4.4	3.2	2.87
85	49	8.9	9.3	2.87
86	51	4.8	7.2	0.69
87	51	10.7	3.0	1.72
88	52	8.4	8.4	2.07
89	52	7.8	7.0	1.84
90	52	6.8	7.7	1.38
91	53	2.2	7.1	0.80
92	53	10.7	5.4	1.95
93	54	10.1	2.2	1.49
94	54	2.9	10.3	0.80
95	54	9.0	3.9	1.61
96	55	6.7	1.7	1.03
97	55	10.0	6.1	0.34
98	55	9.9	5.5	0.46
99	55	9.0	6.1	1.26
100	55	9.8	4.6	1.15
101	55	1.5	2.3	1.95
102	55	1.4	4.4	1.95
103	55	5.4	8.6	0.34
104	56	4.8	2.8	2.07
105	56	8.3	0.8	1.49
106	59	9.1	8.6	0.80
107	59	1.7	6.1	3.10
108	60	3.8	3.8	0.92
109	60	4.0	8.6	2.41
110	61	9.8	5.5	0.69
111	61	8.2	3.0	1.95
112	62	9.0	5.5	0.34
113	63	3.9	4.4	0.80
114	64	4.7	3.8	1.15
115	64	4.4	2.4	0.92
116	65	3.3	2.9	1.95
117	65	9.9	2.4	2.07
118	67	11.5	5.7	2.07
119	67	5.7	10.1	2.87
120	70	1.5	8.4	1.95

## RUN 4 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
121	71	1.5	2.6	0.46
122	72	7.2	5.5	2.41
123	72	6.0	4.1	1.61
124	72	5.3	5.5	1.15
125	72	3.6	4.8	1.15
126	72	3.7	6.2	1.95
127	72	2.4	6.9	1.38
128	72	2.4	5.6	1.03
129	73	9.4	8.4	0.92
130	73	8.4	6.9	0.92
131	73	8.4	8.4	1.49
132	73	6.2	11.3	1.49
133	75	9.5	4.8	2.41
134	75	5.3	1.5	3.33
135	75	4.6	11.2	0.46
136	75	4.4	10.1	1.26
137	76	0.3	4.6	1.15
138	77	9.5	6.8	1.03
139	77	0.3	6.1	1.61
140	78	4.4	2.9	0.69
141	79	2.6	3.3	2.07
142	79	1.1	4.4	1.49
143	81	0.9	9.0	0.57
144	82	8.9	0.9	1.49
145	82	4.0	2.1	1.49
146	85	6.6	4.8	2.41
147	85	4.4	3.8	1.95
148	86	0.9	8.4	1.95
149	88	8.6	5.5	0.92
150	90	0.3	5.4	1.95
151	92	6.7	3.4	1.49
152	92	8.6	8.2	1.95
153	92	6.7	8.6	1.49
154	92	4.8	2.0	2.87
155	94	7.2	7.2	2.87
156	94	10.1	3.1	1.49
157	95	8.4	2.9	2.87
158	95	5.9	10.2	1.95
159	96	9.5	9.0	1.03
160	98	3.8	4.4	1.72

## RUN 4 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
161	98	3.6	10.1	2.30
162	98	1.4	8.7	0.46
163	102	9.2	1.5	1.49
164	103	9.2	8.2	1.95
165	104	10.7	3.0	1.15
166	104	7.1	1.5	1.95
167	104	4.9	1.1	1.26
168	104	3.0	2.3	2.07
169	104	1.5	9.3	0.57
170	104	0.7	8.2	1.49
171	105	7.7	7.7	1.49
172	106	6.2	7.8	1.95
173	106	3.2	8.5	2.41
174	110	1.5	6.7	1.95
175	110	3.1	5.9	1.49
176	110	1.7	4.8	2.41
177	111	10.1	2.2	1.95
178	113	3.4	8.4	1.49
179	113	4.0	3.3	1.95
180	114	7.2	2.4	2.41
181	115	7.7	5.1	2.41
182	115	5.7	9.5	1.95
183	116	3.3	1.5	2.87
184	116	2.1	9.5	0.92
185	118	0.3	6.7	1.49
186	119	1.5	4.4	1.49
187	120	4.0	2.0	2.07
188	120	9.5	4.8	1.49
189	121	4.9	10.1	0.57
190	121	7.7	1.5	1.95
191	121	7.7	8.9	2.64
192	122	8.9	5.3	2.53
193	122	10.1	2.1	1.49
194	122	11.5	6.1	1.49
195	123	1.8	5.4	2.87
196	124	5.3	6.1	1.49
197	126	0.5	4.0	1.95
198	126	7.8	9.5	2.07
199	127	7.6	3.4	2.87
200	129	6.2	1.4	1.95

## RUN 4 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
201	130	8.6	7.1	2.07
202	130	5.6	7.2	2.41
203	130	3.1	9.2	1.49
204	132	1.6	6.2	2.87
205	133	2.0	2.9	1.95
206	134	9.1	5.1	1.15
207	136	9.8	2.4	1.95
208	137	0.8	3.6	1.49
209	137	6.0	3.1	1.03
210	137	7.2	2.9	1.95
211	137	4.3	4.3	1.26
212	139	0.8	8.2	0.92
213	139	2.5	9.8	1.49
214	140	1.8	6.8	0.69
215	141	3.8	7.2	3.33
216	142	7.0	9.8	2.18
217	142	4.8	1.5	2.07
218	143	6.7	4.5	0.92
219	143	2.4	3.7	2.41
220	144	7.7	1.5	1.95
221	145	0.5	6.2	1.95
222	148	9.1	5.3	2.18
223	149	8.0	8.2	2.76
224	150	2.0	8.6	2.07
225	153	0.8	4.1	1.49
226	154	9.1	3.8	1.95
227	155	7.8	4.9	1.61
228	155	7.9	2.0	1.95
229	155	5.3	1.5	2.41
230	155	3.3	1.7	1.95
231	155	4.8	9.2	1.95
232	155	2.4	7.8	1.03
233	156	2.0	4.0	1.95
234	158	10.3	8.3	1.61
235	158	10.6	6.1	1.95
236	158	7.2	6.7	2.64
237	159	6.0	7.4	1.49
238	159	4.4	5.7	3.56
239	161	1.3	9.0	0.92
240	162	4.4	8.5	2.07

RUN 4 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
241	163	4.1	2.9	2.07
242	163	5.7	10.3	1.49
243	163	7.7	2.0	1.84
244	165	10.6	2.6	2.41
245	166	2.0	9.0	1.95
246	168	0.7	4.9	3.22
247	168	7.2	5.7	0.69
248	170	3.2	2.8	0.69
249	171	9.3	4.5	0.80
250	171	8.4	5.3	0.92
251	171	9.0	3.7	1.49
252	171	8.0	4.4	0.92
253	171	7.2	6.4	1.49
254	172	3.8	5.3	2.07
255	173	4.8	2.3	2.41
256	176	7.2	0.9	2.41
257	176	7.9	8.6	2.87
258	176	3.6	9.5	2.41
259	176	5.6	9.0	1.49
260	177	5.3	10.7	1.61
261	179	0.8	3.3	1.95
262	179	2.2	4.9	1.84
263	180	4.0	3.3	0.92
264	180	2.0	7.7	3.10
265	182	3.9	2.1	0.92
266	182	8.3	9.8	0.69
267	182	5.7	9.2	0.46
268	182	5.9	8.3	0.46
269	183	7.4	10.3	1.03
270	183	8.9	3.8	3.10
271	184	7.5	9.1	0.57
272	184	6.8	8.9	1.61
273	184	4.8	8.2	2.53
274	185	4.1	2.0	2.87
275	185	10.1	2.4	2.87
276	186	7.0	4.1	0.80
277	188	6.6	9.8	0.92
278	189	7.6	4.0	1.03
279	190	0.9	3.8	0.92
280	191	2.9	4.8	2.30

RUN 4 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
281	191	4.4	6.2	2.18

RUN 5 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	200	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.149	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.209	FT./SEC.
BED HEIGHT.	20.4	IN.
SETTLED BED HEIGHT	19.0	IN.
PRESSURE DROP THROUGH BED	71.1	CM. OF WATER
AIR TEMPERATURE	77	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	4.580	SEC.

RUN 5 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	108	2.2	6.9	1.42
2	117	7.1	4.4	4.91
3	119	8.3	9.0	4.31
4	121	2.5	7.7	1.13
5	121	1.1	4.1	0.90
6	121	4.4	8.3	1.05
7	130	8.5	4.3	1.19
8	130	4.8	9.9	0.90
9	130	7.2	3.1	1.15
10	130	5.1	1.3	1.05
11	130	7.3	4.3	1.76
12	131	7.5	6.4	2.81
13	133	4.8	3.8	2.19
14	133	5.7	9.5	1.66
15	143	6.7	3.7	4.59
16	143	1.6	6.9	1.44
17	146	1.1	6.2	2.15
18	146	8.0	3.5	3.64
19	151	8.7	3.8	1.42
20	151	5.8	2.7	1.52
21	151	7.2	6.6	2.14
22	151	8.0	3.7	0.86
23	151	10.6	4.6	0.86
24	151	10.1	3.3	2.71
25	152	6.9	3.7	1.05
26	154	8.8	3.5	1.05
27	154	3.4	4.2	1.44
28	154	8.2	6.7	3.07
29	154	7.2	3.2	1.77
30	157	3.4	4.9	2.73
31	161	6.3	3.0	4.86
32	162	9.1	8.4	2.20
33	163	3.0	7.4	1.25
34	163	2.3	3.2	3.25
35	163	5.6	7.4	3.89
36	165	9.2	3.8	2.50
37	165	8.7	7.8	1.19
38	165	1.6	5.1	1.42
39	167	10.0	7.6	2.56
40	168	4.4	6.8	1.96

## RUN 5 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	170	4.3	1.1	1.92
42	172	4.8	3.0	2.68
43	174	6.6	1.8	2.62
44	175	4.4	6.8	2.34
45	178	3.4	3.1	3.47
46	179	3.7	5.2	1.85
47	181	2.0	6.8	0.48
48	181	2.8	4.4	0.48
49	181	2.5	4.3	0.96
50	181	9.9	1.6	1.62
51	181	6.8	4.7	3.15
52	188	5.8	2.8	1.29
53	189	7.2	6.6	1.48
54	189	10.2	2.0	1.82
55	190	10.6	6.5	2.30
56	190	10.1	3.3	2.95
57	190	9.0	1.8	3.24
58	191	8.0	7.2	4.40
59	191	3.5	4.2	4.26
60	202	2.3	3.0	3.40
61	202	7.7	6.3	0.68
62	202	2.7	8.0	1.19
63	202	5.3	3.2	2.86
64	202	9.5	3.8	1.38
65	203	6.5	6.5	0.98
66	203	3.8	8.1	1.04
67	204	9.0	7.1	2.30
68	205	5.0	9.5	2.46
69	210	4.9	4.0	3.73
70	214	6.7	2.1	2.15
71	219	2.1	7.0	5.40
72	225	5.3	2.9	1.15
73	227	4.2	2.9	2.03
74	227	3.9	9.1	1.71
75	230	8.0	9.3	3.73
76	230	6.9	9.4	1.67
77	234	3.9	4.8	2.59
78	234	1.9	8.2	1.00
79	234	5.0	6.9	0.80
80	234	9.1	3.6	1.48

RUN 5 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	235	1.2	4.0	2.34
82	235	6.7	0.8	1.57
83	235	1.1	4.3	1.66
84	235	4.5	8.2	0.80
85	235	6.2	6.8	1.33
86	235	0.7	4.4	1.53
87	235	8.1	4.7	2.32
88	235	3.4	6.1	1.19
89	235	9.0	7.2	1.48
90	240	7.7	8.6	2.38
91	242	7.7	4.8	1.42
92	242	5.1	9.6	1.66
93	243	1.1	8.8	1.95
94	243	0.6	5.9	2.28
95	249	8.9	8.4	2.63
96	249	6.4	1.5	1.95
97	251	6.9	3.4	2.39
98	252	3.4	7.7	1.73
99	252	5.5	9.6	2.64
100	258	0.4	5.3	2.94
101	260	5.2	0.3	0.80
102	261	9.6	3.4	1.64
103	261	8.1	3.6	3.91
104	262	3.7	3.8	1.91
105	263	0.6	7.7	0.62
106	263	8.6	5.9	0.66
107	263	7.7	1.0	0.57
108	263	9.1	6.2	1.20
109	263	5.8	3.0	3.64
110	264	3.4	7.7	0.77
111	267	6.7	8.6	2.25
112	267	1.4	9.1	2.62
113	267	2.4	2.2	1.63
114	269	7.8	2.9	1.82
115	270	5.3	3.4	2.31
116	270	2.7	6.0	2.95
117	271	3.3	5.0	0.86
118	271	4.7	1.9	0.96
119	271	1.0	7.7	1.29
120	271	1.7	5.3	1.55

RUN 5 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
121	275	9.1	7.0	2.37
122	276	8.1	8.7	1.35
123	277	1.4	5.2	1.57
124	277	2.9	8.4	1.82
125	278	6.4	0.7	2.97
126	278	8.8	2.5	0.74
127	278	7.7	2.0	1.37
128	279	6.2	4.5	0.96
129	280	7.7	3.6	2.11
130	282	8.4	5.0	1.36
131	282	5.7	2.4	1.09
132	285	4.8	3.6	1.86
133	286	4.3	1.7	2.70
134	288	2.8	3.0	3.19
135	288	6.1	7.5	4.93
136	292	7.3	3.3	0.96
137	292	2.3	6.2	1.82
138	292	9.1	2.9	1.05
139	292	6.1	6.1	1.72
140	294	8.6	7.5	1.37
141	294	9.6	5.5	1.59
142	295	4.8	8.4	1.95
143	301	4.8	9.8	2.63
144	301	9.0	4.1	1.82
145	302	7.1	9.1	2.34
146	302	7.3	2.4	3.62
147	306	8.0	2.7	3.68
148	308	9.1	5.9	3.93
149	312	7.8	2.7	1.47
150	312	9.1	6.3	2.61
151	313	2.7	5.7	1.65
152	320	2.4	5.3	0.57
153	320	1.4	3.4	0.86
154	321	5.2	1.8	2.99
155	321	7.2	7.6	2.24
156	323	3.4	3.8	3.72
157	323	4.6	2.7	3.85
158	327	6.2	4.0	1.15
159	327	8.7	5.5	1.05
160	327	6.7	0.8	1.38

RUN 5 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
161	327	2.4	5.7	1.72
162	327	3.7	6.9	1.81

RUN 6 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	200	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.149	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.209	FT./SEC.
BED HEIGHT	25.8	IN.
SETTLED BED HEIGHT	24.0	IN.
PRESSURE DROP THROUGH BED	89.8	CM. OF WATER
AIR TEMPERATURE	77	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	4.230	SEC.

RUN 6 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	8	4.1	5.5	4.58
2	12	8.5	5.7	0.74
3	12	1.7	7.6	1.15
4	13	3.1	6.8	2.24
5	19	2.9	2.7	1.35
6	20	6.0	3.4	3.07
7	20	8.9	7.3	2.30
8	22	3.5	5.5	2.60
9	24	2.4	7.0	4.93
10	25	4.2	4.5	1.59
11	25	5.6	5.0	0.35
12	25	3.8	2.4	0.62
13	25	6.5	7.0	0.88
14	25	4.2	4.8	1.66
15	25	1.9	4.1	0.97
16	26	2.8	3.9	2.83
17	39	5.5	6.5	0.27
18	39	2.9	7.3	0.71
19	39	8.0	4.0	0.56
20	39	5.7	2.3	0.88
21	39	7.3	7.3	2.64
22	40	2.2	1.9	1.63
23	41	1.3	3.6	1.76
24	41	2.6	3.7	3.61
25	41	5.4	5.3	2.99
26	47	7.5	2.7	1.06
27	48	6.9	3.4	4.89
28	53	3.2	7.3	2.29
29	53	6.6	4.2	3.62
30	56	6.3	3.8	3.79
31	61	3.7	5.9	1.47
32	66	7.3	2.7	1.61
33	71	3.7	5.2	4.86
34	71	6.2	6.5	4.46
35	72	2.2	7.3	1.26
36	72	3.6	5.8	2.39
37	76	4.4	4.2	1.80
38	82	6.9	5.3	0.53
39	82	5.7	4.7	3.01
40	83	7.0	7.4	1.24

RUN 6 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	83	4.0	2.1	2.19
42	86	1.9	3.7	2.24
43	87	6.7	6.7	1.30
44	87	6.9	4.2	1.67
45	88	6.7	5.3	1.24
46	89	4.4	7.2	1.54
47	94	2.7	6.6	1.80
48	95	7.6	4.9	1.17
49	95	1.8	3.8	2.42
50	95	7.5	1.7	2.03
51	97	8.3	4.4	2.20
52	97	3.0	2.7	2.83
53	100	6.2	3.7	3.88
54	101	2.8	5.5	1.71
55	104	5.7	6.2	0.74
56	104	7.7	2.2	1.21
57	104	1.8	6.3	1.42
58	105	3.1	7.1	1.06
59	106	8.2	4.3	1.94
60	112	2.3	7.7	3.72
61	119	1.9	4.9	1.68
62	121	8.2	3.7	4.33
63	122	8.2	5.1	4.07
64	127	8.0	6.1	1.55
65	130	5.8	2.0	4.33
66	131	2.4	6.9	1.40
67	131	4.7	2.0	1.42
68	131	7.4	7.1	2.22
69	131	7.6	5.7	2.74
70	132	5.5	0.6	1.43
71	135	2.4	1.6	3.17
72	136	2.9	3.1	1.61
73	136	5.0	5.7	3.59
74	140	1.1	3.9	3.86
75	142	2.4	7.2	4.24
76	145	5.2	1.9	2.44
77	146	2.5	8.0	2.24
78	146	2.7	3.4	1.01
79	152	5.7	3.2	1.50
80	152	6.5	2.9	2.09

RUN 6 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	152	5.6	5.0	4.07
82	154	1.6	2.7	2.95
83	155	4.0	5.7	1.03
84	155	7.7	2.3	0.78
85	155	3.1	4.4	0.71
86	155	3.3	2.5	1.15
87	156	7.1	3.1	2.39
88	156	4.0	5.1	1.59
89	157	5.0	5.0	3.08
90	157	1.6	7.0	2.85
91	161	5.9	6.3	1.06
92	166	3.4	2.7	4.86
93	167	6.8	4.0	2.04
94	174	3.5	4.4	5.11
95	174	4.9	2.5	1.19
96	174	1.1	3.5	1.31
97	177	2.0	7.7	1.47
98	178	4.4	2.2	2.32
99	179	3.9	5.7	1.61
100	179	5.3	4.4	0.93
101	179	8.3	5.8	1.06
102	184	7.5	2.5	1.90
103	184	3.6	6.7	1.99
104	185	1.9	7.4	2.56
105	193	3.4	5.5	1.77
106	194	2.5	7.1	1.75
107	197	3.3	6.5	0.53
108	197	5.9	6.6	0.69
109	197	8.0	6.3	4.81
110	199	3.1	2.7	1.97
111	201	1.9	7.5	0.62
112	201	4.4	3.4	2.87
113	201	6.2	3.1	2.54
114	202	6.6	6.6	3.77

RUN 7 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	200	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.149	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.346	FT./SEC.
BED HEIGHT	1.3	IN.
SETTLED BED HEIGHT	1.0	IN.
PRESSURE DROP THROUGH BED	5.5	CM. OF WATER
AIR TEMPERATURE	82	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	64	FRAMES/SEC.
DURATION OF RUN	0.037	SEC.

RUN 7 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	10.5	8.4	0.77
2	1	8.7	8.2	0.77
3	1	10.6	7.2	0.83
4	1	8.7	6.1	0.96
5	1	10.4	4.9	1.14
6	1	9.7	4.0	0.96
7	1	8.4	4.7	0.83
8	1	7.5	3.8	1.07
9	1	6.8	2.3	0.38
10	1	9.5	2.6	0.68
11	1	8.4	2.6	0.76
12	1	7.9	1.8	0.76
13	1	7.4	9.3	1.33
14	1	5.5	10.5	1.02
15	1	4.0	10.2	1.34
16	1	5.6	7.9	0.76
17	1	4.5	8.6	1.08
18	1	5.6	6.3	0.68
19	1	7.5	7.0	0.89
20	1	6.6	4.7	1.28
21	1	5.4	5.1	0.70
22	1	6.4	4.6	1.01
23	1	6.1	2.6	1.28
24	1	1.8	8.3	1.02
25	1	3.1	6.1	0.70
26	1	3.8	6.5	0.89
27	1	1.2	6.0	0.96
28	1	3.8	4.5	0.64
29	1	2.3	3.8	0.70
30	1	2.7	3.5	0.63
31	2	5.4	8.6	0.70
32	2	5.4	4.6	0.51
33	2	7.9	10.2	0.89
34	2	8.4	7.2	0.76
35	2	8.1	6.6	0.70
36	2	10.2	6.4	0.57
37	2	8.9	2.2	0.89
38	2	8.4	1.3	1.01
39	2	5.0	10.4	0.70
40	2	7.0	10.5	1.02

RUN 7 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	2	7.0	7.7	0.94
42	2	4.9	7.8	0.77
43	2	4.3	7.3	0.77
44	2	4.7	6.1	1.21
45	2	4.3	3.7	0.83
46	2	4.0	3.3	0.57
47	2	7.0	0.9	1.01
48	2	5.5	1.7	0.89
49	2	4.1	1.5	0.83
50	2	2.6	7.9	1.15
51	2	1.0	8.3	0.64
52	2	3.5	7.0	0.96
53	2	2.6	5.2	0.99
54	2	2.3	2.7	0.77
55	2	3.1	2.0	1.20
56	2	3.5	0.9	1.02
57	3	6.9	9.1	0.49
58	3	7.3	8.6	0.64
59	3	6.6	8.7	0.64
60	3	3.2	9.6	1.02
61	3	10.2	7.5	0.83
62	3	10.1	5.5	0.96
63	3	9.3	4.9	0.64
64	3	10.1	2.9	0.96
65	3	6.0	9.3	1.01
66	3	5.6	8.6	1.01
67	3	4.1	7.9	0.64
68	3	4.2	7.2	0.81
69	3	6.8	6.9	0.89
70	3	7.0	5.9	1.08
71	3	7.4	5.4	0.31
72	3	7.0	4.9	0.31
73	3	6.6	4.7	0.89
74	3	5.4	5.0	1.08
75	3	7.4	4.0	0.89
76	3	6.9	3.3	0.44
77	3	6.3	3.3	0.51
78	3	5.4	3.1	0.89
79	3	6.8	2.3	0.96
80	3	5.0	2.3	0.89

RUN 7 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	3	0.8	7.4	0.96
82	3	1.8	7.0	0.51
83	3	1.3	6.6	0.51
84	3	2.2	5.1	0.89
85	3	2.6	4.5	0.64
86	3	1.0	4.7	0.96
87	3	1.5	3.6	1.07
88	3	1.9	3.2	0.51
89	3	2.2	1.5	0.64
90	3	1.8	1.9	0.70

RUN 8 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	200	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.149	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.346	FT./SEC.
BED HEIGHT	2.5	IN.
SETTLED BED HEIGHT	2.0	IN.
PRESSURE DROP THROUGH BED	9.5	CM. OF WATER
AIR TEMPERATURE	82	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	64	FRAMES/SEC.
DURATION OF RUN	0.162	SEC.

RUN 8 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	10.5	5.6	1.51
2	1	9.3	11.2	0.97
3	1	6.2	9.5	1.82
4	1	0.8	8.6	1.78
5	1	2.4	4.1	1.46
6	2	7.7	3.6	1.82
7	2	5.5	7.2	1.68
8	2	3.9	7.9	1.68
9	3	11.2	3.5	1.60
10	3	6.0	10.8	0.83
11	3	5.3	10.1	1.09
12	3	4.9	11.6	1.49
13	3	3.5	11.9	1.40
14	3	2.4	10.8	1.03
15	4	6.3	9.3	0.84
16	4	5.6	5.2	1.54
17	4	3.6	2.4	1.43
18	4	2.5	2.5	1.96
19	5	10.2	2.2	1.54
20	6	11.1	5.5	1.65
21	6	9.5	9.0	2.09
22	6	6.0	6.3	1.46
23	6	8.0	7.2	1.68
24	6	6.5	10.8	2.10
25	6	7.3	12.5	0.98
26	6	6.0	6.3	1.54
27	6	1.7	7.2	1.68
28	7	9.8	5.3	1.05
29	7	7.9	11.2	1.37
30	7	6.3	1.7	1.40
31	7	4.9	7.0	1.40
32	7	2.8	9.5	2.65
33	7	1.1	3.8	1.17
34	7	0.6	4.8	0.98
35	7	2.0	4.6	1.40
36	7	1.0	9.4	0.94
37	8	10.0	5.2	0.97
38	8	8.7	4.6	0.83
39	8	10.8	3.4	1.68
40	8	9.1	3.5	1.80

RUN 8 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	8	6.3	1.5	1.46
42	8	3.5	1.4	1.54
43	8	0.8	5.5	0.70
44	9	10.4	9.8	2.10
45	9	8.0	6.6	1.96
46	9	8.4	8.6	1.40
47	9	3.6	3.8	1.17
48	9	1.7	6.0	1.03
49	9	0.6	7.0	0.70
50	10	11.5	6.7	1.40
51	10	10.8	5.9	1.14
52	10	10.0	7.2	1.25
53	10	11.6	8.7	1.54
54	10	6.5	8.1	1.17
55	10	2.8	6.6	1.32
56	11	9.1	10.8	1.60
57	11	10.5	2.1	1.82
58	11	6.9	9.4	1.80
59	11	7.2	4.2	1.58
60	11	2.7	8.3	1.05
61	11	2.7	3.8	1.54
62	11	2.4	2.5	1.46

RUN 9 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	200	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.149	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.346	FT./SEC.
BED HEIGHT	4.8	IN.
SETTLED BED HEIGHT	4.0	IN.
PRESSURE DROP THROUGH BED	16.8	CM. OF WATER
AIR TEMPERATURE	82	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	0.341	SEC.

RUN 9 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	34	3.8	1.0	2.21
2	35	3.8	6.9	2.21
3	35	1.7	7.0	3.19
4	35	10.2	4.7	2.17
5	35	9.2	2.8	2.43
6	35	3.8	6.9	2.21
7	35	2.6	4.3	2.71
8	37	5.9	1.4	2.21
9	37	2.4	2.0	1.79
10	37	5.9	3.8	2.73
11	39	10.1	7.4	1.28
12	39	9.8	5.1	2.73
13	40	3.3	9.6	3.13
14	40	2.6	2.2	3.19
15	41	1.2	4.3	1.97
16	41	0.9	7.7	1.61
17	41	2.3	7.0	1.61
18	42	8.3	8.9	2.81
19	44	8.9	1.9	1.46
20	44	6.3	8.3	1.53
21	45	10.1	4.3	1.92
22	45	6.9	6.9	2.29
23	45	2.7	2.3	3.50
24	45	3.3	7.5	2.96
25	46	5.5	2.9	2.04
26	46	1.4	6.4	2.29
27	48	5.4	1.7	3.39
28	49	6.6	7.0	1.79
29	49	1.9	2.7	2.21
30	50	7.7	8.7	1.84
31	50	8.2	6.3	2.21
32	50	5.6	10.1	4.11
33	50	8.9	3.2	3.57

RUN 10 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	200	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.149	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.346	FT./SEC.
BED HEIGHT	9.4	IN.
SETTLED BED HEIGHT	8.0	IN.
PRESSURE DROP THROUGH BED	31.6	CM. OF WATER
AIR TEMPERATURE	82	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	0.945	SEC.

RUN 10 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	3	5.2	7.3	5.06
2	4	9.6	8.2	1.57
3	5	3.7	1.0	2.67
4	6	2.7	7.1	4.59
5	7	5.7	3.1	4.43
6	9	3.1	6.8	2.96
7	10	10.5	7.8	2.61
8	12	9.9	4.9	4.05
9	14	4.4	9.4	2.55
10	16	4.5	2.1	2.61
11	17	6.8	6.9	2.31
12	17	9.3	2.9	1.40
13	18	7.6	0.8	2.07
14	20	1.6	2.6	3.47
15	20	9.6	1.8	1.51
16	21	6.3	9.9	5.02
17	23	3.7	3.7	5.23
18	24	8.7	9.0	1.51
19	24	9.4	5.6	5.12
20	25	8.0	1.9	3.62
21	26	2.6	1.9	3.14
22	27	5.2	9.1	4.35
23	28	4.3	0.5	1.65
24	30	4.5	6.8	4.58
25	31	0.8	5.1	1.67
26	32	1.4	6.6	1.33
27	33	3.3	4.5	2.96
28	34	1.7	5.5	1.77
29	35	6.4	8.5	1.36
30	36	6.8	3.1	4.58
31	37	2.1	3.1	2.53
32	37	9.2	7.8	3.86
33	38	4.0	2.0	1.77
34	38	8.4	10.8	2.30
35	39	6.0	1.7	1.60
36	40	4.8	10.9	1.57
37	40	6.6	10.7	1.81
38	42	1.5	5.1	1.36
39	42	2.1	7.5	4.38
40	42	10.1	8.4	2.09

RUN 10 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	43	6.5	1.0	1.81
42	43	4.8	2.6	2.56
43	43	1.5	3.4	2.66
44	44	8.2	1.5	1.87
45	45	8.2	4.4	2.86
46	47	9.2	2.3	2.84
47	47	6.1	2.4	3.24
48	48	6.3	9.4	5.73

RUN 11 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	200	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.149	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.346	FT./SEC.
BED HEIGHT	13.9	IN.
SETTLED BED HEIGHT	12.0	IN.
PRESSURE DROP THROUGH BED	45.4	CM. OF WATER
AIR TEMPERATURE	81	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	4.030	SEC.

RUN 11 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	1.7	3.4	2.30
2	6	8.9	4.8	4.07
3	8	4.0	4.6	6.55
4	13	8.4	5.7	3.73
5	13	10.0	7.9	2.10
6	14	8.6	9.2	1.72
7	19	9.8	4.0	2.30
8	20	9.5	1.7	3.22
9	21	6.6	4.0	3.99
10	23	2.9	2.3	3.54
11	23	3.4	5.2	2.07
12	25	2.0	5.9	2.59
13	28	2.3	2.0	1.85
14	30	4.6	8.9	6.30
15	31	9.2	8.0	4.60
16	32	2.0	5.2	4.89
17	37	7.5	10.9	2.93
18	38	4.6	4.1	2.16
19	39	2.6	5.1	2.30
20	41	8.4	5.4	6.32
21	42	4.5	9.2	2.30
22	50	6.3	6.3	3.45
23	52	2.5	4.6	5.39
24	54	8.0	1.1	1.49
25	57	6.9	2.9	4.60
26	58	9.7	7.8	4.60
27	60	6.3	10.6	2.30
28	61	4.6	9.2	3.78
29	62	8.0	4.0	2.76
30	67	2.3	7.1	3.45
31	69	2.9	3.4	1.72
32	77	4.6	4.6	6.44
33	78	0.9	5.9	2.30
34	80	9.8	7.1	3.68
35	82	4.6	6.9	4.81
36	82	9.2	2.9	3.45
37	87	1.1	3.7	2.52
38	89	8.0	2.6	1.46
39	91	9.8	3.4	2.62
40	91	3.6	6.9	6.09

## RUN 11 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	92	10.1	6.7	1.99
42	94	5.2	2.3	3.99
43	102	6.9	3.4	4.02
44	103	2.6	3.4	3.47
45	105	7.7	9.2	2.30
46	107	6.0	9.8	1.62
47	107	6.1	3.2	2.58
48	109	1.1	4.8	3.27
49	113	3.8	6.9	6.90
50	114	8.6	4.6	6.80
51	120	8.6	2.1	3.10
52	120	10.1	4.1	2.87
53	123	4.0	1.7	3.45
54	124	9.0	5.2	3.91
55	124	9.8	8.0	2.52
56	130	4.6	7.5	4.88
57	138	2.0	6.3	1.15
58	139	9.4	4.0	5.62
59	139	3.4	2.4	4.57
60	140	3.2	8.5	2.62
61	140	6.9	5.7	2.63
62	141	2.3	6.0	2.99
63	142	4.0	6.9	1.61
64	145	7.9	9.7	2.67
65	148	5.2	4.6	3.45
66	148	8.6	7.5	3.32
67	151	1.7	6.3	2.76
68	151	4.6	10.3	2.60
69	151	7.5	5.5	4.02
70	154	7.7	6.9	2.27
71	157	7.5	5.3	1.99
72	158	5.7	9.2	5.75
73	159	2.9	3.4	3.45
74	160	9.8	5.7	4.45
75	160	1.4	8.7	2.52
76	160	5.7	5.1	2.64
77	161	3.7	7.5	3.73
78	161	5.7	3.2	2.53
79	163	8.0	4.7	3.77
80	164	9.4	7.8	1.85

RUN 11 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	165	5.7	6.1	1.49
82	165	3.2	2.3	3.42
83	167	7.5	6.3	1.49
84	170	6.9	5.7	3.45
85	171	6.6	7.5	1.72
86	174	10.7	7.2	2.60
87	175	10.5	2.6	1.38
88	175	9.2	1.4	2.23
89	178	4.5	6.3	6.67
90	179	2.0	4.3	4.61
91	187	7.7	10.0	3.63
92	188	7.7	5.4	6.32
93	189	4.8	7.1	1.72
94	190	3.8	2.5	5.60
95	192	8.2	0.9	1.41
96	194	1.7	7.6	4.66

RUN 12 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	200	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.149	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.346	FT./SEC.
BED HEIGHT	21.7	IN.
SETTLED BED HEIGHT	19.0	IN.
PRESSURE DROP THROUGH BED	72.3	CM. OF WATER
AIR TEMPERATURE	77	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	3.110	SEC.

RUN 12 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	214	2.5	9.0	4.42
2	223	3.8	2.8	4.06
3	224	7.7	6.0	7.98
4	237	0.6	6.6	1.50
5	240	3.0	9.5	3.87
6	245	5.0	7.5	2.00
7	246	2.5	5.0	5.00
8	259	9.0	5.2	7.07
9	261	3.8	5.3	2.79
10	268	6.0	7.0	6.75
11	280	5.3	3.2	8.12
12	287	4.7	5.0	4.90
13	287	7.5	8.3	3.69
14	301	6.8	8.0	9.38
15	307	2.5	7.5	5.25
16	309	1.5	2.5	1.41
17	310	2.8	1.2	1.90
18	310	7.5	8.0	1.50
19	311	1.4	3.8	2.65
20	314	3.0	3.8	2.50
21	315	7.8	1.5	4.90
22	316	3.0	7.0	3.00
23	321	7.1	5.9	6.93
24	329	9.0	1.5	2.50
25	330	10.0	6.2	3.00
26	330	9.5	4.0	2.50
27	332	6.8	1.1	2.10
28	332	7.6	4.3	1.99
29	346	4.5	5.5	9.49

RUN 13 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	200	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.149	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.346	FT./SEC.
BED HEIGHT	27.2	IN.
SETTLED BED HEIGHT	24.0	IN.
PRESSURE DROP THROUGH BED	90.3	CM. OF WATER
AIR TEMPERATURE	77	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	4.150	SEC.

RUN 13 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	241	4.6	5.2	5.82
2	243	3.4	9.2	6.09
3	266	5.7	4.6	10.29
4	288	5.4	5.2	10.06
5	290	7.5	4.6	4.26
6	292	5.7	1.7	4.88
7	315	5.2	5.4	2.80
8	321	4.4	10.5	2.63
9	325	7.5	10.9	1.63
10	326	9.7	9.5	2.14
11	328	6.1	2.9	7.04
12	329	3.7	6.9	2.30
13	329	10.1	6.9	2.87
14	330	8.3	9.4	3.39
15	330	5.2	9.8	3.45
16	331	8.9	8.3	1.84
17	353	2.1	8.6	2.82
18	354	7.5	8.0	5.08
19	355	4.8	4.0	7.97
20	366	5.2	1.7	3.98
21	366	5.7	3.4	6.61
22	380	8.0	3.4	6.90
23	405	4.0	5.7	9.63
24	422	3.9	7.8	2.17
25	425	9.8	9.2	1.23
26	426	2.3	10.2	1.78
27	433	9.2	4.6	2.87
28	433	9.0	8.6	2.87
29	434	5.7	1.7	4.30
30	434	2.9	3.4	5.46
31	434	4.6	8.6	6.30

RUN 14 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.044	FT./SEC.
BED HEIGHT	4.2	IN.
SETTLED BED HEIGHT	4.0	IN.
PRESSURE DROP THROUGH BED	14.3	CM. OF WATER
AIR TEMPERATURE	91	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	0.197	SEC.

RUN 14 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	41	8.8	9.9	0.37
2	41	1.8	8.0	0.60
3	41	0.5	7.9	1.00
4	41	0.4	7.3	0.45
5	41	0.2	6.6	0.65
6	41	0.4	4.5	0.51
7	41	3.9	1.0	1.03
8	42	11.0	6.0	0.94
9	42	10.8	4.8	1.03
10	42	7.2	10.8	1.03
11	42	6.7	10.5	0.43
12	43	6.8	0.2	0.46
13	43	9.8	9.7	0.22
14	43	10.5	8.8	0.33
15	43	4.8	10.6	0.66
16	43	1.4	2.5	0.86
17	43	1.1	7.0	0.46
18	43	0.6	5.5	0.60
19	43	0.4	4.7	0.88
20	43	2.7	1.5	0.80
21	44	10.7	3.2	0.54
22	44	9.9	2.2	0.62
23	44	9.4	1.4	0.36
24	44	10.4	7.7	0.69
25	44	10.9	7.1	0.46
26	44	9.9	8.5	0.40
27	44	10.8	8.3	0.45
28	44	9.9	8.8	0.57
29	44	9.3	9.6	0.51
30	44	1.6	9.6	0.26
31	44	1.0	5.1	0.37
32	44	1.1	4.5	0.30
33	44	1.6	4.0	0.49
34	44	0.9	3.7	0.74
35	44	1.4	2.8	0.77
36	44	2.9	1.3	0.48
37	44	3.6	0.7	0.86
38	44	5.0	1.0	0.83
39	45	7.2	1.0	0.65
40	45	8.5	1.4	0.96

RUN 14 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	45	8.7	2.2	1.03
42	45	10.9	7.4	0.23
43	45	10.6	7.4	0.17
44	45	9.2	9.3	0.40
45	45	1.6	8.9	0.69
46	45	0.5	7.0	0.57
47	45	2.8	1.0	0.92
48	46	10.4	7.9	0.92
49	46	9.8	8.7	0.46
50	46	10.8	4.5	1.00
51	46	10.8	5.4	0.30
52	46	9.3	9.1	0.28
53	46	9.3	9.4	0.29
54	46	8.8	9.9	0.37
55	46	1.1	7.0	0.34
56	46	0.9	7.7	0.92
57	46	1.0	5.1	0.99
58	46	4.7	0.3	0.77
59	46	5.2	1.3	0.66
60	46	6.1	0.9	0.51
61	46	6.7	0.3	0.89
62	47	10.9	6.0	0.63
63	47	6.5	10.8	0.77
64	47	4.0	11.0	0.65
65	47	1.0	4.8	0.97
66	47	0.6	6.2	0.85
67	47	2.8	3.0	0.46
68	47	4.2	1.0	0.94
69	47	6.9	0.6	0.80
70	48	10.1	3.1	0.67
71	48	10.3	3.6	0.63
72	48	10.5	5.3	0.54
73	48	10.6	4.8	0.57
74	48	10.3	8.5	0.63
75	48	9.8	8.3	0.50
76	48	1.6	9.0	1.21
77	48	0.7	6.2	0.72
78	48	1.0	3.0	0.40
79	48	1.8	2.3	0.47
80	48	4.9	0.5	0.80

RUN 14 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	49	9.5	2.1	0.72
82	49	10.9	6.6	0.63
83	49	10.8	7.5	1.08
84	49	9.7	9.3	0.48
85	49	7.5	10.3	0.54
86	49	4.9	11.3	0.34
87	49	1.0	0.3	0.91
88	49	2.4	2.1	0.75
89	49	6.2	0.7	0.66
90	49	8.2	1.1	1.15
91	50	8.8	9.5	0.48
92	50	10.4	8.6	0.85
93	50	2.8	10.2	0.77
94	50	1.6	9.0	1.15
95	50	0.5	7.1	0.97
96	50	1.0	4.5	0.80

RUN 15 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.044	FT./SEC.
BED HEIGHT	8.3	IN.
SETTLED BED HEIGHT	8.0	IN.
PRESSURE DROP THROUGH BED	28.0	CM. OF WATER
AIR TEMPERATURE	93	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	0.843	SEC.

RUN 15 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	60	9.9	2.4	0.67
2	60	9.7	3.4	1.10
3	60	0.9	7.7	0.63
4	60	1.1	8.2	0.63
5	60	8.9	1.8	0.44
6	61	10.3	7.8	1.23
7	61	1.6	7.4	1.30
8	62	6.5	0.7	0.54
9	62	1.6	2.5	1.54
10	62	2.5	2.0	1.91
11	64	10.7	5.2	0.57
12	64	8.0	1.4	0.48
13	64	4.8	1.1	0.84
14	65	2.7	9.5	0.78
15	65	0.7	5.9	0.59
16	66	0.4	7.0	1.12
17	66	0.3	4.2	1.64
18	66	9.1	1.6	1.31
19	66	10.1	3.0	0.29
20	67	10.7	5.5	0.77
21	67	1.7	5.1	0.50
22	67	3.7	3.2	1.01
23	68	8.0	1.4	0.67
24	68	2.2	4.7	1.59
25	68	4.9	0.3	1.57
26	70	10.6	5.9	1.85
27	71	10.9	4.4	1.22
28	71	4.1	11.0	1.48
29	71	10.9	6.7	1.62
30	71	1.6	2.1	1.61
31	72	8.8	2.2	0.65
32	72	9.0	1.5	0.78
33	72	9.5	2.0	1.56
34	72	1.7	9.6	0.73
35	72	4.2	1.0	1.21
36	72	3.8	0.7	0.86
37	73	7.5	1.6	0.63
38	73	3.6	1.3	0.94
39	74	0.4	6.5	1.07
40	74	1.4	3.8	1.36

RUN 15 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	76	10.3	7.2	0.75
42	76	3.6	1.4	0.78
43	76	6.1	0.5	1.46
44	77	9.3	3.1	1.66
45	77	0.9	6.4	1.52
46	77	1.1	5.7	1.49
47	77	0.6	5.8	1.07
48	78	0.9	7.4	1.38
49	78	10.8	7.1	0.31
50	78	3.9	1.4	0.57
51	79	10.8	5.9	1.38
52	79	11.2	5.1	1.31
53	79	2.3	9.5	1.69
54	79	1.3	8.3	1.46
55	79	4.7	1.0	1.14
56	80	2.0	2.4	1.55
57	80	8.6	1.8	1.41
58	83	3.2	10.8	1.90
59	83	10.9	5.1	1.10
60	83	10.5	5.0	1.37
61	83	11.1	5.6	1.70
62	83	11.1	8.1	0.53
63	83	1.1	6.0	0.47
64	83	1.5	4.8	0.78
65	84	2.0	2.7	1.27
66	84	7.1	3.6	1.10
67	84	7.7	0.9	1.41
68	84	2.3	1.6	1.64
69	85	0.8	7.5	1.68
70	85	0.5	6.7	0.76
71	85	3.8	1.6	0.95
72	85	5.5	1.3	1.23
73	89	4.3	0.6	0.64
74	89	9.4	3.1	0.60
75	90	10.3	4.9	0.76
76	90	8.1	1.8	0.42
77	90	5.9	0.9	0.62
78	91	7.6	10.0	0.73
79	91	3.0	0.9	1.05
80	91	0.9	4.9	0.75

RUN 15 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	92	2.8	9.7	0.55
82	92	2.1	8.3	0.50
83	92	9.5	3.9	1.43
84	93	11.0	7.1	1.26
85	93	10.2	7.3	1.00
86	93	7.0	0.4	1.61
87	93	9.9	3.5	0.87
88	98	9.4	2.3	1.37
89	99	2.7	1.9	1.24
90	99	8.6	1.3	1.48
91	99	1.0	4.9	0.63
92	100	1.8	3.2	0.64
93	100	7.2	1.5	0.57

RUN 16 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.044	FT./SEC.
BED HEIGHT	12.5	IN.
SETTLED BED HEIGHT	12.0	IN.
PRESSURE DROP THROUGH BED	43.1	CM. OF WATER
AIR TEMPERATURE	87	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	1.340	SEC.

RUN 16 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	37	10.7	4.8	1.03
2	37	10.0	4.1	1.25
3	38	9.0	2.6	1.27
4	39	10.9	3.9	2.80
5	39	1.3	6.9	1.31
6	40	8.4	9.3	2.44
7	40	9.7	8.1	1.83
8	42	9.8	3.5	2.12
9	43	9.5	7.7	2.22
10	43	6.4	10.2	1.98
11	44	6.7	10.4	2.48
12	44	3.5	8.9	0.68
13	46	8.4	8.9	1.74
14	47	6.8	10.7	2.42
15	47	1.8	6.3	0.52
16	48	3.8	10.9	0.84
17	49	10.5	4.7	0.86
18	51	11.1	5.1	1.40
19	52	9.8	2.0	0.81
20	52	1.0	6.6	1.21
21	52	2.5	5.1	1.98
22	53	9.7	4.2	1.17
23	55	1.9	9.1	1.15
24	55	8.5	8.6	2.00
25	55	10.2	6.5	2.22
26	58	2.7	3.7	0.91
27	58	0.5	3.6	0.65
28	58	11.0	7.1	0.72
29	58	10.2	7.1	1.48
30	60	9.9	9.3	1.28
31	61	7.3	11.1	1.04
32	61	9.5	3.0	1.41
33	61	9.6	5.1	1.05
34	62	4.3	10.3	2.14
35	63	2.2	9.1	2.04
36	65	7.1	11.1	1.07
37	65	9.7	9.3	1.61
38	66	10.0	4.4	1.50
39	66	0.9	7.7	1.92
40	67	11.0	4.0	0.87

RUN 16 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	67	9.8	2.1	1.44
42	67	4.9	10.2	1.64
43	68	1.6	7.6	1.92
44	68	9.4	8.2	1.98
45	69	11.1	4.1	0.63
46	70	9.7	6.0	2.30
47	73	3.9	10.7	1.28
48	73	9.6	3.9	1.21
49	75	9.5	1.8	0.70
50	76	9.7	3.9	0.73
51	76	5.3	10.7	1.04
52	76	1.0	7.1	0.52
53	76	1.6	6.8	1.05
54	76	2.1	8.5	2.06
55	76	7.2	9.1	2.48
56	78	11.0	7.4	0.69
57	79	9.8	1.9	0.68
58	79	11.2	7.8	0.57
59	79	1.4	6.1	0.74
60	79	1.0	6.7	1.21
61	82	2.5	6.7	0.39
62	82	1.3	6.5	1.61
63	82	2.5	7.8	2.19
64	82	7.8	7.7	0.89
65	82	8.5	7.7	0.52
66	82	9.0	8.8	0.70
67	82	9.6	8.2	1.88
68	82	9.8	9.0	0.96
69	82	9.7	3.9	1.27
70	82	9.9	5.2	1.74
71	83	5.3	1.8	0.74
72	83	3.9	9.9	1.96
73	83	9.9	2.2	0.60
74	83	9.1	3.0	0.96
75	85	4.7	9.2	0.66
76	85	3.9	9.6	1.17
77	86	10.9	7.7	0.91
78	87	1.0	7.1	2.09
79	88	2.8	10.0	0.99
80	88	10.6	5.0	0.72

RUN 16 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	89	10.0	7.4	0.96
82	90	6.5	10.5	1.36
83	91	4.7	9.6	1.98
84	91	8.5	2.4	1.72
85	92	2.6	7.6	2.20
86	93	2.6	9.0	0.47
87	93	1.9	8.8	0.73
88	93	4.9	9.8	1.57
89	93	10.5	7.2	1.78
90	95	0.4	4.1	0.61
91	95	9.3	1.6	0.48
92	95	1.0	5.1	0.99
93	95	8.0	9.5	2.04
94	96	6.3	10.6	1.99
95	98	9.7	1.7	0.87
96	98	10.9	3.6	0.59
97	98	1.5	7.3	0.37
98	99	9.7	8.6	2.30

RUN 17 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.044	FT./SEC.
BED HEIGHT	25.0	IN.
SETTLED BED HEIGHT	24.0	IN.
PRESSURE DROP THROUGH BED	85.6	CM. OF WATER
AIR TEMPERATURE	90	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	1.580	SEC.

RUN 17 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	8.6	8.8	3.33
2	2	10.3	3.5	2.09
3	4	3.8	8.7	3.54
4	11	4.7	6.3	0.67
5	11	4.7	6.8	0.81
6	11	5.5	7.3	0.88
7	11	5.8	6.3	1.56
8	12	10.4	6.3	2.01
9	14	7.8	5.7	1.08
10	14	10.6	4.7	1.95
11	17	10.3	2.6	1.21
12	22	3.7	6.4	0.87
13	22	1.8	6.6	2.36
14	22	3.1	7.4	1.46
15	22	4.6	8.8	2.86
16	23	8.8	3.7	1.80
17	24	10.2	3.1	1.91
18	26	6.7	10.8	1.02
19	26	8.9	5.4	2.18
20	28	10.9	4.1	1.35
21	30	9.4	7.1	2.47
22	30	8.1	8.1	1.62
23	31	7.5	10.7	1.35
24	33	6.2	9.0	2.40
25	34	6.8	11.0	1.29
26	34	9.8	9.2	1.54
27	34	9.8	2.1	1.16
28	37	2.4	7.8	3.81
29	39	9.4	1.7	0.98
30	40	5.5	9.4	3.68
31	40	9.7	7.1	1.73
32	40	9.3	5.4	1.91
33	43	11.6	5.7	0.94
34	43	9.1	2.8	0.55
35	43	8.7	3.7	0.71
36	43	8.3	2.9	0.59
37	47	11.0	4.2	1.16
38	49	9.8	1.9	0.99
39	50	3.8	8.5	2.09
40	50	2.1	8.2	2.14

RUN 17 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	50	3.3	6.6	1.32
42	51	11.2	4.7	0.77
43	51	9.2	9.8	1.37
44	51	10.6	3.9	1.10
45	51	11.0	6.3	1.27
46	51	8.3	7.9	3.49
47	51	9.0	3.2	2.27
48	54	4.5	9.5	1.62
49	56	5.6	11.0	1.62
50	59	4.7	9.3	1.12
51	61	5.8	10.9	1.81
52	61	9.7	5.3	2.56
53	65	9.7	2.0	1.20
54	65	11.0	5.3	1.85
55	67	7.7	6.4	2.59
56	68	9.0	3.7	2.44
57	71	5.5	9.4	2.18
58	71	3.5	9.3	1.88
59	71	6.3	5.4	1.60
60	71	4.6	6.5	1.94
61	72	9.4	9.7	1.52
62	72	9.7	2.1	1.18
63	74	11.1	4.7	1.26
64	75	7.8	9.0	1.47
65	75	8.5	3.4	2.17

RUN 18 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.044	FT./SEC.
BED HEIGHT	37.5	IN.
SETTLED BED HEIGHT	36.0	IN.
PRESSURE DROP THROUGH BED	130.0	CM. OF WATER
AIR TEMPERATURE	91	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	2.460	SEC.

RUN 18 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	3	3.6	7.6	3.92
2	4	8.7	5.7	4.21
3	9	6.3	3.6	1.25
4	11	5.0	9.5	3.60
5	12	5.9	8.1	2.21
6	14	10.2	6.4	1.20
7	20	1.3	9.1	1.28
8	34	7.0	10.8	1.77
9	34	8.1	4.8	2.85
10	34	9.1	2.8	1.11
11	34	7.4	2.4	2.13
12	35	6.7	8.2	3.67
13	40	3.6	5.3	4.20
14	42	7.7	10.3	2.08
15	47	7.7	7.4	4.77
16	48	4.7	9.6	1.00
17	48	4.1	8.3	1.77
18	55	10.8	3.7	1.29
19	55	10.4	2.7	0.61
20	64	2.1	5.3	0.34
21	64	9.3	9.9	1.36
22	64	2.6	5.7	1.12
23	64	1.7	5.8	0.95
24	72	1.8	9.9	0.63
25	76	2.0	6.6	3.33
26	77	4.8	9.3	2.61
27	78	7.9	8.2	3.75
28	80	11.2	4.2	0.84
29	84	11.1	3.5	0.61
30	84	7.3	11.0	1.10
31	85	7.2	7.9	2.86
32	88	9.4	5.0	3.16
33	88	7.2	3.1	3.44
34	93	4.4	9.4	3.70
35	97	10.8	4.0	1.84
36	100	6.4	9.5	1.06
37	100	7.3	10.1	2.37
38	103	11.0	4.4	0.55
39	104	5.8	8.6	0.58
40	104	5.9	8.1	0.48

RUN 18 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	104	8.9	8.0	1.23
42	117	2.7	7.3	3.30
43	118	7.9	4.2	5.02
44	118	2.9	4.1	2.59

RUN 19 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.059	FT./SEC.
BED HEIGHT	1.1	IN.
SETTLED BED HEIGHT	1.0	IN.
PRESSURE DROP THROUGH BED	3.3	CM. OF WATER
AIR TEMPERATURE	94	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	0.004	SEC.

RUN 19 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	2.9	6.9	0.18
2	1	3.0	7.4	0.42
3	1	2.6	7.5	0.36
4	1	2.6	7.1	0.27
5	1	2.5	6.9	0.34
6	1	2.4	7.3	0.33
7	1	2.2	7.7	0.28
8	1	2.0	7.6	0.38
9	1	1.9	7.2	0.29
10	1	1.7	7.6	0.21
11	1	1.6	7.3	0.23
12	1	1.4	6.7	0.21
13	1	1.4	7.5	0.33
14	1	1.3	7.1	0.29
15	1	1.1	7.2	0.42
16	1	0.9	7.7	0.30
17	1	0.7	8.0	0.30
18	1	0.4	7.1	0.33
19	1	0.5	6.7	0.29
20	1	2.8	6.2	0.25
21	1	2.7	6.6	0.22
22	1	2.5	6.1	0.33
23	1	2.4	6.4	0.21
24	1	2.0	6.2	0.21
25	1	1.9	6.1	0.27
26	1	1.6	6.1	0.23
27	1	1.0	6.6	0.33
28	1	0.5	6.4	0.33
29	1	3.0	5.8	0.12
30	1	2.9	6.0	0.12
31	1	2.6	5.8	0.24
32	1	2.6	5.6	0.25
33	1	2.2	5.8	0.16
34	1	1.9	5.6	0.23
35	1	1.7	5.5	0.18
36	1	1.6	5.6	0.25
37	1	1.4	5.8	0.29
38	1	1.1	5.5	0.23
39	1	1.0	5.9	0.48
40	1	0.8	5.6	0.45

RUN 19 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	1	0.4	5.5	0.27
42	1	0.4	5.8	0.30
43	1	0.2	5.6	0.39
44	1	0.1	5.3	0.25
45	1	3.0	5.2	0.18
46	1	2.8	5.4	0.15
47	1	2.6	5.2	0.21
48	1	2.1	5.2	0.18
49	1	2.0	5.3	0.12
50	1	1.7	4.9	0.17
51	1	1.4	5.2	0.33
52	1	0.4	5.1	0.39
53	1	1.7	4.6	0.21
54	1	1.6	4.4	0.12
55	1	1.1	4.6	0.38
56	1	0.7	4.5	0.27
57	1	0.8	4.3	0.15
58	1	0.5	4.3	0.15
59	1	3.0	3.6	0.21
60	1	2.9	3.9	0.27
61	1	2.8	4.2	0.15
62	1	2.6	4.0	0.12
63	1	2.6	3.9	0.12
64	1	2.7	3.7	0.18
65	1	1.1	4.2	0.12
66	1	1.4	4.0	0.15
67	1	1.2	3.8	0.18
68	1	1.0	3.8	0.33
69	1	0.6	3.9	0.18
70	1	2.5	3.3	0.30
71	1	2.2	3.6	0.15
72	1	2.2	3.1	0.12
73	1	1.9	3.6	0.18
74	1	2.0	3.3	0.21
75	1	1.8	3.2	0.12
76	1	1.4	3.0	0.12
77	1	0.9	3.4	0.18
78	1	2.3	3.0	0.30
79	1	2.0	3.0	0.24
80	1	1.5	2.8	0.44

## RUN 19 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	1	1.2	2.9	0.36
82	1	2.7	2.1	0.18
83	1	2.3	1.9	0.15
84	1	1.9	2.1	0.42
85	1	1.6	2.3	0.36
86	1	2.1	1.7	0.17
87	1	2.2	1.4	0.21
88	1	2.8	2.2	0.18
89	1	3.0	1.4	0.21
90	1	2.8	1.4	0.29

RUN 20 PART A

PARTICLES		GLASS BEADS
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.059	FT./SEC.
BED HEIGHT	4.4	IN.
SETTLED BED HEIGHT	4.0	IN.
PRESSURE DROP THROUGH BED	14.6	CM. OF WATER
AIR TEMPERATURE	91	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	0.354	SEC.

RUN 20 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	44	6.8	3.5	1.00
2	44	6.5	1.9	0.63
3	44	7.8	6.4	1.44
4	44	1.1	7.4	1.49
5	45	7.9	8.3	1.06
6	45	9.1	8.4	0.99
7	45	4.7	2.2	0.98
8	45	4.6	1.1	0.55
9	45	3.9	2.8	0.62
10	45	7.3	8.6	0.83
11	45	7.9	9.3	0.91
12	46	7.0	0.9	0.50
13	46	2.8	4.4	0.83
14	46	2.2	3.7	0.93
15	46	1.7	3.7	0.43
16	46	6.6	9.4	1.16
17	47	6.2	2.0	0.55
18	47	4.5	3.7	0.67
19	47	9.1	9.7	1.36
20	47	3.2	3.4	1.56
21	48	5.8	8.9	0.37
22	48	5.7	2.8	0.29
23	48	5.9	2.2	0.51
24	48	5.0	1.4	1.32
25	48	6.8	7.8	1.12
26	48	1.6	8.8	0.85
27	49	8.2	7.9	1.66
28	49	7.1	1.6	1.44
29	49	4.9	3.6	0.45
30	49	5.0	5.0	0.66
31	49	9.7	9.0	1.07
32	50	0.9	4.8	0.60
33	50	10.9	5.4	1.03
34	50	8.6	9.4	1.49
35	50	7.2	1.7	0.63
36	50	2.6	4.3	1.55
37	50	1.6	4.0	1.09
38	50	1.7	7.6	0.69
39	51	8.3	7.8	1.48
40	51	7.3	8.7	1.25

RUN 20 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	51	6.2	1.8	1.30
42	51	4.8	3.6	0.40
43	51	4.9	10.7	0.72
44	52	7.6	0.9	1.03
45	52	8.2	9.7	1.04
46	52	2.5	4.3	0.63
47	52	2.6	3.6	0.57
48	52	1.3	4.0	1.43
49	52	2.0	6.7	1.55
50	52	0.6	7.8	1.20
51	52	1.8	8.5	0.74
52	52	1.9	9.3	0.97
53	53	7.4	10.8	0.94
54	53	9.7	3.4	0.71
55	53	4.1	0.7	1.06
56	53	5.6	0.5	0.80
57	53	3.9	3.9	1.10
58	53	2.2	10.2	0.28
59	54	1.0	7.0	0.57
60	54	11.0	5.2	0.96
61	54	10.2	4.5	1.16
62	54	4.5	2.5	1.25
63	54	2.8	1.6	0.76
64	54	0.9	7.0	0.57
65	54	2.2	5.9	1.56
66	55	5.3	2.4	1.01
67	55	8.2	2.5	1.34
68	55	4.6	1.0	0.55
69	55	3.4	4.3	0.71
70	55	2.3	3.6	1.32
71	55	1.4	5.8	1.20
72	56	7.8	1.8	0.74
73	57	5.2	2.6	1.38
74	57	10.2	4.2	1.34
75	57	9.4	3.7	1.44
76	57	8.2	3.7	1.14
77	57	5.9	1.1	1.48
78	57	3.3	2.9	0.55
79	57	3.7	3.0	0.75
80	57	4.2	3.4	0.97

RUN 20 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	58	6.9	1.2	1.56
82	58	1.3	8.7	0.62
83	58	1.9	9.1	0.74
84	59	4.4	0.8	0.92
85	59	3.9	3.4	0.55
86	59	4.6	2.5	0.92
87	59	3.5	4.0	0.40
88	59	1.7	4.1	0.43
89	59	2.5	4.7	1.26
90	59	2.4	9.8	0.80
91	60	7.0	0.9	0.87
92	60	9.3	3.9	1.44
93	60	7.6	3.6	1.29
94	60	0.8	5.5	1.06
95	60	1.9	6.7	1.06
96	60	0.6	7.0	0.86
97	60	0.9	7.9	1.03
98	60	1.7	8.4	0.74
99	60	2.0	8.7	0.54
100	60	1.7	5.3	0.60

RUN 21 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.059	FT./SEC.
BED HEIGHT	8.6	IN.
SETTLED BED HEIGHT	8.0	IN.
PRESSURE DROP THROUGH BED	28.4	CM. OF WATER
AIR TEMPERATURE	93	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	1.020	SEC.

RUN 21 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	40	3.6	2.6	3.52
2	40	9.8	2.3	0.82
3	40	1.0	4.5	1.74
4	43	5.9	2.1	2.01
5	43	1.1	4.9	1.67
6	44	2.5	6.4	1.31
7	44	1.7	7.1	1.29
8	44	7.9	3.0	3.15
9	45	10.9	4.9	1.42
10	45	6.2	1.5	0.78
11	45	5.9	2.6	1.57
12	45	5.1	1.5	1.00
13	45	4.2	2.6	3.00
14	45	1.9	2.5	1.25
15	45	1.4	5.7	1.02
16	46	10.9	3.7	0.76
17	46	10.5	7.0	0.66
18	46	7.0	0.9	1.45
19	47	9.1	2.7	1.81
20	47	7.5	2.5	2.60
21	47	2.0	8.6	1.02
22	48	3.6	2.4	2.63
23	48	5.8	2.9	1.78
24	50	1.1	5.5	1.52
25	51	3.3	0.8	0.64
26	52	4.5	1.3	1.77
27	52	1.8	3.9	2.32
28	52	3.1	2.6	2.41
29	52	9.9	3.0	2.09
30	53	11.1	6.0	0.61
31	53	10.8	4.9	1.19
32	54	5.8	2.4	2.31
33	54	1.6	7.7	1.48
34	55	1.4	9.1	0.94
35	55	10.5	5.0	0.65
36	56	7.7	2.5	3.22
37	56	9.7	3.5	1.86
38	57	3.2	2.8	2.50
39	59	1.9	8.0	1.79
40	59	11.1	7.5	0.45

RUN 21 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	59	4.7	1.8	2.80
42	60	10.3	4.5	1.09
43	60	9.3	2.5	1.96
44	61	10.8	6.3	0.69
45	61	1.2	5.6	2.40
46	61	2.3	3.3	2.50
47	63	2.8	2.5	1.83
48	64	8.9	1.9	1.01
49	64	9.9	3.2	1.68
50	65	10.7	6.2	0.69
51	66	10.7	5.5	0.82
52	66	10.6	4.5	1.02
53	66	6.5	2.3	3.05
54	66	0.5	6.1	0.43
55	66	2.1	2.7	0.91
56	66	3.7	2.6	0.85
57	67	1.9	7.5	1.19
58	67	0.7	7.0	1.12
59	68	1.8	3.8	2.12
60	69	0.9	6.0	1.25
61	69	2.8	2.4	1.33
62	69	4.6	1.5	2.18
63	69	6.9	1.8	1.89
64	70	1.2	6.7	1.27
65	70	5.5	2.9	0.99
66	70	0.9	4.7	0.66
67	71	7.8	3.6	0.84
68	72	7.3	3.6	1.12
69	72	10.0	3.1	1.33
70	72	7.1	1.5	1.78
71	73	2.1	9.2	1.45
72	73	1.9	7.9	1.53
73	73	11.0	4.4	0.49
74	73	10.5	4.5	0.84
75	73	4.4	3.3	0.76
76	73	3.3	3.1	0.82
77	74	8.8	2.4	1.84
78	75	10.8	6.4	1.35
79	76	5.8	3.7	0.35
80	76	6.4	4.2	0.69

RUN 21 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	76	0.3	6.5	1.22
82	76	1.0	6.1	1.74
83	76	2.7	2.6	2.17
84	76	4.4	2.1	2.50
85	76	6.7	1.8	3.19
86	77	1.3	7.7	1.22
87	78	0.8	4.5	1.10
88	78	10.4	3.6	1.68
89	79	1.8	5.1	1.40
90	81	6.6	3.7	2.40
91	81	8.9	3.8	1.33
92	82	9.8	3.7	1.55
93	82	10.9	5.9	0.72
94	82	2.6	4.3	0.71
95	83	7.3	2.3	1.76
96	83	6.1	2.9	1.97
97	83	11.4	6.6	0.27
98	83	2.0	9.6	0.31
99	83	1.7	9.1	0.31
100	83	1.7	7.4	0.36
101	83	1.3	8.1	0.87
102	83	3.7	1.9	2.03
103	84	10.1	3.6	1.51
104	84	7.7	3.4	0.63
105	84	6.5	2.3	0.45
106	84	4.0	1.5	1.91
107	86	10.1	4.9	0.66
108	86	1.4	7.3	1.55
109	86	1.0	5.4	1.32
110	87	11.0	4.6	0.66
111	87	6.8	4.4	1.24
112	88	9.7	2.3	1.49
113	88	7.1	1.9	2.22
114	88	5.1	2.6	2.49

RUN 22 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.059	FT./SEC.
BED HEIGHT	12.8	IN.
SETTLED BED HEIGHT	12.0	IN.
PRESSURE DROP THROUGH BED	43.7	CM. OF WATER
AIR TEMPERATURE	87	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	4.210	SEC.

RUN 22 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	0	10.2	5.6	2.29
2	0	10.7	6.3	0.30
3	0	4.0	10.0	0.38
4	99	7.6	9.3	0.79
5	99	3.8	10.0	2.42
6	100	9.9	5.9	2.80
7	101	2.2	7.3	2.29
8	104	3.5	0.7	2.96
9	104	9.6	1.7	0.76
10	104	11.0	5.9	0.50
11	104	9.9	8.0	2.09
12	105	10.0	9.0	0.92
13	106	1.8	6.5	0.76
14	106	5.8	1.0	2.32
15	107	8.1	2.5	1.35
16	107	8.5	8.5	2.25
17	107	2.0	3.3	3.12
18	107	9.6	1.6	1.86
19	108	7.0	11.1	0.69
20	108	1.8	7.4	1.12
21	108	10.3	6.5	2.80
22	109	2.1	7.1	1.43
23	110	9.0	4.9	1.52
24	110	10.4	5.3	1.77
25	111	8.7	5.2	2.53
26	113	9.7	7.3	1.09
27	113	9.6	8.3	0.89
28	114	1.3	4.1	1.02
29	114	2.7	1.4	2.30
30	114	8.9	8.4	1.10
31	114	5.8	1.1	2.07
32	114	2.3	8.8	1.35
33	114	5.4	9.5	1.40
34	115	6.9	10.3	0.58
35	115	10.2	8.2	2.17
36	116	6.9	9.7	1.13
37	117	4.9	10.3	1.02
38	117	4.8	8.5	1.97
39	118	10.3	6.3	1.35
40	118	10.3	5.7	0.26

RUN 22 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	118	10.3	5.1	0.31
42	118	2.0	7.0	0.48
43	119	8.4	1.8	1.94
44	119	6.6	7.6	2.35
45	119	9.4	8.6	1.70
46	119	7.9	7.4	1.28
47	120	0.6	5.0	1.81
48	120	1.5	4.4	1.05
49	121	1.1	5.7	0.77
50	121	3.6	9.6	1.15
51	121	3.3	8.4	1.54
52	121	10.3	8.3	0.87
53	121	9.6	9.1	0.91
54	123	3.4	0.6	1.60
55	123	3.3	1.6	0.71
56	124	1.3	3.6	1.04
57	124	9.7	5.3	1.51
58	125	4.9	9.1	2.07
59	125	8.2	8.1	2.49
60	125	1.6	3.1	2.11
61	125	1.4	7.2	2.29
62	126	6.0	1.0	2.60
63	127	8.2	10.3	2.22
64	128	6.4	10.0	2.00
65	128	4.0	7.9	1.71
66	130	2.0	8.7	1.91
67	131	4.7	9.4	2.23
68	131	8.7	10.4	2.59
69	132	8.6	8.4	1.17
70	132	3.0	1.1	2.50
71	134	1.0	3.4	1.17
72	135	9.1	3.6	2.06
73	137	1.6	4.5	0.56
74	137	5.3	9.5	2.06
75	138	2.8	7.9	1.94
76	138	9.7	7.7	2.49
77	138	7.4	7.6	2.46
78	139	8.2	8.9	2.23
79	139	0.4	6.2	1.35
80	140	3.6	1.4	1.97

RUN 22 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	140	1.5	8.3	1.37
82	140	0.4	6.6	0.64
83	140	8.7	9.5	1.51
84	140	1.5	8.7	0.91
85	141	11.2	5.3	2.31
86	142	10.1	4.9	1.19
87	144	10.4	3.8	0.89
88	144	9.2	4.1	0.65
89	146	10.1	6.1	1.22
90	146	10.4	8.3	1.40
91	146	10.0	7.7	2.09
92	146	1.2	7.2	1.02
93	147	2.5	2.9	1.08
94	147	5.1	1.0	1.35
95	147	5.4	10.0	1.77
96	147	2.8	9.0	1.23
97	147	9.5	5.7	2.06
98	147	6.0	7.3	2.73
99	148	8.3	5.0	1.81
100	148	8.9	5.4	1.21
101	149	5.6	11.1	0.94
102	150	7.4	1.5	1.38
103	150	3.1	8.9	1.32
104	151	1.3	4.0	0.48
105	151	3.3	8.7	2.81
106	152	9.1	4.3	1.71
107	152	10.3	8.6	2.33
108	153	5.8	10.4	1.28
109	154	1.3	6.8	1.78
110	155	1.2	5.3	1.10
111	156	7.8	2.1	1.62
112	156	9.9	4.9	1.73
113	156	7.3	9.6	2.42
114	156	6.0	8.2	2.63
115	157	7.2	2.7	2.53
116	157	1.8	8.6	1.02
117	157	4.6	10.6	0.86
118	158	9.6	4.6	0.82
119	159	6.2	1.2	1.53
120	159	1.3	8.7	1.81

RUN 22 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
121	160	1.7	6.6	0.92
122	160	1.0	6.5	0.86
123	160	0.5	6.6	0.63
124	162	1.3	7.8	0.53
125	162	11.0	6.7	0.65
126	162	10.2	4.9	0.76
127	162	7.4	9.4	1.22
128	162	2.8	8.0	2.13
129	163	9.5	8.6	2.83
130	163	9.5	5.9	2.81
131	163	10.1	8.1	0.97
132	163	2.3	3.6	1.38
133	164	0.9	5.1	1.05
134	164	8.0	2.1	2.07
135	164	7.7	1.5	1.12
136	164	6.2	7.7	0.40
137	165	8.6	9.5	0.66
138	165	2.6	1.0	0.77
139	165	5.1	0.1	1.04
140	165	3.8	1.8	0.69
141	167	2.6	7.2	0.43
142	168	0.7	3.7	0.66
143	168	7.1	1.2	1.90
144	168	5.5	9.7	1.29
145	168	1.2	5.7	1.23
146	168	3.4	2.0	3.32
147	170	5.3	1.2	1.95
148	171	3.4	8.9	0.41
149	171	5.7	0.9	1.63
150	172	8.7	9.3	1.31
151	172	7.0	8.3	1.18
152	172	9.9	7.3	2.63
153	173	2.1	8.2	1.16
154	173	8.9	2.8	2.56
155	174	8.4	8.8	2.45
156	174	10.6	4.4	1.93
157	174	8.9	4.3	1.77
158	174	6.6	9.2	1.65
159	175	8.0	1.7	1.98
160	177	2.6	1.3	2.08

RUN 22 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
161	177	6.7	10.0	1.61
162	177	6.6	8.8	1.25
163	178	3.4	8.7	1.15
164	178	4.6	0.4	1.68
165	179	0.2	5.7	1.41
166	179	9.7	8.6	1.13
167	179	9.2	7.3	0.82
168	179	5.4	8.4	1.35
169	181	10.0	7.8	2.40
170	185	10.7	4.1	0.92
171	185	5.1	9.7	3.40
172	185	1.7	7.2	2.80
173	186	7.8	1.8	2.46
174	186	7.6	8.7	2.19
175	187	2.7	2.5	1.48
176	188	0.5	3.8	0.97
177	189	2.1	9.1	0.71
178	189	1.6	4.9	1.37
179	189	7.9	0.7	0.89
180	191	2.6	3.0	1.10
181	192	10.1	4.9	3.07
182	192	1.7	2.0	0.96
183	193	5.8	1.2	1.30
184	194	9.3	2.1	0.63
185	194	9.7	2.6	0.89
186	195	10.8	5.2	0.81
187	196	9.7	7.9	1.75
188	196	7.6	9.6	1.97
189	196	4.3	1.5	1.07
190	196	4.1	9.2	2.69
191	196	8.6	3.1	2.30
192	198	8.5	3.3	1.84
193	198	8.5	3.6	1.65
194	198	10.8	5.5	1.74
195	199	7.9	8.2	2.75
196	200	2.1	4.9	1.38
197	203	1.0	6.1	2.40
198	203	0.5	10.2	2.83
199	203	1.8	1.8	0.44
200	203	4.1	2.2	0.38

RUN 22 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
201	204	2.5	6.2	1.73
202	205	6.2	1.3	1.48
203	207	3.2	2.0	0.97
204	208	4.4	1.1	1.66
205	208	9.1	9.4	1.69
206	208	2.0	3.2	2.54
207	208	9.2	3.4	2.17
208	209	9.8	4.7	1.02
209	209	8.7	4.7	0.99
210	210	2.6	9.7	1.70
211	210	3.9	9.3	1.91
212	210	2.7	10.0	1.28
213	213	2.3	7.7	2.29
214	215	7.5	9.5	2.68
215	215	7.1	1.6	1.79
216	215	9.1	8.7	1.66
217	215	9.6	7.6	2.09
218	216	4.0	0.4	0.53
219	216	10.6	4.0	0.41
220	216	10.4	3.3	0.77
221	216	8.8	2.8	2.53
222	218	3.4	9.4	2.31
223	218	6.8	10.8	0.99
224	220	9.8	5.7	2.81
225	222	1.3	3.7	1.89
226	223	6.6	1.1	1.27
227	224	2.8	8.0	2.71
228	224	0.7	6.3	1.55
229	225	1.3	7.2	1.54
230	227	10.1	4.7	1.33
231	227	1.7	5.2	1.71
232	227	2.4	3.5	1.84
233	228	3.5	0.6	0.97
234	228	5.6	11.2	1.24
235	229	5.9	1.1	1.66
236	229	5.3	1.4	1.15
237	229	10.5	3.8	0.82
238	229	1.7	6.6	1.56
239	230	9.8	3.8	0.77
240	230	2.4	2.0	1.54

## RUN 22 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
241	230	8.7	8.2	0.66
242	230	8.8	7.7	0.61
243	231	8.0	9.3	0.58
244	232	9.3	8.8	0.87
245	232	7.2	11.0	1.29
246	232	6.1	0.9	1.66
247	232	9.3	9.9	1.01
248	232	7.8	8.7	1.78
249	232	6.6	9.6	1.43
250	232	11.3	5.9	0.78
251	232	6.4	1.2	0.87
252	232	4.0	10.2	1.45
253	233	4.7	9.2	1.95
254	235	1.5	5.4	2.04
255	235	3.0	10.5	0.92
256	235	2.5	9.3	1.19
257	237	8.7	2.6	1.72
258	237	9.8	4.0	2.14
259	237	10.0	7.5	2.17
260	237	3.9	10.5	0.99
261	237	2.2	6.6	3.32
262	239	5.2	10.0	2.74
263	240	6.4	0.9	0.74
264	241	7.1	1.3	1.25
265	241	8.6	9.7	2.10
266	242	4.9	10.2	2.23
267	242	1.4	3.4	1.91
268	242	6.8	1.2	1.66
269	244	8.7	1.9	1.99
270	244	1.9	1.7	0.72
271	246	9.7	6.9	2.29
272	246	4.8	0.3	0.87
273	247	4.2	1.7	1.12
274	248	9.3	8.9	1.84
275	248	7.7	9.8	1.92
276	248	5.3	10.6	1.52
277	249	1.6	2.0	0.81
278	249	9.4	9.5	1.66
279	250	9.5	3.4	0.56
280	251	10.7	5.4	1.66

RUN 22 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
281	252	2.7	2.1	1.30
282	252	2.5	9.3	2.27
283	254	1.5	7.3	2.07
284	254	7.9	10.5	1.45
285	254	7.2	1.5	2.06
286	254	4.3	1.5	2.42
287	255	1.1	2.8	1.12
288	255	9.5	3.1	1.99
289	255	4.3	9.8	2.08
290	256	10.3	7.6	2.42
291	256	8.1	7.9	1.62
292	256	9.8	4.7	1.07
293	257	9.8	7.7	2.29
294	260	5.9	11.3	0.82
295	261	1.1	3.6	1.64
296	262	1.8	7.7	2.40
297	262	3.7	9.0	3.54
298	262	6.0	0.8	1.94
299	263	2.1	1.5	1.06
300	264	10.1	8.4	1.51
301	266	9.9	6.7	1.98
302	267	9.5	3.3	2.46
303	267	9.4	5.1	0.58
304	268	0.7	6.8	0.89
305	269	1.1	7.8	1.28
306	269	7.7	2.5	0.88
307	269	7.4	1.6	0.82
308	269	9.2	6.4	0.84
309	269	8.8	5.9	0.56
310	270	8.5	4.9	0.89
311	270	8.2	1.7	1.68
312	270	10.6	4.9	1.91
313	270	7.9	9.6	1.94
314	270	5.5	10.0	2.80
315	270	1.6	4.5	2.12
316	270	2.0	3.0	1.23
317	270	8.7	0.9	0.48
318	272	5.5	11.1	1.17
319	273	10.2	7.2	1.41
320	273	8.9	6.4	0.66

RUN 22 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
321	273	6.7	8.5	0.97
322	275	5.9	10.0	1.51
323	275	9.7	6.4	1.49
324	275	0.9	3.0	0.97
325	276	2.0	1.5	0.93
326	276	5.1	1.5	1.66
327	277	7.9	10.7	0.92
328	278	6.9	11.1	0.72
329	278	1.8	7.7	2.81
330	279	4.1	9.2	3.42
331	280	6.7	10.9	1.73
332	281	8.7	9.4	1.73
333	281	3.1	2.3	1.10
334	282	9.7	4.5	2.68
335	282	7.1	1.9	2.76
336	283	9.3	8.3	2.59
337	284	4.4	9.7	3.38
338	286	7.3	11.1	0.65
339	287	7.1	2.0	2.07
340	287	1.4	6.7	2.07
341	287	6.5	9.9	1.35
342	288	11.0	5.3	1.92
343	288	9.7	6.1	0.91
344	289	8.6	3.2	1.76
345	289	1.5	9.1	1.21
346	289	1.6	1.8	0.72
347	289	10.1	2.5	0.69
348	290	7.7	9.7	2.14
349	290	1.1	4.8	1.10
350	290	9.4	1.5	0.84
351	290	3.6	1.8	1.30
352	291	9.6	7.8	1.34
353	292	8.2	9.5	1.08
354	292	1.8	2.1	0.69
355	293	4.9	1.3	1.53
356	293	0.8	6.1	1.74
357	293	6.9	1.8	0.89
358	294	1.0	6.6	1.39
359	295	8.8	10.1	1.52
360	295	9.9	5.5	1.19

RUN 22 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
361	296	1.3	5.4	2.24
362	296	1.6	4.4	0.60
363	296	10.9	3.9	1.84
364	297	1.3	4.2	0.56
365	297	2.6	2.5	1.00
366	297	2.5	3.1	0.60
367	298	2.0	3.5	0.51
368	298	1.5	3.2	0.89
369	298	1.1	5.6	1.51
370	298	5.9	11.1	1.25
371	298	4.0	9.3	2.27
372	300	6.6	0.4	1.08
373	300	4.7	0.3	0.79
374	300	9.5	6.9	2.32

RUN 23 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.059	FT./SEC.
BED HEIGHT	25.4	IN.
SETTLED BED HEIGHT	24.0	IN.
PRESSURE DROP THROUGH BED	86.5	CM. OF WATER
AIR TEMPERATURE	91	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	1.600	SEC.

RUN 23 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	275	6.5	10.9	1.84
2	1	8.7	3.0	4.49
3	4	8.5	8.0	0.89
4	7	4.8	0.3	4.35
5	10	3.9	8.8	2.87
6	11	2.0	6.1	0.81
7	14	2.7	3.1	2.17
8	15	10.9	7.6	3.98
9	16	7.0	2.8	2.66
10	18	8.5	6.8	0.72
11	19	2.0	4.1	0.86
12	19	2.5	3.9	1.37
13	21	0.6	5.2	2.16
14	23	3.1	7.6	1.46
15	30	5.3	0.3	1.55
16	31	7.3	0.6	3.04
17	31	8.1	8.6	2.68
18	31	8.5	6.3	0.87
19	32	7.9	2.1	3.06
20	32	9.0	3.9	3.17
21	33	4.3	9.6	2.86
22	33	4.8	7.3	1.35
23	35	10.8	6.4	2.41
24	38	4.9	1.8	1.12
25	41	7.6	9.6	0.98
26	41	2.2	3.1	0.78
27	42	2.0	6.3	3.03
28	42	7.7	0.8	1.42
29	46	3.6	8.5	2.13
30	50	10.7	8.4	0.95
31	50	11.1	7.5	0.74
32	50	4.8	1.7	2.52
33	51	7.6	1.1	2.66
34	52	7.0	9.8	1.71
35	52	8.2	9.4	1.25
36	53	2.8	8.1	4.06
37	57	8.7	3.5	3.31
38	58	4.6	2.4	2.02
39	60	10.0	7.4	3.20
40	62	4.2	0.4	0.84

RUN 23 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	62	4.4	8.9	2.85
42	65	8.6	8.7	1.09
43	65	7.3	8.4	2.52
44	66	8.5	10.2	1.29
45	66	4.0	0.6	1.11
46	67	2.6	5.8	3.58
47	72	7.4	0.4	1.51
48	72	4.7	9.5	2.97
49	72	6.6	8.7	2.94
50	73	6.7	3.5	2.16
51	75	10.5	7.4	1.84
52	76	9.8	8.3	1.40
53	76	7.5	0.7	1.64

RUN 24 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.059	FT./SEC.
BED HEIGHT	38.0	IN.
SETTLED BED HEIGHT	36.0	IN.
PRESSURE DROP THROUGH BED	131.0	CM. OF WATER
AIR TEMPERATURE	91	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	3.020	SEC.

RUN 24 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	3	2.8	7.6	4.63
2	6	7.6	7.1	3.77
3	8	5.8	8.2	2.51
4	14	9.6	4.2	2.51
5	18	3.1	4.4	1.31
6	18	7.2	8.8	5.67
7	25	6.7	3.6	1.01
8	25	8.1	5.1	3.35
9	27	4.9	4.1	2.62
10	34	2.1	8.0	4.20
11	46	9.7	6.3	3.44
12	46	7.5	4.5	4.27
13	49	1.8	9.5	1.05
14	54	4.1	8.8	4.36
15	54	3.7	5.6	4.09
16	55	7.1	7.7	0.64
17	57	7.5	6.8	0.75
18	57	9.8	5.5	0.40
19	57	10.7	6.7	2.07
20	63	4.5	7.8	5.62
21	70	1.9	9.6	1.44
22	79	4.8	6.5	5.35
23	82	11.1	6.6	1.69
24	86	8.4	8.0	4.95
25	102	8.6	4.5	4.36
26	102	5.8	5.1	3.32
27	107	3.0	9.1	4.00
28	107	7.5	7.9	3.31
29	111	4.9	4.0	3.38
30	114	9.4	4.1	3.21
31	125	1.4	9.0	1.65
32	126	9.2	9.7	2.00
33	134	9.1	8.0	4.09
34	137	3.5	6.7	1.66
35	137	1.9	6.0	1.74
36	137	3.5	4.7	3.23
37	141	3.5	8.7	3.41

RUN 25 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.088	FT./SEC.
BED HEIGHT	0.6	IN.
SETTLED BED HEIGHT	0.5	IN.
PRESSURE DROP THROUGH BED	1.6	CM. OF WATER
AIR TEMPERATURE	94	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	0.002	SEC.

RUN 25 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	11.0	10.3	0.21
2	1	10.8	10.7	0.15
3	1	10.5	10.4	0.27
4	1	12.2	10.2	0.24
5	1	12.0	9.9	0.42
6	1	11.7	9.9	0.12
7	1	11.6	9.7	0.09
8	1	11.5	10.0	0.18
9	1	11.2	10.3	0.20
10	1	11.3	10.0	0.21
11	1	10.8	10.0	0.18
12	1	10.8	9.8	0.15
13	1	10.6	10.0	0.30
14	1	10.4	10.0	0.18
15	1	12.2	9.2	0.36
16	1	12.0	9.6	0.21
17	1	11.8	9.7	0.24
18	1	11.6	9.5	0.24
19	1	11.7	9.2	0.42
20	1	11.4	9.3	0.27
21	1	11.3	9.2	0.15
22	1	11.2	9.5	0.23
23	1	11.1	9.3	0.15
24	1	11.0	9.4	0.23
25	1	10.9	9.6	0.18
26	1	10.7	9.1	0.12
27	1	10.8	9.3	0.24
28	1	10.7	9.6	0.15
29	1	10.6	9.4	0.23
30	1	10.5	9.2	0.30
31	1	13.3	9.0	0.09
32	1	13.4	8.9	0.19
33	1	13.3	8.8	0.06
34	1	12.8	9.0	0.31
35	1	12.4	8.6	0.25
36	1	12.2	8.8	0.25
37	1	12.1	8.6	0.09
38	1	12.0	8.5	0.15
39	1	11.8	9.0	0.25
40	1	11.8	8.7	0.21

RUN 25 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	1	11.7	8.8	0.21
42	1	11.5	8.7	0.21
43	1	11.4	8.9	0.15
44	1	11.2	9.0	0.27
45	1	11.2	8.6	0.24
46	1	11.0	8.8	0.21
47	1	13.7	8.0	0.12
48	1	13.4	8.4	0.21
49	1	13.3	8.4	0.15
50	1	13.1	7.9	0.18
51	1	12.4	8.2	0.17
52	1	12.9	8.4	0.33
53	1	12.2	8.0	0.21
54	1	12.1	7.9	0.12
55	1	12.1	8.2	0.15
56	1	11.7	8.5	0.24
57	1	11.7	8.1	0.34
58	1	11.5	7.9	0.15
59	1	11.4	8.2	0.18
60	1	11.3	8.4	0.21
61	1	11.1	8.2	0.16
62	1	10.9	8.4	0.36
63	1	10.7	8.3	0.28
64	1	10.4	8.0	0.25
65	1	13.9	7.6	0.24
66	1	13.9	7.8	0.15
67	1	13.6	7.7	0.18
68	1	13.4	7.8	0.14
69	1	13.3	7.4	0.27
70	1	12.9	7.7	0.24
71	1	12.6	7.7	0.16
72	1	12.6	7.4	0.33
73	1	12.3	7.4	0.30
74	1	12.3	7.8	0.21
75	1	12.1	7.6	0.18
76	1	12.1	7.4	0.33
77	1	11.8	7.4	0.31
78	1	11.6	7.7	0.18
79	1	11.6	7.5	0.21
80	1	11.4	7.7	0.27

RUN 25 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	1	11.3	7.4	0.21
82	1	11.1	7.3	0.30
83	1	11.0	7.6	0.15
84	1	10.9	7.9	0.25
85	1	10.8	7.7	0.06
86	1	10.8	7.5	0.09
87	1	10.6	7.6	0.27
88	1	10.5	7.5	0.12
89	1	10.5	7.9	0.27
90	1	10.3	7.7	0.39

RUN 26 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.088	FT./SEC.
BED HEIGHT	1.2	IN.
SETTLED BED HEIGHT	1.0	IN.
PRESSURE DROP THROUGH BED	3.4	CM. OF WATER
AIR TEMPERATURE	94	DEGREES F.
CAMERA		HYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	0.006	SEC.

RUN 26 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	3.3	10.3	0.32
2	1	3.5	9.9	0.24
3	1	3.0	10.2	0.24
4	1	3.0	9.9	0.21
5	1	2.9	9.6	0.26
6	1	2.5	9.9	0.61
7	1	2.2	9.9	0.30
8	1	3.1	9.5	0.24
9	1	3.6	9.2	0.33
10	1	3.1	9.1	0.57
11	1	2.6	9.4	0.45
12	1	2.4	9.1	0.18
13	1	1.9	9.1	0.24
14	1	3.4	8.6	0.12
15	1	2.7	8.5	0.61
16	1	2.2	8.7	0.51
17	1	1.9	8.4	0.28
18	1	2.7	8.2	0.24
19	1	2.2	8.0	0.36
20	1	3.4	7.8	0.60
21	1	3.1	7.3	0.33
22	1	2.9	7.7	0.48
23	1	2.6	7.6	0.32
24	1	2.5	7.4	0.61
25	1	2.4	7.4	0.15
26	1	2.1	7.6	0.26
27	1	1.8	7.5	0.23
28	1	2.0	7.3	0.15
29	1	2.4	6.9	0.18
30	1	2.3	6.8	0.15
31	1	2.5	6.7	0.12
32	1	3.1	7.0	0.39
33	1	2.9	6.8	0.15
34	1	2.5	7.1	0.39
35	1	2.2	6.9	0.33
36	1	3.5	6.4	0.49
37	1	3.2	6.2	0.21
38	1	3.0	6.4	0.30
39	1	3.0	6.6	0.12
40	1	2.7	6.2	0.23

RUN 26 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	1	2.5	6.4	0.15
42	1	2.4	6.5	0.18
43	1	2.0	6.2	0.48
44	1	3.1	5.9	0.18
45	1	3.3	5.5	0.21
46	1	2.8	5.6	0.18
47	1	2.4	6.0	0.30
48	1	2.8	5.8	0.12
49	1	2.0	5.9	0.24
50	1	2.9	5.4	0.30
51	1	2.4	5.1	0.12
52	1	2.2	3.9	0.15
53	1	2.4	3.8	0.18
54	1	2.6	4.2	0.15
55	1	2.5	4.1	0.09
56	1	3.1	3.9	0.27
57	1	3.3	4.1	0.21
58	1	3.4	3.6	0.54
59	1	3.0	3.3	0.53
60	1	3.0	2.5	0.32
61	1	2.7	2.8	0.38
62	1	2.3	3.1	0.27
63	1	2.2	3.5	0.18
64	1	1.9	3.6	0.15
65	1	1.9	2.6	0.42
66	1	3.4	2.1	0.18
67	1	3.3	2.4	0.47
68	1	3.5	1.6	0.18
69	1	3.3	1.8	0.26
70	1	2.9	2.0	0.27
71	1	2.5	2.2	0.53
72	1	2.0	1.8	0.42
73	1	3.3	1.3	0.23
74	1	3.6	1.2	0.15
75	1	2.3	1.3	0.12
76	1	2.8	1.3	0.60
77	1	3.0	0.9	0.36
78	1	3.5	0.8	0.42
79	1	1.6	9.2	0.32
80	1	1.8	8.7	0.42

RUN 26 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	1	1.5	8.7	0.33
82	1	1.0	8.6	0.30
83	1	1.3	8.4	0.26
84	1	0.9	8.3	0.39
85	1	0.8	7.7	0.63
86	1	1.0	7.7	0.09
87	1	1.3	8.0	0.39
88	1	1.6	7.9	0.53
89	1	1.5	7.4	0.70
90	1	0.1	7.2	0.12
91	1	0.4	7.3	0.18
92	1	0.2	7.1	0.06
93	1	0.5	6.1	0.12
94	1	0.7	7.0	0.15
95	1	0.2	6.7	0.24
96	1	0.5	6.2	0.21
97	1	0.1	6.2	0.27
98	1	1.3	6.7	0.33
99	1	0.6	6.1	0.15
100	1	1.7	6.6	0.60
101	1	1.0	6.2	0.42
102	1	1.7	6.1	0.15
103	1	1.5	5.6	0.33
104	1	1.6	5.0	0.30
105	1	1.7	4.6	0.27
106	1	1.6	5.8	0.18
107	1	0.4	5.3	0.12
108	1	0.4	5.8	0.45
109	1	0.8	5.1	0.42
110	1	1.1	4.1	0.48
111	1	0.7	4.9	0.24
112	1	0.8	4.6	0.30
113	1	1.1	5.4	0.51
114	1	1.3	5.0	0.45
115	1	1.4	4.5	0.30
116	1	1.7	3.3	0.51

RUN 27 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.088	FT./SEC.
BED HEIGHT	4.5	IN.
SETTLED BED HEIGHT	4.0	IN.
PRESSURE DROP THROUGH BED	14.3	CM. OF WATER
AIR TEMPERATURE	91	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	0.197	SEC.

RUN 27 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	1.2	2.9	0.70
2	1	0.8	5.9	0.91
3	1	1.6	3.9	1.11
4	1	1.2	4.7	0.49
5	1	1.7	4.7	0.52
6	1	1.6	5.9	1.35
7	1	2.1	8.9	1.00
8	1	1.5	7.9	1.10
9	1	7.0	8.7	0.70
10	1	9.6	4.3	1.20
11	1	9.6	2.9	1.33
12	2	2.5	3.1	1.43
13	2	3.3	9.4	0.81
14	2	3.4	10.3	1.20
15	2	5.3	10.5	1.01
16	2	6.5	9.0	0.54
17	3	6.9	2.1	0.76
18	3	9.6	4.2	1.05
19	3	4.5	5.2	1.00
20	3	7.0	1.2	1.19
21	3	8.5	2.3	1.74
22	4	3.7	1.9	0.35
23	4	4.2	0.9	0.79
24	4	8.6	8.6	0.93
25	4	9.4	8.2	0.52
26	4	10.3	6.3	1.02
27	4	6.5	2.8	0.84
28	4	6.3	1.9	1.15
29	5	1.5	4.1	0.98
30	5	3.2	1.2	0.73
31	5	4.9	0.7	1.05
32	5	6.7	5.5	0.97
33	5	5.4	5.0	0.64
34	6	10.6	5.8	1.14
35	6	4.9	10.4	1.10
36	6	4.0	10.0	1.22
37	6	4.8	7.7	0.73
38	6	2.7	9.2	0.96
39	6	1.8	6.2	0.81
40	6	2.4	4.2	0.94

RUN 27 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	6	4.2	3.5	0.75
42	6	3.7	3.2	0.73
43	6	4.4	2.1	0.87
44	7	9.5	6.7	1.82
45	7	5.5	7.9	0.62
46	7	2.3	5.2	0.93
47	7	1.4	2.9	1.20
48	7	2.3	3.0	1.17
49	7	6.6	5.9	0.64
50	8	8.9	3.8	0.94
51	8	3.3	4.1	0.62
52	8	1.2	6.7	0.23
53	8	1.5	7.2	0.41
54	8	1.6	6.7	0.56
55	8	9.3	5.6	0.70
56	8	0.6	5.9	1.82
57	8	2.2	4.4	1.36
58	8	9.7	2.9	1.40
59	8	10.0	4.4	1.43
60	8	5.5	1.5	1.58
61	9	2.1	5.3	0.63
62	9	1.5	5.2	0.94
63	9	1.9	7.2	1.13
64	9	8.1	10.0	0.23
65	9	8.3	10.0	0.38
66	9	5.9	11.1	0.29
67	9	7.9	9.2	0.96
68	9	6.6	9.7	0.59
69	9	5.9	10.0	0.76
70	9	5.0	10.2	0.50
71	9	4.2	10.2	1.05
72	10	3.6	5.8	0.82
73	10	4.6	7.6	0.50
74	10	7.2	9.7	0.86
75	10	8.3	9.6	0.54
76	10	9.0	6.0	0.79
77	10	8.6	3.9	0.94
78	10	7.2	1.9	1.22
79	10	5.6	2.2	1.29
80	10	3.7	3.1	0.82

RUN 27 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	10	2.6	3.2	1.83
82	10	2.1	4.4	1.24

RUN 28 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.088	FT./SEC.
BED HEIGHT	13.1	IN.
SETTLED BED HEIGHT	12.0	IN.
PRESSURE DROP THROUGH BED	44.2	CM. OF WATER
AIR TEMPERATURE	87	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	1.080	SEC.

RUN 28 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	71	10.1	5.7	2.34
2	73	10.1	5.4	1.52
3	73	1.7	9.1	0.81
4	73	5.5	3.9	1.52
5	80	2.0	8.1	2.50
6	82	3.1	6.6	1.25
7	82	2.9	4.4	2.02
8	82	1.3	4.9	2.93
9	83	4.1	0.9	1.41
10	83	3.9	2.9	2.34
11	83	2.5	1.8	2.02
12	83	3.4	9.9	1.72
13	83	9.5	3.8	2.74
14	86	7.6	0.7	0.87
15	89	3.6	7.6	0.73
16	89	1.1	8.4	1.42
17	89	2.5	8.4	1.31
18	91	5.2	0.8	2.31
19	91	2.2	1.4	1.40
20	91	1.8	4.4	1.83
21	91	3.7	5.1	1.65
22	91	3.4	2.8	2.46
23	92	9.6	4.4	2.38
24	95	8.6	1.6	1.12
25	95	7.5	0.8	1.05
26	95	6.9	3.1	1.57
27	96	5.2	3.1	3.20
28	96	2.8	10.1	1.94
29	98	8.6	1.8	1.31
30	98	6.3	0.2	0.81
31	98	10.0	4.7	1.96
32	98	0.6	5.7	2.22
33	98	3.0	4.5	3.28
34	102	7.0	2.4	2.97
35	103	9.8	4.2	2.87
36	104	9.1	1.9	1.69
37	104	6.3	0.5	1.12
38	105	2.1	8.7	2.05
39	106	7.8	4.4	2.09
40	106	3.7	3.9	4.70

RUN 28 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	108	1.8	5.5	1.38
42	108	3.7	6.3	1.69
43	108	3.9	5.0	1.52
44	108	6.3	2.6	1.79
45	108	2.7	9.1	3.09
46	113	6.3	3.7	1.11
47	113	6.8	2.0	2.98
48	113	10.3	3.7	2.34
49	114	1.8	6.2	2.22
50	115	9.3	5.6	1.79
51	115	10.0	4.5	1.57
52	116	6.5	2.4	2.33
53	117	1.7	3.7	2.22
54	117	2.9	4.4	1.68
55	117	4.3	5.3	2.60
56	120	1.3	7.1	2.61
57	122	7.7	4.7	2.98
58	122	1.5	5.6	2.22

RUN 29 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.088	FT./SEC.
BED HEIGHT	26.0	IN.
SETTLED BED HEIGHT	24.0	IN.
PRESSURE DROP THROUGH BED	86.5	CM. OF WATER
AIR TEMPERATURE	91	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	1.330	SEC.

RUN 29 PART 8

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	6	5.8	6.7	3.98
2	6	6.9	1.9	3.15
3	8	3.9	5.1	0.92
4	8	9.2	5.3	3.73
5	8	2.5	2.1	1.32
6	9	6.6	8.3	4.81
7	9	2.1	7.7	0.96
8	9	7.2	2.1	3.66
9	9	2.9	3.6	1.22
10	9	1.6	4.3	2.32
11	12	6.7	9.4	3.28
12	12	4.9	9.3	2.03
13	12	2.9	3.4	1.23
14	12	2.9	2.3	1.11
15	12	9.1	3.6	1.37
16	13	7.6	1.7	3.15
17	16	4.0	9.3	1.44
18	16	6.4	7.6	1.63
19	17	1.1	6.3	2.01
20	21	3.6	8.3	3.40
21	22	9.1	6.6	4.56
22	22	6.9	2.0	4.15
23	27	0.6	5.4	1.51
24	27	2.1	5.0	1.63
25	30	1.7	5.4	2.57
26	31	7.4	8.9	3.95
27	32	7.2	3.3	4.30
28	35	0.4	4.7	1.22
29	39	7.2	7.2	3.17
30	40	7.0	3.0	2.93
31	40	1.8	7.6	2.87
32	41	4.9	9.8	3.66
33	43	9.3	2.8	2.03
34	43	7.2	3.7	4.27
35	44	7.4	6.9	2.30
36	44	9.3	8.2	3.33
37	44	10.3	5.2	1.94
38	45	1.1	4.2	1.84
39	47	7.7	2.0	1.86
40	51	7.5	6.0	3.40

RUN 29 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	54	5.9	9.2	2.23
42	55	8.3	9.5	1.70
43	55	6.3	8.9	4.01
44	55	9.4	6.3	4.60
45	55	7.5	0.9	2.03
46	56	6.8	3.0	1.89
47	57	1.4	4.1	2.99
48	63	6.0	9.7	3.40
49	65	7.9	7.6	1.03
50	65	6.8	7.5	1.41
51	65	9.5	6.6	2.70
52	66	9.3	8.9	3.09
53	66	7.5	1.9	3.57
54	68	2.5	2.6	1.29
55	68	4.1	2.2	2.95

RUN 30 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.088	FT./SEC.
BED HEIGHT	38.8	IN.
SETTLED BED HEIGHT	36.0	IN.
PRESSURE DROP THROUGH BED	130.0	CM. OF WATER
AIR TEMPERATURE	91	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	2.480	SEC.

RUN 30' PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	5	5.9	5.9	3.37
2	13	5.3	6.7	6.64
3	22	4.8	7.9	5.99
4	23	9.0	9.5	6.40
5	42	8.0	8.6	4.45
6	42	4.6	5.4	4.97
7	48	5.3	6.2	8.13
8	53	4.8	5.6	6.43
9	59	5.3	6.7	6.92
10	63	5.3	8.7	5.13
11	63	7.9	5.2	5.83
12	75	6.2	7.0	7.85
13	83	3.9	8.7	5.14
14	95	7.0	5.9	7.12
15	119	5.9	6.9	7.57

RUN 31 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.117	FT./SEC.
BED HEIGHT	8.6	IN.
SETTLED BED HEIGHT	8.0	IN.
PRESSURE DROP THROUGH BED	27.9	CM. OF WATER
AIR TEMPERATURE	93	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	0.917	SEC.

RUN 31 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	57	5.2	1.3	1.27
2	57	6.5	9.2	3.97
3	58	8.6	3.9	3.37
4	58	9.8	2.5	1.82
5	58	7.0	2.0	1.99
6	59	9.7	7.6	3.04
7	59	3.9	1.4	1.38
8	60	9.2	3.1	2.45
9	62	8.0	3.3	4.11
10	62	4.9	8.6	2.83
11	63	9.8	4.3	1.72
12	63	7.3	7.4	0.80
13	63	6.4	6.9	1.17
14	63	5.6	6.4	0.89
15	63	4.4	1.2	0.98
16	65	4.0	9.0	1.92
17	65	5.8	6.7	1.17
18	65	7.5	7.2	1.69
19	66	9.7	3.1	1.46
20	66	9.7	8.5	1.98
21	66	8.0	8.8	1.96
22	66	5.0	1.5	1.64
23	67	7.8	1.8	2.56
24	68	5.1	8.5	2.10
25	68	9.8	5.1	2.25
26	68	6.7	5.0	3.80
27	69	4.4	10.8	1.13
28	69	6.0	0.5	1.62
29	69	2.1	2.5	3.03
30	71	6.4	8.8	0.96
31	71	3.5	9.7	1.27
32	71	4.3	8.8	1.77
33	71	5.5	8.1	1.41
34	71	9.0	7.9	2.53
35	73	4.1	2.0	1.36
36	74	8.4	7.3	2.51
37	74	8.9	2.1	2.56
38	74	7.2	0.8	1.59
39	75	2.9	8.9	2.60
40	75	9.1	5.2	2.81

RUN 31 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	76	6.7	2.4	2.66
42	77	7.3	9.8	1.12
43	77	8.9	9.4	1.36
44	77	8.9	6.6	1.72
45	77	8.6	4.5	2.40
46	78	7.5	8.9	1.62
47	78	6.3	1.7	3.08
48	79	7.0	6.0	2.14
49	79	3.1	9.4	1.81
50	79	5.5	6.5	2.35
51	79	8.8	4.2	3.14
52	80	10.7	6.9	2.06
53	80	8.9	8.3	2.86
54	81	5.2	0.9	2.29
55	83	9.1	4.7	2.89
56	83	8.9	7.8	2.34
57	85	8.1	1.6	2.07
58	85	10.2	5.6	0.78
59	85	9.3	6.0	1.19
60	85	8.4	6.0	0.96
61	85	8.3	5.1	0.99
62	85	10.7	7.6	1.54
63	85	9.8	7.4	1.29
64	86	7.5	9.7	1.96
65	86	6.6	7.4	2.35
66	86	5.6	9.4	2.76
67	86	8.9	4.2	2.19
68	86	2.6	9.8	0.53
69	86	3.1	9.0	0.54
70	86	2.7	8.2	1.33
71	88	3.4	1.9	2.00
72	89	6.0	1.6	2.07
73	90	9.4	6.5	1.18
74	90	7.8	6.3	1.06
75	90	6.2	3.7	2.50
76	90	7.5	2.2	2.22
77	91	7.4	5.6	2.48
78	91	3.4	9.7	1.64
79	91	3.5	2.3	1.52
80	92	9.0	5.1	2.92

RUN 31 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	92	9.3	8.8	2.67
82	94	5.6	9.6	2.45
83	94	9.8	3.8	2.21
84	95	5.7	10.0	1.11
85	95	2.9	8.7	1.28
86	96	10.2	8.5	0.60
87	96	4.5	8.7	0.63
88	97	5.1	5.9	1.85
89	98	3.9	8.9	1.68
90	99	7.7	2.1	2.18
91	99	9.3	5.2	3.53

RUN 32 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.117	FT./SEC.
BED HEIGHT	12.9	IN.
SETTLED BED HEIGHT	12.0	IN.
PRESSURE DROP THROUGH BED	43.6	CM. OF WATER
AIR TEMPERATURE	88	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	1.290	SEC.

RUN 32 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	130	2.0	5.1	2.24
2	130	10.0	7.5	1.56
3	130	9.5	3.8	2.98
4	131	1.2	3.6	1.88
5	131	1.9	7.8	2.40
6	132	4.3	3.1	3.43
7	133	9.0	8.6	2.17
8	133	7.4	10.6	1.62
9	134	2.2	7.0	1.98
10	134	0.9	6.0	2.11
11	134	4.1	6.4	2.54
12	134	5.3	10.0	3.13
13	135	8.9	1.8	2.64
14	135	10.2	4.3	2.56
15	136	1.4	3.6	2.29
16	136	10.2	7.4	2.03
17	140	4.6	8.7	4.29
18	140	8.9	3.1	2.46
19	140	7.7	2.0	2.15
20	140	8.7	8.9	3.11
21	141	3.1	2.6	2.69
22	143	6.3	7.3	1.91
23	143	4.1	5.9	3.13
24	143	1.6	6.4	2.14
25	145	5.5	0.5	1.25
26	147	7.5	2.4	2.40
27	148	4.6	10.2	1.37
28	148	3.1	10.0	1.45
29	148	5.4	9.2	1.07
30	148	6.7	9.3	1.97
31	148	6.1	7.4	1.42
32	148	9.2	8.7	2.42
33	148	2.0	6.1	3.32
34	149	3.0	6.7	2.88
35	151	4.6	8.6	2.75
36	151	1.8	3.0	2.17
37	152	3.0	10.1	1.69
38	152	6.9	1.8	2.17
39	152	5.7	2.6	2.01
40	152	8.9	2.9	2.03

RUN 32 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	152	9.4	5.4	3.45
42	154	4.0	5.1	2.85
43	156	6.9	11.0	0.91
44	156	6.0	10.2	1.33
45	156	7.1	10.1	1.02
46	156	6.7	9.5	0.92
47	156	8.0	10.6	1.31
48	156	8.7	3.6	1.98
49	156	9.6	5.1	1.94
50	156	10.4	7.8	1.92
51	158	3.8	4.3	3.01
52	161	2.8	7.9	3.07
53	162	5.1	1.7	2.56
54	162	1.8	3.3	0.77
55	163	8.5	3.1	3.11
56	163	1.2	4.0	1.53
57	163	2.1	4.1	0.97
58	164	2.6	4.8	0.99
59	167	4.2	9.8	1.19
60	167	5.9	1.2	2.42
61	167	5.1	7.4	1.70
62	167	4.1	8.7	1.64
63	167	3.7	7.5	1.14
64	167	2.7	3.4	4.74
65	167	2.6	7.9	1.77
66	168	10.0	5.4	3.60
67	169	6.1	9.3	2.88
68	171	3.3	3.0	3.16
69	173	8.5	6.0	1.40
70	173	8.4	4.9	2.49
71	173	7.7	9.5	1.77
72	173	4.7	7.7	1.09
73	173	3.8	8.4	1.18
74	173	2.9	8.5	0.97
75	173	3.0	7.7	1.40
76	173	3.3	5.5	0.51
77	173	2.0	5.6	1.02
78	173	2.5	4.7	0.97
79	173	1.1	5.4	0.91
80	174	7.7	1.1	0.92

## RUN 32 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	174	8.6	1.5	1.53
82	175	6.7	1.6	1.50
83	175	6.7	0.4	1.51
84	175	7.9	6.3	1.91
85	175	1.6	8.2	2.04
86	175	3.8	2.7	1.02
87	175	5.2	7.3	1.94
88	175	3.7	8.3	1.25
89	175	4.5	8.8	1.51
90	176	8.4	3.7	1.75
91	177	7.2	1.8	1.76
92	178	3.1	7.4	2.06
93	178	4.6	2.1	1.86
94	178	0.8	6.8	1.94
95	178	2.3	6.4	1.79
96	179	6.4	9.8	1.73
97	179	3.8	2.1	2.66
98	180	1.5	2.6	1.94
99	180	1.8	6.9	2.18
100	181	9.3	2.5	2.17
101	181	6.0	1.4	2.54
102	182	6.4	3.8	1.90
103	183	10.0	6.4	1.91
104	183	7.6	8.8	1.93
105	183	2.7	10.2	1.30
106	183	1.8	5.6	2.05
107	184	4.3	7.9	1.08
108	184	3.3	7.3	0.94
109	184	4.1	7.2	0.58
110	184	3.6	5.8	2.04
111	185	4.8	6.4	1.44
112	185	6.6	10.5	2.38
113	185	8.8	2.9	1.71
114	187	4.6	5.2	2.30
115	187	7.2	3.9	2.23
116	187	9.4	4.7	1.66
117	187	10.3	5.6	2.38
118	189	3.1	3.8	3.63
119	190	7.4	2.8	1.28
120	191	9.8	2.3	1.56

RUN 33 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.117	FT./SEC.
BED HEIGHT	24.8	IN.
SETTLED BED HEIGHT	24.0	IN.
PRESSURE DROP THROUGH BED	86.6	CM. OF WATER
AIR TEMPERATURE	91	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	2.480	SEC.

RUN 33 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	2	4.3	2.3	4.01
2	2	1.9	4.3	3.40
3	3	4.6	10.3	2.63
4	9	6.0	3.6	6.09
5	13	9.9	4.5	3.83
6	19	6.4	9.5	4.12
7	20	4.9	2.3	5.30
8	21	9.9	9.1	1.64
9	26	8.9	8.6	1.77
10	26	5.6	5.4	2.34
11	26	3.6	3.3	5.17
12	30	4.9	3.8	5.17
13	33	6.3	4.0	4.96
14	34	3.7	9.2	4.57
15	35	8.2	8.7	3.36
16	38	2.9	4.3	4.39
17	38	8.6	2.9	4.56
18	41	5.1	4.6	1.00
19	41	4.5	5.8	1.38
20	41	3.4	6.5	0.92
21	43	2.1	4.5	2.99
22	44	10.2	5.7	2.76
23	45	7.0	2.4	2.34
24	49	4.6	6.6	5.28
25	49	9.9	3.0	1.41
26	49	8.7	3.2	1.56
27	51	5.5	9.9	3.66
28	54	6.2	10.2	2.28
29	55	8.3	1.6	3.37
30	55	4.6	3.7	3.81
31	60	6.0	2.9	3.15
32	62	3.7	4.4	3.30
33	63	9.9	5.4	3.93
34	65	5.7	7.5	2.78
35	65	4.8	9.8	0.80
36	65	2.8	9.2	1.19
37	65	3.5	7.5	0.80
38	67	3.4	7.1	1.34
39	67	5.7	1.3	1.47
40	69	4.9	8.9	3.57

RUN 33 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	74	9.5	2.6	2.57
42	75	8.2	4.4	4.15
43	75	6.8	1.7	2.01
44	77	1.7	6.5	0.98
45	77	2.4	5.5	1.57
46	79	4.3	4.7	3.15
47	79	3.3	2.0	2.70
48	83	4.0	7.5	4.01
49	83	8.6	7.2	4.44
50	83	6.3	0.9	2.44
51	84	6.4	2.6	2.11
52	86	5.6	0.2	0.73
53	86	3.2	5.2	1.99
54	87	5.7	10.3	0.86
55	87	8.4	2.6	3.40
56	91	6.3	7.8	0.74
57	91	9.9	6.3	1.57
58	91	2.0	4.1	2.30
59	94	4.3	9.1	4.01
60	94	9.0	3.5	4.00
61	94	4.4	2.3	4.30
62	100	1.3	6.3	2.20
63	102	0.2	5.5	0.86
64	102	5.7	6.9	3.25
65	104	8.8	3.3	5.49
66	107	7.2	8.0	4.60
67	107	4.3	5.7	3.44
68	109	2.0	4.0	4.05
69	112	7.9	6.7	3.45
70	113	2.6	4.3	5.01
71	113	9.1	2.5	4.16
72	116	2.0	9.4	1.91
73	116	3.8	8.0	2.76
74	117	7.0	9.3	1.34
75	117	2.1	4.6	4.56
76	118	8.8	2.8	2.93

RUN 34 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.117	FT./SEC.
BED HEIGHT	38.7	IN.
SETTLED BED HEIGHT	36.0	IN.
PRESSURE DROP THROUGH BED	128.0	CM. OF WATER
AIR TEMPERATURE	91	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	3.330	SEC.

RUN 34 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	15	3.6	7.9	6.84
2	29	8.5	5.2	3.00
3	29	3.8	6.6	6.55
4	46	6.3	6.3	8.54
5	66	5.7	5.7	3.97
6	77	8.8	5.5	7.66
7	85	3.8	7.2	7.39
8	99	6.6	7.4	4.97
9	100	3.6	4.7	5.69
10	112	7.0	0.8	1.73
11	112	4.1	0.7	1.97
12	112	3.0	6.3	7.43
13	144	7.1	4.9	2.90
14	145	4.1	4.9	7.92
15	158	5.2	7.8	8.54

RUN 35 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.147	FT./SEC.
BED HEIGHT	8.7	IN.
SETTLED BED HEIGHT	8.0	IN.
PRESSURE DROP THROUGH BED	28.0	CM. OF WATER
AIR TEMPERATURE	93	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	0.813	SEC.

RUN 35 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	61	3.2	5.5	1.69
2	61	2.2	8.0	1.94
3	63	3.6	9.4	0.70
4	63	3.6	8.8	0.48
5	63	3.6	8.3	0.26
6	63	3.3	8.5	0.37
7	63	3.2	8.1	0.21
8	63	3.6	7.9	0.52
9	63	3.0	10.2	1.52
10	63	8.5	3.1	3.23
11	63	1.6	3.9	0.88
12	63	0.6	4.2	1.17
13	64	8.4	5.3	0.89
14	64	7.6	9.1	3.91
15	65	10.1	6.8	2.09
16	65	1.3	4.4	1.50
17	66	0.8	7.1	1.36
18	67	2.5	7.0	2.34
19	67	8.0	10.2	2.22
20	68	7.5	8.9	2.04
21	68	6.0	8.0	1.41
22	68	2.4	5.1	1.64
23	69	8.6	2.1	1.55
24	69	7.1	2.7	2.35
25	69	3.8	3.9	3.69
26	71	8.9	9.7	0.73
27	71	10.7	7.6	0.96
28	72	3.8	4.7	0.44
29	72	3.3	4.9	0.36
30	72	2.4	4.3	1.01
31	72	3.3	8.6	2.29
32	73	7.3	9.4	1.11
33	73	6.3	9.0	1.54
34	73	1.1	7.7	1.55
35	74	2.2	4.9	1.46
36	74	7.3	1.4	2.22
37	75	9.7	4.4	4.03
38	77	8.0	7.6	2.12
39	78	7.1	9.1	1.92
40	78	4.8	9.8	2.34

RUN 35 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	78	4.8	8.3	1.25
42	79	2.9	8.9	1.61
43	79	4.7	6.4	1.05
44	79	10.3	6.1	2.86
45	80	1.6	9.1	1.45
46	80	3.5	7.1	1.99
47	80	5.3	0.4	1.11
48	81	6.5	9.1	1.92
49	81	6.4	6.8	0.70
50	81	10.1	7.4	1.37
51	81	9.6	3.4	1.98
52	81	9.6	5.7	1.92
53	81	6.7	5.2	1.73
54	86	7.2	8.9	2.87
55	86	7.5	6.5	2.86
56	86	2.5	6.6	2.70
57	86	5.9	2.0	2.35
58	87	7.2	1.9	2.01
59	87	4.3	6.8	2.90
60	88	8.6	2.1	1.65
61	89	1.5	6.4	2.48
62	89	5.0	6.5	3.14
63	90	7.3	5.7	0.91
64	90	1.8	6.3	3.41
65	90	9.6	6.8	1.31
66	91	9.4	5.5	1.31
67	91	7.6	3.4	2.48
68	92	9.0	8.2	1.57
69	92	6.5	8.1	3.57
70	92	4.2	5.2	1.96
71	92	2.4	9.7	1.92
72	95	5.6	5.8	1.24
73	97	3.6	8.3	3.20
74	97	8.5	5.0	2.78
75	97	7.6	3.4	1.56
76	97	1.0	4.8	1.54
77	99	7.3	7.6	1.88
78	99	5.7	6.4	1.98

RUN 36 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.147	FT./SEC.
BED HEIGHT	13.1	IN.
SETTLED BED HEIGHT	12.0	IN.
PRESSURE DROP THROUGH BED	43.2	CM. OF WATER
AIR TEMPERATURE	88	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	1.810	SEC.

RUN 36 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	14	2.7	4.3	2.87
2	20	4.1	0.8	1.62
3	23	3.3	2.8	1.77
4	23	10.0	3.6	3.13
5	23	5.6	3.6	5.05
6	25	2.5	9.6	1.14
7	25	1.3	7.6	2.80
8	25	8.8	7.5	4.28
9	32	8.0	9.2	2.09
10	32	1.6	4.4	4.54
11	32	7.7	4.9	5.87
12	36	5.8	10.6	1.40
13	37	2.0	4.8	3.31
14	37	4.6	0.8	2.50
15	37	8.1	3.4	2.97
16	37	5.7	2.7	3.17
17	38	6.1	10.0	1.45
18	38	8.6	9.1	1.27
19	41	3.1	8.3	3.10
20	42	4.7	2.0	3.07
21	43	9.1	8.5	1.84
22	43	1.1	7.1	1.64
23	43	6.1	8.4	2.89
24	43	5.6	2.2	4.64
25	45	7.7	6.1	4.83
26	48	8.8	1.6	2.19
27	48	5.4	2.8	2.90
28	50	3.3	9.8	2.27
29	50	5.9	10.1	2.33
30	55	7.6	9.2	4.28
31	56	8.4	4.6	5.24
32	57	2.2	4.5	3.13
33	57	4.3	5.5	2.54
34	57	4.9	2.4	3.96
35	61	7.4	7.9	3.07
36	68	2.7	4.0	3.06
37	68	4.9	10.0	1.91
38	69	9.3	2.1	1.98
39	69	5.7	3.2	1.77
40	69	6.6	5.2	2.81

RUN 36 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	69	7.4	7.7	3.02
42	72	5.4	7.2	3.57
43	72	3.3	3.7	1.32
44	72	3.0	9.1	2.47
45	73	6.6	2.0	4.43
46	73	3.8	0.6	0.92
47	77	4.6	3.8	2.14
48	77	8.6	6.4	3.38
49	79	7.7	2.8	3.69
50	80	2.1	7.9	2.42
51	80	8.7	6.6	4.06
52	82	2.8	3.6	4.17
53	84	8.4	6.4	5.62
54	84	6.2	5.3	2.02
55	85	6.0	2.1	2.29
56	85	3.3	9.2	2.44
57	87	6.6	2.8	2.09
58	91	1.5	4.3	3.76
59	92	6.6	5.6	3.80
60	92	5.9	2.0	4.54
61	95	9.9	8.2	1.88
62	95	4.4	9.9	2.31
63	97	8.3	6.6	4.87
64	97	6.4	1.9	4.31
65	100	6.6	2.0	2.42

RUN 37 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.147	FT./SEC.
BED HEIGHT	26.2	IN.
SETTLED BED HEIGHT	24.0	IN.
PRESSURE DROP THROUGH BED	86.4	CM. OF WATER
AIR TEMPERATURE	91	DEGREES F.
CAMERA		EYEMO
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	1.540	SEC.

RUN 37 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	2	8.4	1.7	3.15
2	4	5.8	3.4	3.03
3	4	8.2	5.3	5.02
4	6	3.4	8.4	4.98
5	11	8.9	7.0	2.64
6	11	6.8	3.3	1.98
7	12	2.7	4.3	2.23
8	13	4.1	4.5	1.50
9	14	2.5	5.9	3.48
10	16	6.7	5.2	2.38
11	17	1.1	3.4	1.66
12	17	2.5	2.5	1.82
13	17	6.2	9.5	8.53
14	18	2.2	5.2	1.84
15	18	3.8	2.1	1.82
16	19	2.2	3.0	2.91
17	19	8.4	5.0	4.71
18	28	6.5	10.8	2.10
19	30	2.5	5.6	5.47
20	30	7.4	1.6	2.24
21	30	5.0	1.1	2.63
22	34	8.1	5.2	5.32
23	34	6.7	8.7	2.10
24	38	3.8	9.3	1.77
25	38	2.4	9.6	1.54
26	38	1.4	7.6	2.75
27	38	6.7	3.5	3.44
28	39	4.4	3.9	4.49
29	41	5.0	7.3	3.32
30	42	7.3	9.0	3.07
31	44	4.2	3.6	3.55
32	45	9.7	9.7	1.29
33	45	7.0	2.2	5.25
34	45	2.2	8.1	3.60
35	50	5.6	4.9	1.00
36	50	4.7	3.6	1.25
37	50	3.1	3.6	2.17
38	50	7.7	2.4	3.55
39	53	3.8	5.3	5.58
40	53	3.9	2.0	2.78

RUN 37 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	55	8.1	8.7	4.69
42	59	6.7	10.4	3.01
43	59	7.7	8.2	2.75
44	59	3.6	8.4	5.45
45	64	8.5	3.6	5.14
46	67	7.9	8.7	5.32
47	68	3.9	2.5	4.45
48	68	1.7	6.0	0.64
49	72	6.7	8.1	2.46
50	73	8.1	8.4	2.28
51	74	3.6	7.9	6.40

RUN 38 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	85	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.026	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.147	FT./SEC.
BED HEIGHT	39.2	IN.
SETTLED BED HEIGHT	36.0	IN.
PRESSURE DROP THROUGH BED	129.0	CM. OF WATER
AIR TEMPERATURE	91	DEGREES F.
CAMERA		EYEMO.
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	2.000	SEC.

RUN 38 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	8	8.8	5.9	4.09
2	8	6.8	8.8	5.00
3	8	7.7	1.8	5.36
4	10	10.3	8.8	2.14
5	10	10.6	5.9	2.36
6	10	10.1	2.5	2.47
7	10	3.8	5.6	6.85
8	10	5.3	0.9	3.06
9	20	6.5	6.5	8.00
10	43	10.9	7.5	2.36
11	43	5.6	3.1	3.65
12	44	5.5	7.7	7.82
13	45	2.8	4.1	2.47
14	45	7.7	2.1	2.47
15	46	9.7	3.8	3.39
16	50	4.7	5.9	9.44
17	55	5.7	2.9	7.46
18	82	9.7	6.2	2.17
19	82	8.6	4.4	2.50
20	82	8.1	1.6	3.64
21	70	4.4	5.3	8.00
22	78	7.7	2.7	4.85
23	78	3.5	2.1	3.61
24	95	5.4	5.4	9.28

RUN 41 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	470	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.510	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.638	FT./SEC.
BED HEIGHT	1.2	IN.
SETTLED BED HEIGHT	1.0	IN.
PRESSURE DROP THROUGH BED	4.0	CM. OF WATER
AIR TEMPERATURE	82	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	64	FRAMES/SEC.
DURATION OF RUN	0.063	SEC.

RUN 41 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	5.5	10.4	0.49
2	1	10.5	4.5	0.89
3	1	6.9	9.6	0.68
4	1	5.2	9.6	0.70
5	1	4.3	8.6	0.77
6	1	8.3	4.9	1.14
7	1	6.3	4.7	0.76
8	1	6.1	3.7	0.89
9	1	5.2	9.5	0.77
10	1	4.7	2.3	0.89
11	1	1.4	7.3	0.70
12	1	2.3	6.5	1.02
13	1	2.4	4.6	0.57
14	1	1.5	3.2	0.64
15	2	1.8	5.2	0.70
16	2	6.8	11.1	0.83
17	2	7.5	10.7	0.44
18	2	5.8	8.6	0.64
19	2	5.0	7.4	0.57
20	2	5.4	6.6	0.70
21	2	5.1	3.6	0.64
22	2	3.8	5.2	0.44
23	2	3.7	4.9	0.44
24	2	3.7	6.3	0.83
25	2	0.4	6.1	1.01
26	2	2.6	3.7	0.83
27	2	1.8	3.6	0.77
28	3	9.2	3.7	0.51
29	3	9.5	4.3	0.89
30	3	10.1	6.9	0.51
31	3	9.7	6.4	0.64
32	3	9.3	5.0	0.77
33	3	9.8	3.5	0.83
34	3	8.9	8.4	0.70
35	3	6.4	5.6	0.83
36	3	5.6	6.1	0.83
37	3	5.4	7.4	0.57
38	3	4.6	6.0	0.63
39	3	3.8	9.8	0.89
40	3	0.4	4.9	0.70

RUN 41 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	3	0.5	4.1	0.76
42	3	1.7	2.3	0.57
43	4	8.9	3.1	0.83
44	4	6.4	10.0	0.77
45	4	8.2	7.3	0.83
46	4	6.8	4.9	0.64
47	4	6.6	4.1	0.77
48	4	4.7	4.5	0.38
49	4	4.2	4.6	0.89
50	4	4.2	3.1	0.31
51	4	1.0	5.5	0.64
52	4	0.9	4.0	0.64

RUN 42 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	470	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.510	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.638	FT./SEC.
BED HEIGHT	2.4	IN.
SETTLED BED HEIGHT	2.0	IN.
PRESSURE DROP THROUGH BED	7.7	CM. OF WATER
AIR TEMPERATURE	86	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	64	FRAMES/SEC.
DURATION OF RUN	0.484	SEC.

RUN 42 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	95	5.6	0.7	0.87
2	95	3.5	1.5	0.92
3	96	6.6	1.6	1.50
4	96	5.7	3.8	1.69
5	96	4.7	1.9	1.93
6	97	9.7	2.2	1.05
7	97	8.8	2.0	1.44
8	97	6.9	5.1	0.94
9	97	7.5	4.7	0.87
10	97	7.6	3.5	1.25
11	97	8.2	4.1	0.68
12	97	8.6	3.5	0.68
13	97	8.8	5.9	1.12
14	97	10.2	5.9	1.05
15	97	9.2	4.5	1.50
16	97	10.7	3.8	1.06
17	98	4.6	4.4	0.87
18	98	5.6	5.7	0.50
19	98	5.2	5.2	1.05
20	99	4.4	1.9	1.00
21	99	3.6	3.4	0.63
22	99	3.0	3.2	0.87
23	100	9.9	7.4	1.00
24	100	8.9	8.1	1.56
25	100	4.1	7.2	1.56
26	100	3.4	8.8	1.24
27	100	3.2	5.7	1.62
28	100	1.4	7.1	1.55
29	101	11.0	7.5	0.87
30	101	10.9	6.3	0.75
31	101	5.1	9.5	1.19
32	101	4.4	10.2	1.25
33	101	2.1	9.1	1.24
34	102	1.1	5.7	1.00
35	102	1.6	5.0	1.12
36	102	5.1	6.1	1.00
37	103	8.4	1.0	0.87
38	103	7.5	0.9	0.87
39	105	4.1	0.7	1.12
40	105	3.0	1.3	0.87

RUN 42 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	105	5.2	2.5	1.80
42	105	10.5	5.2	1.43
43	105	6.7	4.1	1.43
44	105	7.4	2.9	1.55
45	106	10.7	4.0	0.97
46	106	9.1	3.4	1.81
47	106	5.9	5.1	1.37
48	106	4.1	5.0	1.50
49	107	8.2	4.6	1.31
50	107	3.4	3.9	1.30
51	108	5.6	6.6	1.12
52	108	4.1	8.0	1.05
53	109	8.9	6.7	1.50
54	109	7.9	9.4	1.62
55	109	3.9	7.0	1.24
56	109	2.9	8.1	1.31
57	109	2.4	6.4	1.62
58	110	1.6	8.0	1.30
59	110	4.7	7.9	0.75
60	110	5.6	9.7	0.68
61	110	5.5	6.6	0.75
62	111	7.6	6.9	0.75
63	111	7.1	7.2	0.68
64	111	0.9	7.2	0.75
65	113	4.9	3.4	1.75
66	114	8.2	1.9	1.49
67	114	6.6	5.6	0.94
68	114	6.5	3.0	1.62
69	114	1.5	4.5	1.12
70	115	4.0	10.4	0.68
71	115	9.4	5.0	1.75
72	115	9.4	2.5	1.06
73	115	4.7	5.6	1.68
74	115	5.7	0.9	1.19
75	115	4.6	1.3	1.75
76	116	11.1	5.7	0.94
77	116	10.2	6.1	1.24
78	116	10.1	7.6	1.22
79	116	0.9	7.9	0.75
80	116	2.2	4.4	0.81

RUN 42 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	116	2.0	2.9	0.92
82	116	2.4	5.4	0.94
83	117	7.2	8.6	0.97
84	117	8.8	8.8	0.99
85	117	7.6	10.4	1.12
86	117	6.3	10.9	1.24
87	117	7.4	4.9	0.94
88	117	7.4	6.5	0.56
89	117	5.0	9.7	1.37
90	117	3.2	6.9	1.73
91	117	1.0	6.4	1.44
92	118	3.9	10.0	1.49
93	118	6.5	7.1	1.30
94	118	8.0	1.7	1.06
95	118	6.0	0.9	0.75
96	118	4.5	1.3	1.12
97	119	4.1	7.7	1.17
98	119	2.1	9.6	1.12
99	119	1.9	8.5	1.17
100	120	7.4	4.7	0.56
101	120	3.2	1.4	0.38
102	120	2.9	1.7	0.25
103	120	4.0	2.6	0.31
104	120	3.0	3.0	0.74
105	120	2.0	2.6	0.43
106	120	1.4	5.5	0.56
107	120	2.4	4.0	1.06
108	120	4.1	7.7	0.87
109	122	6.9	0.9	1.12
110	122	5.0	2.7	2.06
111	123	8.0	5.9	1.37
112	123	8.9	1.5	1.61
113	124	10.4	4.0	0.87
114	124	8.6	4.2	1.69
115	124	7.2	2.1	1.49
116	124	3.6	3.4	1.31
117	124	2.2	4.0	0.87
118	124	2.6	5.0	1.06
119	124	1.5	5.1	1.30
120	125	9.9	7.2	1.37

RUN 42 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	

RUN 43 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	470	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.510	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.638	FT./SEC.
BED HEIGHT	4.6	IN.
SETTLED BED HEIGHT	4.0	IN.
PRESSURE DROP THROUGH BED	15.5	CM. OF WATER
AIR TEMPERATURE	88	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	64	FRAMES/SEC.
DURATION OF RUN	0.906	SEC.

RUN 43 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	58	5.4	10.4	0.61
2	58	4.9	1.3	2.00
3	59	6.6	2.1	1.50
4	59	4.6	9.0	1.37
5	59	4.1	5.7	1.87
6	60	5.2	8.1	1.31
7	60	9.2	2.0	1.56
8	60	7.7	3.1	1.61
9	60	7.4	4.5	1.62
10	61	4.9	3.2	1.35
11	62	9.1	5.2	1.98
12	63	8.0	0.9	1.05
13	63	9.4	2.1	1.37
14	63	7.0	5.7	1.25
15	63	6.1	7.4	1.43
16	64	6.5	2.5	2.43
17	66	2.5	5.1	1.00
18	66	2.4	4.1	1.27
19	66	4.0	4.5	1.93
20	67	6.6	2.4	1.87
21	67	6.4	4.9	1.49
22	68	1.7	6.4	1.66
23	68	1.4	5.1	1.05
24	68	3.6	10.2	1.12
25	68	4.9	10.0	1.37
26	68	2.7	8.4	2.44
27	69	10.4	4.6	1.75
28	71	2.5	2.2	1.69
29	73	7.9	1.7	2.05
30	73	6.0	1.0	1.50
31	73	6.0	10.2	1.31
32	74	6.0	9.0	1.98
33	74	4.0	1.9	2.24
34	75	5.9	5.9	2.43
35	75	10.1	3.0	1.79
36	75	8.8	3.4	1.62
37	75	3.5	6.0	1.98
38	76	8.5	5.0	1.49
39	76	8.4	6.9	2.37
40	76	5.9	10.2	0.94

RUN 43 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	76	2.0	2.6	1.62
42	77	4.1	7.2	1.19
43	78	1.0	7.7	1.98
44	79	8.8	3.2	1.17
45	82	6.1	3.1	2.75
46	83	4.7	8.5	2.50
47	84	10.2	6.1	2.12
48	84	1.0	6.5	1.24
49	86	9.1	2.1	2.12
50	86	6.6	4.0	1.22
51	86	3.0	6.6	2.06
52	86	2.5	3.4	2.06
53	87	7.0	6.6	2.00
54	89	4.9	3.4	2.75
55	89	4.6	4.9	2.25
56	90	9.2	4.5	1.80
57	90	2.9	6.4	2.43
58	91	9.1	2.1	1.62
59	91	1.0	4.1	1.25
60	91	7.1	9.6	1.49
61	93	10.9	4.6	1.17
62	93	5.4	10.0	0.99
63	94	1.1	4.1	0.92
64	94	3.8	9.7	1.86
65	95	7.5	0.6	1.36
66	95	7.7	4.2	1.24
67	95	3.0	6.1	1.49
68	95	0.5	6.3	1.68
69	99	5.4	1.0	1.12
70	99	4.1	1.3	1.12
71	99	9.7	7.4	0.75
72	99	7.6	4.4	0.94
73	100	8.1	1.7	2.11
74	100	3.0	4.4	2.24
75	102	10.5	5.2	1.43
76	102	4.2	1.0	0.99
77	102	4.4	2.5	1.24
78	102	4.5	3.9	0.97
79	102	1.0	4.7	1.98
80	103	7.6	3.2	1.06

RUN 43 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	103	8.6	5.5	1.93
82	104	8.9	7.5	1.12
83	104	3.2	8.2	2.62
84	105	5.4	7.1	0.87
85	105	1.4	7.6	1.37
86	105	9.9	3.1	1.91
87	105	6.6	4.7	2.36
88	106	6.4	8.2	1.98
89	107	4.2	2.2	1.75
90	108	5.6	6.9	0.87
91	108	1.9	5.9	2.25
92	109	6.0	10.4	1.49
93	109	4.4	4.2	1.75
94	110	10.0	3.4	1.24
95	111	1.1	8.2	0.99
96	111	4.1	6.7	1.49
97	111	8.9	3.4	1.45
98	112	7.2	3.8	2.30
99	112	1.4	3.1	1.86
100	113	9.5	6.4	1.00
101	113	5.4	3.5	1.43
102	113	3.2	2.6	1.68
103	114	9.7	2.6	1.37
104	114	3.9	6.7	1.37
105	114	1.1	8.1	0.94
106	115	6.3	0.9	2.17

RUN 44 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	470	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.510	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.638	FT./SEC.
BED HEIGHT	9.1	IN.
SETTLED BED HEIGHT	8.0	IN.
PRESSURE DROP THROUGH BED	30.7	CM. OF WATER
AIR TEMPERATURE	88	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	64	FRAMES/SEC.
DURATION OF RUN	2.500	SEC.

RUN 44 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	8.5	2.0	2.71
2	4	9.6	5.6	2.92
3	4	6.6	7.7	2.87
4	5	4.4	8.5	2.24
5	5	1.0	5.2	2.33
6	6	3.1	5.2	3.33
7	9	7.3	3.0	2.61
8	11	6.9	6.1	1.81
9	11	5.8	1.4	2.70
10	17	1.0	7.1	2.26
11	20	9.4	2.3	3.09
12	21	6.3	5.9	1.35
13	21	5.1	5.1	3.19
14	22	3.5	9.6	2.92
15	22	3.2	3.1	3.50
16	23	8.7	7.0	3.08
17	26	7.1	9.4	2.23
18	36	7.1	7.7	0.96
19	36	1.6	8.2	2.13
20	36	2.7	5.0	2.28
21	36	1.1	5.3	2.56
22	36	6.4	3.9	3.18
23	40	10.4	5.5	1.52
24	40	9.4	6.6	1.37
25	40	9.4	4.4	2.92
26	43	6.4	3.4	4.37
27	45	4.8	10.1	1.65
28	45	5.9	9.1	2.13
29	45	4.2	8.4	2.07
30	45	3.7	6.6	2.26
31	48	6.0	3.1	3.73
32	48	1.5	6.9	2.66
33	50	3.0	1.6	1.52
34	53	6.9	0.9	0.87
35	54	4.2	8.1	2.11
36	55	5.8	5.0	0.64
37	55	4.9	5.0	1.06
38	55	4.5	4.0	1.38
39	55	1.9	3.2	1.70
40	56	8.5	2.2	2.02

RUN 44

PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	56	8.4	4.5	2.80
42	61	5.9	5.2	0.95
43	61	4.7	5.0	1.69
44	62	1.2	7.6	2.60
45	62	5.4	6.5	1.27
46	62	4.6	6.8	1.32
47	63	9.3	7.5	2.74
48	65	6.1	1.3	1.54
49	67	3.8	2.2	2.71
50	73	2.9	8.6	3.69
51	75	7.1	5.5	3.62
52	76	9.4	3.9	3.13
53	77	6.1	8.1	1.27
54	79	5.1	2.1	3.52
55	79	2.0	3.7	3.34
56	84	6.8	8.9	1.22
57	86	9.3	2.3	2.13
58	86	7.9	2.9	1.59
59	86	4.8	8.6	0.53
60	87	5.6	8.0	1.01
61	89	5.2	1.5	2.52
62	93	9.4	5.4	4.07
63	96	6.2	9.7	2.77
64	98	4.5	5.1	1.36
65	99	4.6	7.5	4.02
66	99	1.2	6.4	2.65
67	101	6.2	9.6	2.13
68	103	7.2	2.3	3.71
69	104	3.2	10.1	1.49
70	104	3.4	2.4	2.77
71	107	7.1	2.0	3.30
72	114	2.1	3.7	3.84
73	115	7.5	1.8	2.17
74	117	5.9	6.0	0.85
75	118	8.5	6.6	3.83
76	119	4.3	8.5	3.41
77	119	6.8	4.6	2.41
78	121	10.9	5.8	2.20
79	125	8.7	3.8	2.02
80	125	2.3	7.7	2.56

RUN 44 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	128	5.1	3.7	3.98
82	130	1.0	6.6	2.26
83	136	5.0	8.0	1.28
84	136	5.1	9.5	1.63
85	136	6.6	8.0	3.25
86	136	9.6	3.6	3.07
87	137	8.3	1.3	1.89
88	140	4.3	1.3	2.00
89	143	2.3	2.4	2.00
90	147	4.8	10.4	1.44
91	148	2.9	5.9	3.70
92	151	9.3	6.1	2.97
93	151	6.7	10.1	2.49
94	151	5.9	4.8	3.50
95	152	7.7	3.3	2.84
96	153	3.7	9.7	2.87
97	155	5.6	1.3	2.74
98	157	0.9	7.8	1.92
99	159	1.1	4.3	2.25

RUN 45 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	470	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.510	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.638	FT./SEC.
BED HEIGHT	13.5	IN.
SETTLED BED HEIGHT	12.0	IN.
PRESSURE DROP THROUGH BED	46.0	CM. OF WATER
AIR TEMPERATURE	89	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	4.940	SEC.

RUN 45 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	104	5.3	2.1	1.82
2	104	2.2	3.2	2.39
3	108	4.6	10.3	1.53
4	111	4.5	10.4	1.01
5	112	7.1	1.1	2.42
6	112	3.8	6.5	5.71
7	117	6.1	1.6	1.17
8	117	3.7	5.8	4.33
9	117	6.6	3.9	1.53
10	117	7.4	2.5	1.72
11	118	2.2	8.0	2.40
12	124	6.5	9.8	2.27
13	126	10.6	4.7	1.52
14	126	8.8	2.8	4.08
15	126	3.3	1.5	2.19
16	127	2.1	7.1	3.64
17	128	6.3	9.3	3.83
18	132	8.1	8.6	0.88
19	132	6.5	9.2	2.54
20	134	5.2	1.3	1.09
21	135	7.4	6.1	2.78
22	141	5.2	5.1	5.82
23	142	7.7	4.3	2.85
24	145	3.2	9.0	3.21
25	146	10.4	5.6	1.55
26	146	10.3	4.1	1.95
27	147	1.9	3.1	3.37
28	155	9.4	6.3	4.69
29	158	7.1	1.2	0.90
30	158	6.2	1.0	1.09
31	158	3.1	5.8	3.21
32	158	2.1	4.4	1.60
33	160	3.7	7.9	2.68
34	161	5.7	8.5	2.96
35	164	3.0	3.7	0.80
36	164	3.4	2.9	0.90
37	164	4.4	4.4	1.94
38	165	5.6	8.6	3.69
39	165	5.6	2.2	4.50
40	167	8.4	2.8	2.29

RUN 45 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	168	5.1	2.3	3.30
42	168	1.0	5.8	2.24
43	169	2.4	8.1	3.78
44	169	5.6	8.4	2.48
45	170	8.0	3.4	2.63
46	179	7.1	8.0	1.77
47	179	5.8	7.2	2.07
48	181	3.6	6.7	4.01
49	183	7.2	4.3	4.60
50	184	10.3	5.2	2.98
51	185	2.9	3.4	3.00
52	188	7.4	1.0	2.16
53	193	0.8	5.5	2.27
54	196	3.9	9.1	4.79
55	198	8.2	9.9	0.77
56	198	7.3	8.7	1.34
57	199	5.4	1.2	3.40
58	203	4.1	1.7	1.13
59	203	2.5	1.5	1.00
60	209	8.6	2.1	3.81
61	210	7.7	5.7	1.15
62	210	4.2	5.5	4.88
63	218	2.3	3.1	1.74
64	222	5.9	8.8	5.17
65	224	8.9	5.3	4.53
66	224	2.2	5.1	3.45
67	225	1.0	3.5	0.86
68	225	3.1	7.4	1.68
69	229	4.7	3.7	4.23
70	231	1.3	8.2	1.52
71	235	7.2	1.2	1.15
72	242	10.2	2.7	0.67
73	243	5.7	10.8	1.47
74	247	7.7	10.3	1.51
75	248	4.4	9.4	4.21
76	249	2.0	8.1	1.73
77	251	8.8	8.4	3.30
78	251	6.1	6.1	3.44
79	251	2.7	2.1	3.14
80	251	1.1	5.6	3.11

RUN 45 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	253	8.5	2.0	2.23
82	254	6.8	1.5	2.49
83	255	8.2	3.7	2.64
84	265	4.1	3.3	5.40
85	270	7.3	1.7	2.24
86	274	1.1	6.9	3.28
87	275	6.3	7.7	4.98
88	276	3.4	7.2	2.39
89	277	10.6	5.0	3.28
90	281	5.4	1.2	2.68
91	285	5.3	1.4	3.43
92	285	7.8	3.2	2.34
93	289	1.8	2.9	4.20
94	291	4.3	6.5	1.56
95	291	8.7	2.2	3.21
96	291	4.1	8.9	3.87
97	292	5.3	2.9	2.78
98	293	8.1	5.9	3.02
99	294	8.4	2.2	2.01
100	295	5.7	2.0	2.57
101	305	9.1	4.8	4.25
102	306	3.1	7.2	3.77
103	306	3.3	3.6	2.39
104	307	9.5	8.0	3.44
105	314	8.1	2.4	3.83
106	315	7.3	8.2	2.14
107	316	8.0	2.5	2.62
108	316	5.6	1.7	2.83
109	317	8.4	7.9	2.19
110	317	7.3	4.6	2.07
111	317	5.9	6.2	2.45
112	317	4.7	7.4	1.66
113	317	4.5	4.5	2.23
114	319	3.4	1.4	1.65
115	319	3.3	3.4	2.96
116	319	1.3	6.8	1.10
117	327	2.4	9.1	2.20
118	330	3.3	8.9	2.01
119	331	5.3	4.5	4.20
120	331	1.7	6.7	3.74

RUN 45 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
121	332	4.8	10.1	2.46
122	334	8.7	5.4	4.35
123	337	4.6	2.9	4.78
124	340	4.9	3.6	3.35

RUN 46 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	470	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.510	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.638	FT./SEC.
BED HEIGHT	26.7	IN.
SETTLED BED HEIGHT	24.0	IN.
PRESSURE DROP THROUGH BED	92.2	CM. OF WATER
AIR TEMPERATURE	91	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	3.710	SEC.

RUN 46 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	3.5	8.5	6.59
2	8	2.1	8.1	2.91
3	23	3.9	5.1	7.91
4	32	8.9	6.6	3.86
5	51	2.3	8.9	2.52
6	56	1.2	7.8	2.97
7	57	3.3	7.1	2.79
8	57	6.3	8.9	5.33
9	57	8.5	2.8	5.00
10	65	6.7	4.9	1.41
11	65	6.4	2.8	3.19
12	65	6.0	0.7	1.98
13	65	4.6	1.8	1.99
14	65	3.8	4.3	3.38
15	88	2.9	3.4	1.91
16	88	2.3	5.1	1.06
17	88	2.4	7.3	2.10
18	88	6.0	2.0	3.27
19	88	6.5	6.8	7.49
20	102	3.9	9.0	3.33
21	102	1.7	7.9	3.51
22	105	6.9	3.0	3.68
23	113	2.1	6.8	1.42
24	119	1.6	3.2	1.33
25	129	5.5	5.7	8.65
26	158	9.7	6.4	3.13
27	158	7.4	6.8	2.75
28	158	7.4	2.8	5.76
29	160	2.7	9.5	0.75
30	163	1.2	7.7	2.76
31	172	4.1	7.5	6.43
32	172	4.8	1.8	4.98

RUN 47 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	470	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.510	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.638	FT./SEC.
BED HEIGHT	39.8	IN.
SETTLED BED HEIGHT	36.0	IN.
PRESSURE DROP THROUGH BED	138.0	CM. OF WATER
AIR TEMPERATURE	86	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	3.500	SEC.

RUN 47 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	8.2	3.1	2.42
2	1	5.0	5.0	7.11
3	1	8.8	7.4	5.71
4	47	5.9	5.0	2.67
5	48	7.9	1.7	4.22
6	48	4.5	1.9	3.90
7	49	9.0	7.2	5.91
8	52	3.9	8.3	5.48
9	110	5.6	3.8	8.52
10	115	8.2	9.1	4.04
11	149	6.6	4.0	8.51

RUN 48 PART A

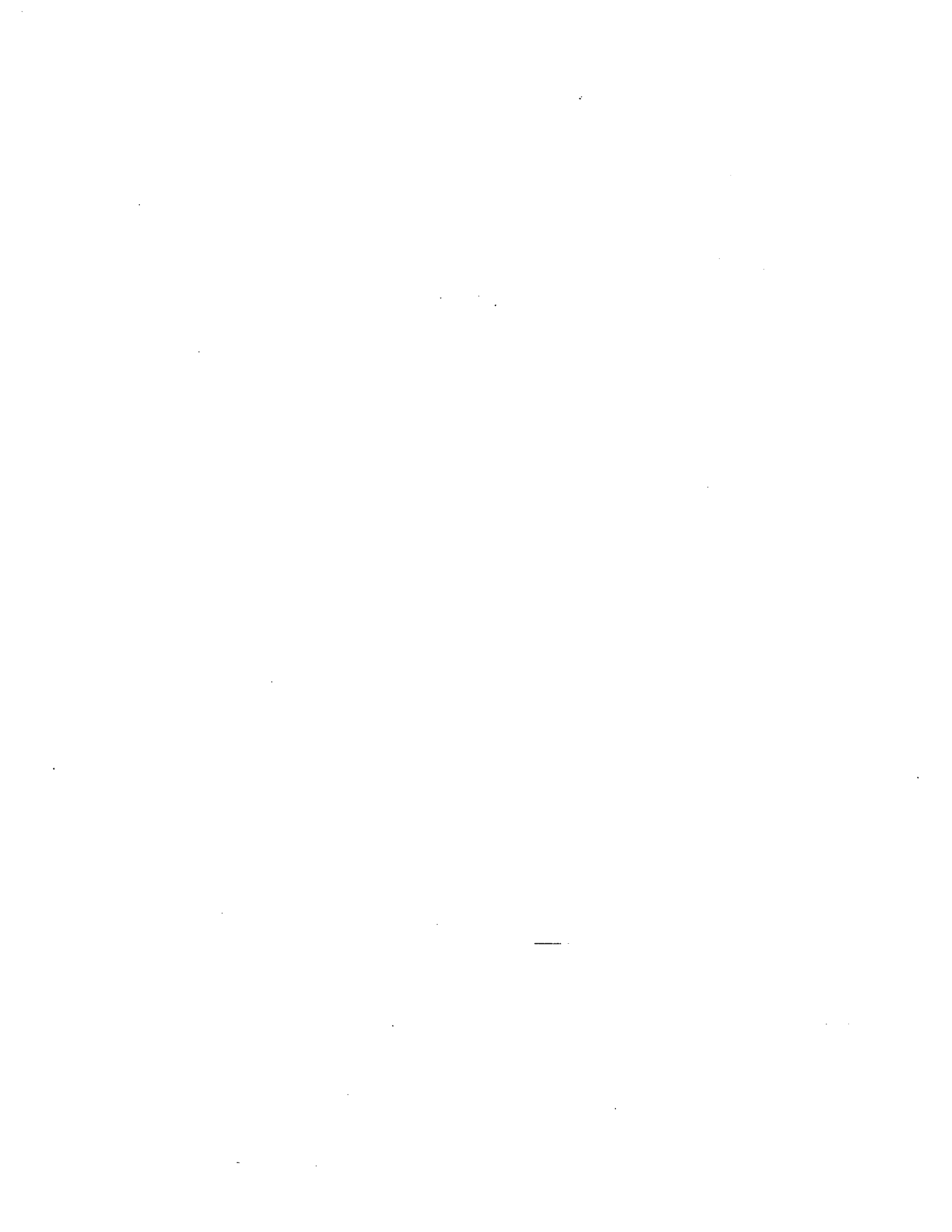
PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	470	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.510	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.765	FT./SEC.
BED HEIGHT	1.3	IN.
SETTLED BED HEIGHT	1.0	IN.
PRESSURE DROP THROUGH BED	4.2	CM. OF WATER
AIR TEMPERATURE	82	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	64	FRAMES/SEC.
DURATION OF RUN	0.037	SEC.

RUN 48 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	8.7	9.3	0.89
2	1	8.6	1.9	0.89
3	1	10.2	4.1	0.99
4	1	11.1	6.1	0.94
5	1	8.4	6.9	0.89
6	1	10.0	8.6	0.89
7	1	9.2	8.2	1.08
8	1	10.5	7.2	1.47
9	1	8.7	5.4	1.46
10	1	6.4	10.1	0.57
11	1	6.1	9.1	0.83
12	1	3.3	8.6	0.64
13	1	4.0	10.7	1.01
14	1	5.1	3.2	1.34
15	1	2.2	4.9	0.76
16	1	2.4	5.8	1.41
17	1	2.2	3.7	0.89
18	2	9.2	6.6	0.96
19	2	9.6	6.0	0.76
20	2	7.9	4.3	0.89
21	2	7.4	10.0	1.28
22	2	7.7	7.5	1.08
23	2	5.6	5.2	1.02
24	2	6.6	6.0	0.96
25	2	7.4	5.2	0.89
26	2	7.9	4.2	1.01
27	2	6.5	4.5	0.94
28	2	6.6	0.5	0.89
29	2	4.9	1.5	1.14
30	2	4.6	10.4	0.76
31	2	3.6	10.0	0.89
32	2	2.9	10.0	0.64
33	2	3.1	7.3	1.28
34	2	4.3	5.9	1.14
35	2	3.8	3.5	0.89
36	2	3.3	2.3	1.08
37	2	1.7	9.1	0.77
38	2	1.0	8.6	0.77
39	2	0.5	4.6	1.14
40	2	1.5	4.0	0.70

RUN 48 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	2	0.8	3.7	0.57
42	2	1.0	2.9	0.68
43	3	2.8	4.6	0.54
44	3	2.7	2.9	0.63
45	3	9.2	3.5	1.07
46	3	8.7	2.9	0.83
47	3	7.9	2.0	0.64
48	3	5.1	6.4	0.83
49	3	1.4	3.5	0.51
50	3	2.4	8.1	0.64
51	3	1.5	7.8	1.02
52	3	0.6	7.4	0.83
53	3	2.3	2.3	0.70
54	3	1.7	2.2	0.51



RUN 49 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	470	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.510	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.765	FT./SEC.
BED HEIGHT	2.6	IN.
SETTLED BED HEIGHT	2.0	IN.
PRESSURE DROP THROUGH BED	8.0	CM. OF WATER
AIR TEMPERATURE	86	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	64	FRAMES/SEC.
DURATION OF RUN	0.297	SEC.

RUN 49 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	4.9	2.1	2.17
2	1	10.7	3.2	1.19
3	1	11.3	5.2	0.88
4	1	6.0	4.2	1.30
5	1	9.2	2.1	1.80
6	2	6.6	5.2	0.99
7	2	9.2	6.7	1.50
8	2	9.9	5.0	1.62
9	2	8.9	4.9	1.68
10	2	6.6	6.5	1.75
11	2	2.2	5.1	1.80
12	2	2.0	2.6	1.56
13	2	0.7	4.5	1.37
14	3	10.9	6.5	1.00
15	3	10.0	7.5	0.87
16	3	7.7	5.4	0.97
17	3	7.5	1.9	1.05
18	3	7.7	0.9	1.05
19	3	6.6	0.5	0.75
20	4	1.4	9.2	1.80
21	4	9.5	6.7	0.99
22	4	3.1	3.9	1.12
23	5	2.0	3.4	1.00
24	5	2.7	2.1	0.74
25	5	9.0	9.0	0.99
26	5	9.4	2.7	1.24
27	5	2.5	5.5	1.30
28	5	1.7	7.1	1.55
29	5	1.4	5.6	1.43
30	5	0.9	4.6	1.06
31	6	6.9	5.5	1.00
32	6	7.1	10.0	0.63
33	6	7.7	9.7	1.25
34	6	6.0	10.6	1.22
35	6	1.9	4.6	1.05
36	7	1.4	8.4	1.12
37	7	3.1	4.1	1.44
38	7	6.9	9.0	1.37
39	7	3.0	8.1	0.99
40	8	4.2	8.2	1.12

RUN 49 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	8	4.1	8.9	1.37
42	8	5.9	6.5	0.74
43	8	5.6	7.0	0.68
44	8	5.2	7.4	0.97
45	8	3.0	6.3	0.74
46	8	4.2	10.6	1.44
47	8	3.9	6.7	1.05
48	8	5.2	9.7	0.87
49	8	2.6	9.4	0.99
50	9	6.5	1.9	1.37
51	9	7.6	3.5	0.61
52	9	7.2	4.1	1.02
53	9	5.2	4.0	1.25
54	9	4.2	3.8	1.43
55	10	1.9	4.1	0.81
56	10	1.4	8.4	0.81
57	10	7.5	3.0	0.99
58	10	5.0	5.2	1.62
59	10	7.5	7.5	1.68
60	11	4.2	10.2	0.97
61	11	4.7	1.6	1.12
62	11	3.8	2.1	1.50
63	11	10.1	7.1	1.55
64	11	7.5	1.3	2.08
65	12	4.5	3.6	1.30
66	12	10.7	4.1	1.32
67	12	9.5	4.1	1.37
68	12	9.7	6.1	0.97
69	12	9.1	6.1	1.15
70	12	4.7	5.2	1.12
71	12	3.1	1.3	0.87
72	12	7.2	5.5	1.50
73	13	9.0	7.2	0.68
74	13	8.5	7.0	0.87
75	13	7.5	7.2	1.12
76	13	2.1	6.0	1.87
77	13	3.2	6.6	0.87
78	13	1.3	5.0	1.00
79	13	1.1	3.5	1.61
80	14	7.2	10.7	1.02

RUN 49 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	14	2.9	2.6	1.12
82	14	0.6	7.4	1.72
83	15	3.6	3.4	1.50
84	15	5.2	0.4	1.44
85	15	3.8	10.4	1.22
86	15	4.5	9.6	1.05
87	15	4.9	10.4	1.00
88	15	5.5	7.9	0.66
89	15	7.7	1.5	1.71
90	16	2.1	6.0	1.19
91	16	2.0	8.5	1.50
92	16	3.2	8.0	1.73
93	16	5.4	8.9	1.35
94	16	6.9	10.1	1.22
95	16	7.4	5.7	1.06
96	16	9.2	2.1	1.75
97	18	10.9	7.1	0.79
98	18	6.1	4.1	1.80
99	18	6.4	6.3	1.22
100	18	4.9	6.1	1.31
101	18	3.6	6.4	1.62
102	19	7.6	2.0	1.93
103	19	8.6	4.5	1.37
104	19	5.9	2.7	2.06
105	19	4.5	4.5	1.55

RUN 50 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	470	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.510	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.765	FT./SEC.
BED HEIGHT	5.0	IN.
SETTLED BED HEIGHT	4.0	IN.
PRESSURE DROP THROUGH BED	15.6	CM. OF WATER
AIR TEMPERATURE	88	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	64	FRAMES/SEC.
DURATION OF RUN	1.000	SEC.

RUN 50 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	4.5	9.5	1.12
2	1	5.6	3.9	3.61
3	1	10.4	4.7	1.53
4	2	1.4	8.0	1.73
5	2	9.7	3.8	2.05
6	3	0.7	6.1	1.44
7	3	7.4	1.9	1.49
8	3	8.4	4.9	1.06
9	4	5.0	2.1	2.03
10	4	9.7	7.6	1.68
11	4	7.6	8.6	3.17
12	5	0.9	4.0	2.12
13	6	9.4	3.5	1.43
14	6	9.9	4.2	0.87
15	6	7.7	2.1	0.99
16	7	2.6	9.7	0.87
17	8	4.1	6.7	0.68
18	8	3.9	5.1	0.81
19	8	7.5	5.2	2.67
20	8	3.9	4.0	2.90
21	9	3.9	9.6	1.76
22	10	2.0	7.0	1.55
23	11	10.1	5.6	3.29
24	11	6.3	0.9	2.43
25	11	6.7	10.2	1.66
26	11	2.1	7.7	2.24
27	12	8.9	1.6	2.04
28	12	5.2	9.6	1.37
29	12	4.0	10.0	0.74
30	13	7.6	3.2	2.11
31	14	8.6	5.7	3.05
32	15	6.9	10.4	0.99
33	16	9.6	2.1	1.73
34	18	3.4	9.7	1.61
35	18	3.8	1.1	2.02
36	18	4.7	2.7	1.02
37	18	3.8	7.4	3.10
38	18	3.8	2.9	1.76
39	19	4.9	3.9	0.63
40	20	5.1	4.9	1.75

RUN 50 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	20	2.9	7.7	1.79
42	20	0.9	7.1	1.49
43	20	1.0	3.5	2.80
44	21	6.0	7.5	3.49
45	22	4.6	10.5-	1.73
46	22	3.0	5.0	1.17
47	23	9.7	5.0	1.37
48	23	10.5	5.5	1.55
49	23	10.0	3.1	2.74
50	23	6.5	3.6	3.48
51	25	4.9	1.9	2.93
52	25	6.3	7.5	3.06
53	28	6.6	0.4	0.97
54	29	10.4	3.2	1.81
55	29	8.8	8.0	2.75
56	30	10.6	5.2	1.12
57	30	5.1	1.1	1.34
58	30	8.0	1.7	2.22
59	31	2.5	7.2	1.50
60	31	7.0	6.5	3.03
61	32	1.6	6.4	2.74
62	32	8.6	8.9	1.44
63	32	2.9	4.1	2.62
64	32	7.1	9.7	1.48
65	33	5.2	3.4	2.92
66	33	5.2	9.0	1.43
67	33	2.5	9.2	1.76
68	34	6.4	10.9	1.59
69	34	8.6	5.7	2.80
70	38	7.2	9.7	1.12
71	38	5.0	3.1	3.13
72	38	8.5	2.6	1.06
73	39	8.9	5.5	2.85
74	39	5.4	0.9	1.12
75	40	10.7	5.2	2.32
76	40	7.2	1.6	2.22
77	41	2.9	3.1	1.55
78	42	5.1	8.6	4.81
79	45	6.7	4.7	2.00
80	44	4.0	4.6	1.49

RUN 50 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	44	9.1	7.7	1.30
82	44	8.2	8.4	1.49
83	44	8.0	6.9	1.50
84	44	8.6	4.7	1.84
85	44	10.9	5.1	1.90
86	44	2.7	3.4	1.55
87	45	1.9	8.6	2.27
88	45	9.0	2.0	1.98
89	45	3.4	1.5	1.22
90	46	1.3	4.5	2.90
91	48	3.9	3.5	2.92
92	50	6.7	2.7	1.50
93	50	5.2	1.9	3.18
94	52	9.0	7.9	2.17
95	52	1.6	3.5	3.61
96	54	3.8	2.9	1.50
97	54	6.4	0.6	1.53
98	54	9.6	3.0	2.87
99	55	8.0	0.6	1.12
100	55	4.6	4.6	1.63
101	56	1.7	4.9	3.00
102	56	7.4	3.1	1.44
103	56	6.0	7.9	2.35
104	56	6.5	6.0	1.89
105	57	0.9	7.2	2.03
106	57	2.9	9.5	2.02
107	59	9.6	7.6	1.73
108	59	10.7	6.7	1.30
109	59	6.5	2.0	2.43
110	59	7.7	9.4	0.87
111	60	10.5	5.4	1.37
112	60	3.8	3.6	2.40
113	64	3.6	3.5	2.24
114	64	8.1	8.8	1.53
115	64	5.5	8.9	3.84
116	64	1.9	6.4	3.11

RUN 51 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	470	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.510	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.765	FT./SEC.
BED HEIGHT	9.7	IN.
SETTLED BED HEIGHT	8.0	IN.
PRESSURE DROP THROUGH BED	30.9	CM. OF WATER
AIR TEMPERATURE	88	DEGREES=F.
CAMERA	200 EE	
CAMERA SPEED	64	FRAMES/SEC.
DURATION OF RUN	1.953	SEC.

RUN 51 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	6.6	5.4	2.84
2	1	7.5	8.6	3.83
3	2	10.5	5.7	3.33
4	3	4.4	4.4	4.52
5	5	5.5	10.7	1.97
6	7	1.9	3.3	1.66
7	7	4.5	6.4	4.45
8	7	1.2	5.6	0.91
9	7	0.2	5.5	0.61
10	13	2.6	7.4	5.70
11	13	9.8	6.8	3.67
12	15	4.9	2.4	3.59
13	17	9.0	4.1	4.16
14	22	9.2	5.0	3.28
15	22	3.9	3.1	5.91
16	27	0.8	6.2	3.04
17	27	5.1	10.8	1.56
18	27	3.5	10.4	1.46
19	27	8.6	7.7	3.56
20	28	3.1	2.8	4.69
21	30	8.5	2.3	4.25
22	32	2.0	8.2	3.90
23	40	2.2	7.5	3.99
24	40	9.6	6.8	3.26
25	43	5.8	8.0	5.08
26	44	10.8	7.1	1.64
27	44	3.4	4.9	3.61
28	45	5.9	4.8	2.20
29	48	9.5	5.8	2.99
30	49	7.7	2.0	1.19
31	49	5.0	1.5	0.93
32	51	4.6	2.6	1.52
33	58	8.7	1.8	1.24
34	59	0.8	8.1	1.52
35	59	1.5	5.2	3.51
36	60	5.9	2.6	2.98
37	60	6.2	6.2	3.76
38	60	8.9	6.4	1.13
39	60	9.0	4.1	3.40
40	65	5.9	9.6	1.42

## RUN 51 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	68	9.7	6.5	3.76
42	70	4.2	3.2	6.40
43	71	11.4	6.1	0.52
44	71	11.1	5.0	1.13
45	71	10.5	8.0	1.06
46	71	2.8	9.8	0.78
47	71	3.5	10.6	1.12
48	72	5.9	10.9	1.06
49	74	9.4	4.5	2.81
50	75	3.0	8.0	2.93
51	77	8.7	2.2	3.40
52	78	4.2	4.7	5.15
53	79	1.2	8.2	2.27
54	88	0.8	5.8	2.17
55	88	3.6	6.0	3.65
56	90	8.3	3.7	6.42
57	93	3.9	1.5	2.57
58	95	2.8	4.9	2.06
59	98	4.6	9.2	4.17
60	100	5.4	2.6	3.96
61	101	7.6	6.4	3.38
62	104	5.5	5.5	4.46
63	104	6.0	0.5	1.12
64	104	8.6	1.5	2.15
65	105	1.1	8.1	2.48
66	109	1.8	6.7	2.98
67	112	6.7	5.2	0.93
68	114	3.3	2.8	1.85
69	114	0.9	3.2	1.19
70	115	9.1	5.4	4.86
71	119	2.6	8.0	5.48
72	120	5.4	6.4	3.47
73	121	3.4	6.6	2.35
74	121	6.3	2.2	4.25
75	125	9.7	2.7	1.58

RUN 52 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	470	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.510	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.765	FT./SEC.
BED HEIGHT	14.4	IN.
SETTLED BED HEIGHT	12.0	IN.
PRESSURE DROP THROUGH BED	46.2	CM. OF WATER
AIR TEMPERATURE	90	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	6.271	SEC.

RUN 52 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	3.8	6.5	3.14
2	3	2.3	7.9	4.72
3	3	8.0	8.0	6.36
4	4	4.8	2.8	6.13
5	20	8.9	2.4	4.80
6	20	5.0	5.5	7.21
7	26	10.0	3.3	1.70
8	27	8.8	2.2	2.34
9	36	2.0	8.0	5.58
10	40	4.4	4.1	7.10
11	50	8.3	6.2	7.58
12	55	6.8	4.6	4.92
13	57	2.2	7.8	4.65
14	64	4.5	10.3	2.40
15	71	6.5	0.3	1.79
16	72	1.5	3.4	2.24
17	72	6.1	3.5	6.88
18	76	10.6	3.6	2.15
19	78	9.6	8.3	3.88
20	80	6.0	8.5	3.98
21	90	5.8	7.7	7.65
22	95	2.9	2.1	4.06
23	97	7.7	1.6	4.12
24	99	1.5	5.7	3.85
25	112	7.2	4.2	7.94
26	120	1.3	8.8	2.83
27	121	2.2	6.4	1.06
28	121	1.2	6.7	0.84
29	121	3.1	10.2	0.84
30	121	4.3	9.2	0.98
31	123	8.0	10.0	0.94
32	123	7.8	8.8	1.15
33	127	8.3	2.3	4.37
34	127	10.4	3.8	0.99
35	127	9.9	4.6	1.14
36	127	9.7	7.7	1.93
37	129	6.9	9.3	2.20
38	129	7.3	5.3	2.13
39	129	4.7	1.6	1.77
40	133	5.1	3.6	2.71

RUN 52 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	133	1.9	3.6	1.55
42	141	8.8	4.5	5.99
43	147	9.8	4.5	4.27
44	148	2.1	6.5	6.22
45	152	6.8	8.9	5.60
46	154	6.9	1.2	3.83
47	166	7.5	6.3	6.84
48	167	7.2	1.7	3.92
49	174	2.7	3.9	4.98
50	175	5.0	7.5	4.60
51	176	9.3	4.0	3.97
52	176	3.5	9.5	4.05
53	179	2.3	7.8	4.30
54	184	4.3	0.8	1.86
55	184	7.1	1.6	4.27
56	185	6.2	4.8	3.79
57	196	10.9	4.4	2.44
58	196	4.3	6.0	1.79
59	196	8.0	7.7	5.22
60	198	7.4	3.7	4.97
61	198	6.3	10.5	2.50
62	201	0.9	4.4	2.76
63	201	3.7	9.2	4.28
64	213	2.5	5.8	6.34
65	215	5.8	2.2	4.70
66	217	8.6	6.1	6.49
67	227	3.8	9.2	4.60
68	228	6.2	3.9	7.24
69	236	7.9	7.3	1.50
70	236	5.8	8.9	3.18
71	243	3.0	2.1	5.23
72	243	4.7	6.2	6.31
73	245	8.4	1.7	2.83
74	247	9.1	5.2	4.65
75	255	2.9	7.7	2.69
76	255	1.5	6.7	1.79
77	255	0.8	5.0	2.06
78	256	4.7	6.5	2.65
79	257	3.7	4.0	5.08
80	262	3.2	5.8	3.83

RUN 52 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	264	4.0	10.3	3.35
82	264	1.4	8.9	2.00
83	271	5.0	8.0	3.46
84	271	4.2	5.3	2.65
85	271	1.5	7.6	3.26
86	272	1.7	6.8	4.10
87	273	9.2	5.2	4.74
88	275	9.1	9.4	2.59
89	287	2.2	6.2	5.61
90	288	3.2	1.5	1.14
91	291	4.7	2.9	2.96
92	296	7.3	2.3	5.40
93	296	7.5	8.8	5.14
94	301	6.0	7.7	6.72

RUN 53 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	470	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.510	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.765	FT./SEC.
BED HEIGHT	28.1	IN.
SETTLED BED HEIGHT	24.0	IN.
PRESSURE DROP THROUGH BED	92.5	CM. OF WATER
AIR TEMPERATURE	92	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	3.979	SEC.

RUN 53 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	8.3	5.8	8.88
2	31	6.4	4.2	5.40
3	32	4.1	5.5	9.00
4	66	10.3	6.0	9.65
5	81	3.7	3.6	3.99
6	83	10.1	7.6	2.05
7	84	7.5	0.9	2.63
8	87	7.9	3.6	6.59
9	89	6.2	8.9	5.99
10	108	6.6	2.3	6.27
11	109	2.3	4.2	2.85
12	109	9.8	6.1	3.47
13	109	5.8	6.9	5.48
14	130	1.3	9.7	2.16
15	130	4.0	9.8	2.89
16	130	2.4	5.8	6.08
17	131	7.8	6.4	6.49
18	153	9.5	7.5	4.07
19	155	2.1	7.0	4.42
20	155	3.9	2.3	4.03
21	155	6.7	6.9	7.24
22	162	9.2	2.3	2.79
23	163	9.3	7.1	2.48
24	163	7.6	7.4	1.14
25	164	6.1	8.7	3.36
26	164	6.8	4.3	3.85
27	185	6.0	6.0	10.57

RUN 54 PART A

PARTICLES	GLASS BEADS	
AVERAGE PARTICLE DIAMETER	470	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.510	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.765	FT./SEC.
BED HEIGHT	41.6	IN.
SETTLED BED HEIGHT	36.0	IN.
PRESSURE DROP THROUGH BED	138.5	CM. OF WATER
AIR TEMPERATURE	87	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	48	FRAMES/SEC.
DURATION OF RUN	7.291	SEC.

RUN 54 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	1	6.8	5.4	10.31
2	46	6.0	6.7	10.38
3	86	1.0	6.1	2.50
4	86	6.7	6.2	10.42
5	131	5.3	5.2	10.45
6	176	7.4	7.4	2.87
7	176	8.5	3.9	6.04
8	176	3.2	5.7	7.49
9	223	5.1	5.7	10.96
10	265	6.0	6.2	10.36
11	301	10.0	4.3	4.47
12	301	4.6	6.7	9.56

RUN 56 PART A

PARTICLES	CRACKING	CATALYST
AVERAGE PARTICLE DIAMETER	59	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.003	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.007	FT./SEC.
BED HEIGHT	5.0	IN.
SETTLED BED HEIGHT	5.0	IN.
PRESSURE DROP THROUGH BED	4.5	CM. OF WATER
AIR TEMPERATURE	87	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	64	FRAMES/SEC.
DURATION OF RUN	0.797	SEC.

RUN 56 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	80	10.7	8.3	0.80
2	80	1.4	9.3	0.32
3	81	5.9	10.5	0.73
4	81	5.9	11.0	0.62
5	81	0.8	7.7	0.78
6	82	7.8	10.7	0.45
7	85	1.0	8.1	0.64
8	85	0.5	7.5	0.73
9	85	6.1	11.0	0.71
10	85	4.0	6.4	0.96
11	86	7.8	10.9	0.32
12	86	5.9	4.5	0.96
13	88	5.3	11.0	0.32
14	89	4.2	6.2	1.03
15	90	1.1	7.3	0.32
16	90	0.5	7.0	0.39
17	90	0.6	7.5	0.48
18	90	0.8	7.8	0.64
19	91	9.4	9.6	0.32
20	91	6.2	8.3	0.32
21	91	10.7	4.0	0.68
22	92	4.2	8.9	0.32
23	93	6.1	11.0	0.62
24	95	8.0	1.0	0.85
25	98	8.0	10.7	0.39
26	101	6.1	11.0	0.90
27	102	9.6	9.6	0.62
28	102	4.5	6.2	0.87
29	102	1.1	3.2	0.80
30	103	10.9	4.3	0.78
31	103	1.6	9.3	0.32
32	104	1.3	8.0	0.48
33	104	6.4	8.5	0.32
34	104	7.0	11.0	0.32
35	104	5.9	4.3	0.87
36	105	0.6	6.5	0.39
37	106	6.2	11.0	0.85
38	107	8.0	10.7	0.55
39	108	0.8	7.8	1.07
40	109	9.6	9.7	0.68

RUN 56 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	110	5.6	0.3	0.78
42	110	4.5	6.4	1.03
43	111	5.4	10.5	0.39
44	111	6.1	10.5	0.55
45	111	6.5	11.0	0.78
46	111	6.1	11.2	0.55
47	112	4.8	0.6	0.32
48	113	5.9	1.0	0.39
49	114	5.9	4.5	0.80
50	114	4.2	6.4	0.87
51	114	9.6	9.6	0.55
52	117	1.0	7.7	0.96
53	117	5.6	1.0	0.39
54	117	5.6	0.5	0.71
55	118	10.4	4.0	0.94
56	119	6.1	11.0	0.62
57	119	5.7	11.0	0.48
58	119	6.1	10.2	0.55
59	119	5.4	10.1	0.62
60	119	1.1	3.2	0.80
61	120	7.8	10.4	0.62
62	120	6.1	8.5	0.39
63	121	1.4	8.1	0.32
64	121	0.8	7.5	1.11
65	122	8.0	10.5	0.55
66	122	5.7	4.5	0.78
67	122	5.4	0.5	0.85
68	123	9.4	9.6	0.62
69	125	4.8	0.3	0.78
70	127	6.1	10.2	0.32
71	127	6.1	11.2	0.64
72	127	3.5	10.9	0.32
73	127	6.7	11.0	0.85
74	128	8.0	10.5	0.55
75	128	5.9	4.5	0.80
76	129	0.5	7.5	0.85

RUN 57 PART A

PARTICLES	CRACKING	CATALYST
AVERAGE PARTICLE DIAMETER	59	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.003	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.007	FT./SEC.
BED HEIGHT	10.5	IN.
SETTLED BED HEIGHT	10.0	IN.
PRESSURE DROP THROUGH BED	10.0	CM. OF WATER
AIR TEMPERATURE	86	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	64	FRAMES/SEC.
DURATION OF RUN	1.580	SEC.

RUN 57 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	76	8.2	9.7	0.49
2	76	6.0	10.9	0.92
3	77	8.7	10.2	0.98
4	78	5.3	1.3	0.64
5	78	4.3	0.6	0.64
6	78	3.8	0.9	0.98
7	80	0.7	7.4	0.64
8	80	10.8	7.5	1.04
9	82	10.8	7.8	0.71
10	83	3.4	1.1	0.35
11	83	5.7	10.4	0.28
12	84	1.0	3.5	0.98
13	84	4.1	1.1	0.92
14	85	6.0	11.2	0.64
15	85	5.3	11.1	0.57
16	86	8.8	10.2	0.84
17	86	1.1	8.1	1.10
18	90	11.1	7.5	0.92
19	92	4.0	0.9	1.13
20	94	0.6	4.0	0.55
21	94	0.9	4.3	0.49
22	94	1.1	3.8	0.60
23	94	0.9	3.3	0.49
24	95	8.7	9.9	0.57
25	95	10.8	7.4	0.95
26	96	0.7	7.4	0.70
27	96	3.4	0.7	1.04
28	99	2.0	8.2	0.85
29	99	8.1	9.5	0.92
30	99	0.7	3.8	0.90
31	101	4.4	0.7	1.06
32	101	9.1	10.1	0.64
33	101	8.5	10.1	0.84
34	102	10.8	7.4	0.55
35	102	10.6	7.8	0.64
36	102	1.3	7.7	0.71
37	102	0.9	7.4	0.64
38	106	0.9	3.8	1.19
39	115	5.8	10.9	1.06
40	117	0.9	8.0	0.98

## RUN 57 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	117	0.9	3.7	1.10
42	118	3.8	0.7	0.70
43	119	8.8	10.1	0.95
44	123	1.3	3.0	0.35
45	123	1.1	2.7	0.43
46	123	1.0	3.5	1.04
47	124	8.4	10.2	0.55
48	124	8.8	10.1	0.78
49	126	6.0	10.4	0.92
50	128	8.8	10.2	0.95
51	128	4.3	0.6	1.04
52	131	0.9	7.8	1.10
53	132	6.1	10.8	0.70
54	132	5.4	10.9	0.84
55	137	1.0	8.0	1.00
56	140	3.4	10.2	0.98
57	140	1.0	3.8	1.13
58	140	5.7	11.1	0.28
59	140	5.5	10.9	1.19
60	141	4.1	0.6	0.92
61	141	8.8	10.1	1.25
62	149	0.9	4.0	1.10
63	149	10.6	7.5	0.98
64	153	1.0	8.0	0.98
65	155	10.8	7.4	1.04
66	157	5.5	10.8	1.33
67	163	8.4	9.8	1.20
68	164	1.1	7.4	0.70
69	164	1.0	6.7	0.71
70	164	0.9	3.7	1.10
71	164	4.0	0.9	1.28
72	165	6.7	10.8	0.80
73	165	0.7	8.2	0.75
74	170	6.0	11.1	0.71
75	170	5.4	11.1	0.78
76	170	0.7	4.0	1.10
77	173	4.4	0.7	0.78
78	173	3.1	1.0	0.55
79	173	8.4	10.4	0.60
80	174	1.8	8.9	0.92

RUN 57 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
81	175	8.5	10.2	0.78
82	176	10.8	7.5	1.04

RUN 58 PART A

PARTICLES	CRACKING	CATALYST
AVERAGE PARTICLE DIAMETER	59	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.003	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.007	FT./SEC.
BED HEIGHT	21.2	IN.
SETTLED BED HEIGHT	20.0	IN.
PRESSURE DROP THROUGH BED	20.9	CM. OF WATER
AIR TEMPERATURE	90	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	64	FRAMES/SEC.
DURATION OF RUN	2.970	SEC.

RUN 58 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	98	7.7	10.4	0.86
2	99	7.4	9.9	0.40
3	99	8.3	10.4	0.53
4	99	7.9	9.9	0.46
5	100	1.5	8.5	1.12
6	102	8.1	10.4	0.92
7	102	7.3	10.4	0.78
8	102	0.9	7.1	0.92
9	108	8.9	11.5	0.72
10	108	2.1	8.3	1.02
11	109	1.2	8.1	1.51
12	112	7.1	10.3	0.46
13	112	7.1	9.8	0.40
14	121	5.9	1.1	1.24
15	122	5.2	1.9	0.26
16	122	4.6	1.9	0.65
17	122	4.6	1.2	1.05
18	124	0.9	7.7	1.11
19	128	8.1	10.0	1.02
20	128	7.4	10.6	1.24
21	130	5.8	0.5	1.25
22	132	1.1	7.8	1.51
23	132	4.5	1.1	1.16
24	137	1.1	7.5	1.18
25	145	0.9	7.8	0.93
26	150	5.2	1.2	1.97
27	155	1.2	7.9	1.05
28	160	7.4	11.1	0.40
29	160	7.7	10.6	0.72
30	160	7.1	10.7	0.59
31	171	7.5	10.6	1.32
32	173	5.3	1.3	1.39
33	175	7.8	10.4	0.65
34	175	7.3	10.4	0.84
35	183	4.9	1.1	1.98
36	195	4.2	1.7	1.12
37	195	3.4	1.3	0.78
38	195	5.8	-0.5	0.86
39	198	4.9	0.9	2.02
40	200	7.4	10.4	0.65

## RUN 58 PART B (CONTINUED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	200	6.9	11.0	0.46
42	201	4.5	0.3	0.51
43	204	4.5	2.5	0.59
44	204	4.8	2.1	0.26
45	205	4.1	0.5	1.12
46	205	5.2	0.5	0.32
47	208	4.9	0.7	0.32
48	208	1.1	7.8	0.59
49	208	0.7	7.1	0.46
50	209	5.3	2.4	0.26
51	209	4.8	0.5	0.65
52	210	5.8	0.7	1.24
53	215	0.5	7.8	0.56
54	215	1.3	7.8	0.59
55	215	0.9	7.0	0.86
56	217	3.0	1.1	0.53
57	218	4.9	0.8	1.64
58	220	6.3	1.6	0.40
59	220	6.6	1.2	0.46
60	221	6.2	1.1	0.32
61	223	2.5	10.3	0.26
62	223	2.6	9.8	0.40
63	225	0.7	7.5	1.02
64	226	5.7	1.7	0.40
65	226	4.5	0.4	0.46
66	226	1.1	7.5	0.59
67	226	0.9	6.7	0.65
68	227	1.1	8.1	0.66
69	227	6.2	1.3	0.78
70	227	6.6	0.5	0.65
71	228	5.9	2.1	0.46
72	230	5.3	0.8	0.46
73	230	5.7	0.7	0.51
74	230	5.6	1.1	0.46
75	230	5.0	1.1	0.59
76	233	1.2	7.0	1.50
77	233	5.9	1.3	0.53
78	233	4.2	0.8	0.86
79	237	5.2	0.4	0.46
80	237	4.6	0.3	0.32

RUN 58 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	-Y	
81	238	0.8	7.4	1.18
82	240	5.7	0.5	0.86
83	245	7.7	10.2	0.86
84	253	5.0	0.8	1.52
85	254	0.9	7.7	1.16
86	259	0.9	7.5	1.30
87	260	4.9	0.7	0.49
88	268	0.8	7.7	1.11
89	273	0.9	7.5	1.35
90	281	4.9	1.1	1.85
91	286	7.8	10.3	0.86
92	287	0.8	7.8	0.92
93	287	3.6	1.6	0.59

RUN 59 PART A

PARTICLES	CRACKING	CATALYST
AVERAGE PARTICLE DIAMETER	59	MICRONS
INCIPIENT FLUIDIZATION VELOCITY, SUPERFICIAL	0.003	FT./SEC.
FLUIDIZATION VELOCITY, SUPERFICIAL	0.007	FT./SEC.
BED HEIGHT	31.5	IN.
SETTLED BED HEIGHT	30.0	IN.
PRESSURE DROP THROUGH BED	31.4	CM. OF WATER
AIR TEMPERATURE	89	DEGREES F.
CAMERA	200 EE	
CAMERA SPEED	64	FRAMES/SEC.
DURATION OF RUN	3.180	SEC.

RUN 59 PART B

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
1	120	8.5	9.8	1.78
2	135	8.3	2.4	1.42
3	140	9.0	2.1	1.09
4	141	7.4	2.1	1.66
5	144	8.5	9.6	1.95
6	148	9.4	2.4	0.82
7	151	8.2	2.4	1.54
8	152	8.8	9.6	1.79
9	163	8.4	9.7	1.69
10	163	8.9	8.8	0.58
11	165	8.2	2.6	2.07
12	166	9.1	9.6	0.95
13	172	8.3	4.0	0.34
14	172	9.0	3.4	0.29
15	172	7.2	1.3	0.36
16	183	8.7	9.8	1.72
17	189	8.5	2.4	0.82
18	190	8.2	1.8	0.41
19	190	7.7	2.7	1.30
20	198	8.2	9.7	1.60
21	198	8.1	10.0	0.58
22	202	9.0	9.4	1.16
23	206	7.8	10.0	1.33
24	210	8.2	2.0	1.66
25	216	9.6	9.7	0.58
26	216	9.1	9.8	0.84
27	216	9.1	10.0	0.47
28	216	7.2	8.8	1.06
29	220	8.7	9.4	2.00
30	220	8.5	2.0	1.47
31	227	7.6	2.5	1.33
32	230	9.0	9.7	1.21
33	235	9.4	9.6	0.99
34	235	8.8	10.0	0.87
35	235	8.2	10.0	0.92
36	236	7.9	9.0	0.58
37	239	8.8	9.4	1.33
38	239	7.8	1.7	0.41
39	239	7.6	2.3	1.24
40	240	8.7	2.3	1.13

RUN 59 PART B (CONCLUDED)

TALLY	FRAME NUMBER	BUBBLE COORDINATES INCHES		BURSTING DIAMETER OF BUBBLE INCHES
		X	Y	
41	241	7.4	10.1	0.80
42	252	8.3	10.1	1.21
43	254	9.0	10.2	0.65
44	258	8.9	10.4	0.41
45	260	3.4	1.2	1.69
46	260	9.8	9.3	0.65
47	261	7.8	2.3	0.59
48	261	7.2	2.3	0.71
49	261	7.6	1.9	0.65
50	261	8.1	1.5	1.23
51	262	8.9	3.2	1.96
52	277	9.1	10.0	0.65
53	277	8.7	10.2	0.82
54	277	8.1	10.6	0.89
55	288	7.9	1.1	0.47
56	288	8.2	1.2	0.59
57	288	9.3	1.9	1.71
58	291	8.3	10.4	1.04
59	291	7.8	10.2	0.82
60	295	7.5	1.2	0.96
61	296	8.3	1.8	1.76
62	298	8.7	3.2	0.36
63	298	7.6	2.5	0.36
64	298	7.0	1.8	0.65
65	299	7.2	1.3	0.41
66	300	7.8	1.7	1.33
67	313	8.8	9.8	1.18
68	316	7.8	10.1	0.96
69	316	8.2	1.4	1.66
70	316	9.5	1.8	0.65
71	318	8.9	9.8	1.11

LITERATURE CITED

1. Hulburt, H. M., and Stanley Katz, Chem. Eng. Sci., 19, 555, (1964).
2. Partridge, B. A., and P. N. Rowe, Trans. Instn. Chem. Engrs. (London), 44, T 335, (1966).
3. Ibid., T 349.
4. Ohmae, Tsutomu, and Junji Furukawa, J. Chem. Soc. Japan, Ind. Chem. Sect., 56, 909, (1953).
5. Mathis, J. F., and C. C. Watson, A.I.Ch.E. Journal, 2, 518, (1956).
6. Morse, R. D., and C. O. Ballou, Chem. Eng. Progr., 47, 199, (1951).
7. Yasui, George, and L. N. Johanson, A.I.Ch.E. Journal, 4, 445, (1958).
8. Lanneau, K. P., Trans. Instn. Chem. Engrs. (London), 38, 125, (1960).
9. Porter, James D., Ph.D. thesis, Mass. Inst. Technol. (1963).
10. Grohse, E. W., A.I.Ch.E. Journal, 1, 358, (1955).
11. Baumgarten, P. K., and R. L. Pigford, *ibid.*, 6, 115, (1960).
12. Romero, J. B., and D. W. Smith, *ibid.*, 11, 595, (1965).
13. Harrison, D., and L. S. Leung, Symposium on the Interaction between Fluids and Particles, Instn. Chem. Engrs. (London), page 127, (1962).

14. Harrison, D., and L. S. Leung, Trans. Instn. Chem. Engrs. (London), 40, 146, (1962).
15. Davidson, J. F., R. C. Paul, M. J. S. Smith, and M. A. Duxbury, *ibid.*, 37, 323, (1959).
16. Rowe, P. N., and B. A. Partridge, *ibid.*, 43, 157, (1965).
17. Abramowitz, Milton, and I. A. Stegun, ed., Handbook of Mathematical Functions, p. 253, National Bureau of Standards, Washington, D. C., (1964).
18. Jackson, R., Trans. Instn. Chem. Engrs. (London), 41, 13, (1963).
19. Pigford, R. L., and T. Baron, Ind. Eng. Chem. Fundamentals, 4, 81, (1965).
20. Davidson, J. F., and D. Harrison, Fluidized Particles, p. 85, Cambridge University Press, London, (1963).
21. Shinnar, Reuel, and Pinhas Naor, Chem. Eng. Sci., 15, 220, (1961).
22. Guggenheim, E. A., Edit., The Internatl. Encyclopedia of Phys. Chem. and Chem. Phys., Vol. 1, p. 21, Pergamon Press, London, (1960).
23. Botterill, J. S. M., and J. S. George, paper presented at the A.I.Ch.E. Symposium on Developments in Fluid Particle Technology - Part I, Boston, (1964).
24. Shinnar, Reuel, private communication to the author.

AUTOBIOGRAPHICAL STATEMENT

Dimitris T. Argyriou was born December 19, 1930, in Didymoteihon, Greece. He attended the public school system there, graduating in June, 1948. He then went to the National Polytechnic Institute in Athens, Greece, and received a diploma in Chemical Engineering in June, 1954.

After one year of service in the Greek Army, he did research on the anodic oxidation of aluminum at the National Polytechnic Institute in Athens. A paper titled "Beitrag zur Kinetik der anodischen Oxydation von Aluminium" was published as a result of this work in the Kolloid-Zeitschrift, 168, 154, (1960).

He then went to work for Mines Union as a production supervisor in their Chromite Dressing plant until July 1957, when he left for Canada. There he attended Graduate School in the Department of Chemical Engineering, University of Toronto, while he was a part-time demonstrator. In November, 1958, he came to New York City. He continued his studies in the evenings at City College and in June, 1962, he received his M.S. in Chemical Engineering.

In September, 1959, he went to work for Alloys Unlimited in Long Island City as an Analytical Chemist. In February, 1960, he joined Rayonier Incorporated in Whippany, New Jersey, as a Research and Development Engineer, in cellulose

derivatives. From September 1961 to July 1962 he worked for Isomet Corporation in Palisades Park, New Jersey, on Life Support Systems. From August 1962 to July 1963 he worked for Yardney Electric Corporation in New York City as a Project Engineer in cells and batteries.

In September 1963 he joined the Department of Chemical Engineering at City College as a lecturer where he was teaching in the undergraduate school and working toward a Ph.D. degree. He successfully defended his Ph.D. dissertation on December 15, 1967. He was the recipient of an N.S.F. Summer Traineeship for Graduate Teaching Assistants for the summer of 1967.

In September, 1967, he went to work for E. I. du Pont de Nemours and Company, Wilmington, Delaware, as a Research Engineer.

He has been married to Luz Gomez-Puga since August, 1965, and they are the parents of a son.