PARTICLE SIZE MEASUREMENT AND ANALYSIS OF FLOUR

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ABSTRACT

The present study emphasizes on the measuring the particle size of organic dust (different types of flour). Sieve analysis technique is used in the present study for estimation of weight percentage of micron sized (light weight and flyable) flour particles. The entire study is need based. Flour mill under SME being run today needs to overcome the typical problem of flying flour dust. The traditional model being run since last 5 to 6 decades need reformation. It is observed by H Kakooei and H Marioryad [5] in their study that exposure to flour dust in flour mill is responsible for respiratory as well as lung infection. The threshold limit value (TLV) of 0.5 mg/m3 recommended for reparable dust, by ACGIH. [5]. The present study shows the representative example of current Indian situation, where this recommended value found to get exceed upto 0.952 mg/m3.

Keywords: - Organic dust, sieve, particle size distribution, Flour dust.

I. INTRODUCTION

Flour is known to be a heterogeneous mixture of particles of different densities and shapes. Sieving, sedimentation, and photo extinction techniques have received most of the attention in the measuring of particle size distribution of flour. The mechanics of fine sieving can be divided into two different steps. During the first step, particles with size much smaller than the sieve opening pass through. During the second and relatively slower step, particles whose size is close to that of the opening are sieved through. Irani R.R. and W.S.Fong [1] describe a gravitational sedimentation procedure for determining flour granularity for particle size distribution by weight for a sample of flour from sedimentation in various solvents. Their finding are tabulated here in Table-I. The observation gives clear-cut indication of the heterogeneity in particle size.

Table-I

PARTICLE SIZE DISTRIBUTION BY WEIGHT FOR A SAMPLE OF FLOUR FROM SEDIMENTATION IN VARIOUS SOLVENTS [1]

Size (μ)	Percentage by weight greater than			
	Ethanol	Benzene	Isobutanol	2-Ethyl Hexanol
5	100	99.5	99.5	99.2
10	98.1	96.2	97.8	95.1
20	80	83	85.1	84.9
30	65.1	70.9	71.2	68.7
40	44	49	46	48
50	37	36	38	39
60	30	29.5	28	30
80	17	19	20	18
100	5	4	7	7
120	0	1	0	1

Sieve analysis technique is widely used in manufacturing of the components using metal powder. Similarly it is very common in testing ingredients of concrete such as sand and cement. Paul D. Komar et al.[2] described the analysis of sand measurement by sieving and settling-tube techniques and they concluded that, these procedures avoids the artificiality of pretending that the grains are perfect spheres, that is expressing the grain sizes as “sieve diameters” and “sedimentation diameters”. The same can be applicable in case of flour particle analysis.

Wilson J.T. and D.H. Donelson [3] described the comparison of flour particle size distribution measured by electrical resistivity and microscopy. The data indicate the presence upto 8-10 μm of micron sized particle in the flour, which was tested using both the method (electrical resistivity and microscopy). The distributions of particle size measured by both the method are reported to be in agreement to each other.

Betty Sullivan, W.E. Engebretson and Merlin L. Anderson [4] described the relation of particle size to certain flour with different characteristics such as protein content, maltose ash content and gassing power. It is reported that ash content increases tremendously with the reduction in particle size.

H Kakooei and H Marioryad [5] in their study highlighted the issues related to professional diseases associated with flour dust. The study indicated relevance of occupational exposure to flour dust in flour mill and respiratory symptoms to the different types of organic dust as well as lung infection while working due to considerable exposure. It was observed in this study that respiratory capacity in the worker where decrease due to this exposure to the dust. In similar study Karprnskr [6] reported that flour dust adversely affect lung function parameter FVC, FEV, PEF and causes and obstructive pattern of lung function in impairment which is associated with the dose- effect of years of exposure to flour dust.

So far as Indian scenario is concern much related statistic and serious thought about flour dust particle size, shape and its limiting dose of inhalation has not been given so far. The present experimentation is an attempt to carry out particle size analysis of the flour produced as day to day activity of flour mill run under Small and Medium Enterprises (SME). Awareness and need of reforming routine job in small and Medium Scale Industries and to reduce the allied health risk or problems associated with inhaling of the micron or nano sized particles is the objective of this experimentation. Co-relation of the results with associated profession diseases will defiantly trigger to develop new product which will help in eliminating or reducing the risk associated in these SMEs.

II. METHODOLOGY USED

A. Workplace identified for the detailed analysis:-

Om Flour Mill situated at Bachelor road, Arvi Naka in Wardha (MS), India.

1. Data:- The working area of flour mill is - length: 7 feet, width: 7 feet, height: 10 feet

Volume of working area: 13.23 m3
Production per day –
Wheat : 80 -100 kg
Jowar : 40 - 50 kg
Besan : 30- 40 kg
Total wastage of flour 10-11 kg per day

B. Sieving Method for flours:-

A sieve analysis is a practice or procedure commonly used in engineering to assess the particle size distribution of a granular material. The size distribution is often of critical importance to the way the material performs in use. A sieve analysis can be performed on any type of non-organic or organic granular materials including sands, crushed rock, clays, granite, feldspars, coal, soil, a wide range of manufactured powders, grain and seeds, down to a minimum size depending on the exact method. Being such a simple technique of particle sizing, it is probably the most common.

The technique of sieving and the analysis of the results are deceptively simple, at least as generally practiced. Although recognized by early workers, it is commonly forgotten that sieving sorts the sediment grains by shape as well as by size. Sieves are relatively cheap, cover a much wider size range than any other known particle sizing method (2 to 125 000 µm), and are simple to use.

1000gm sample size was selected for conducting sieve analysis. Test sieves “nest” together to form a “stack” of sieves. In present work 8 inch diameter sieve is used. And test sieve shaker provides both circular and tapping energy and uniform mechanical motion for most consistent result. Since the flour particles are free flowing it require less time than bulky particles. Hence 10-15 minutes time period is sufficient for performing the test. The test is carried out as per ASTM D44 using standard sieve analyzer “Tayels” make.

1. PROCEDURE FOR SIEVE ANALYSIS:-

A representative weighed sample is poured into the top sieve which has the largest screen openings of 1.8mm. Each lower sieve in the column has smaller openings than the one above. At the base is a round pan, called the receiver. The column is typically placed in a mechanical shaker. The shaker shakes the column, usually for 15-20 minutes. After the shaking is complete the material on each sieve is weighed. The weight of the sample of each sieve is then divided by the total weight to give a percentage retained on each sieve. The size of the average particles on each sieve then being analysis to get the cut-point or specific size range captured on screen.

To find the percent of aggregate passing through each sieve, first find the percent retained in each sieve. To do so, the following equation is used,

$$\% \text{ Retained} = \frac{W_{Sieve}}{W_{Total}} \times 100\ \%$$

Where WSieve is the weight of aggregate in the sieve and WTotal is the total weight of the aggregate. The next step is to find the cumulative percent of aggregate retained in each sieve. To do so, add up the total amount of aggregate that is retained in each sieve and the amount in the previous sieves. The cumulative percent passing of the aggregate is found by subtracting the percent retained from 100%.

%Cumulative Passing = 100% - %Cumulative Retained.

The values are then plotted on a graph with cumulative percent passing on the y axis and sieve size on the x axis.

Figure (a) : Sieve

Figure (b) : Mechanical Shaker

Fig-(a): Photograph showing different sieves
Fig-(b): Photograph showing Mechanical Shaker

C. Result and Discussion

The technique of sieving and the analysis of the result are deceptively simple and sieving sorts the sediment grains by shape as well as by size. The principle shape effect is the grains sphericity and the particles are spherical such that their diameters correspond to the sides of the square sieve opening. The following table shows result of experimentation performed on various samples of wheat, jowar and besan.

Table-II
Particle size measurement details of different samples

Sieve Size	Wheat flour particle present (In gm)	Jowar flour particle present (In gm)	Besan flour particle present (In gm)
1.8 mm	260	300	280
600 µm	225	250	240
300 µm	210	150	200
150 µm	138	120	150
106 µm	87	95	85
90 µm	35	60	35
75 µm	30	15	10
45 µm	15	10	

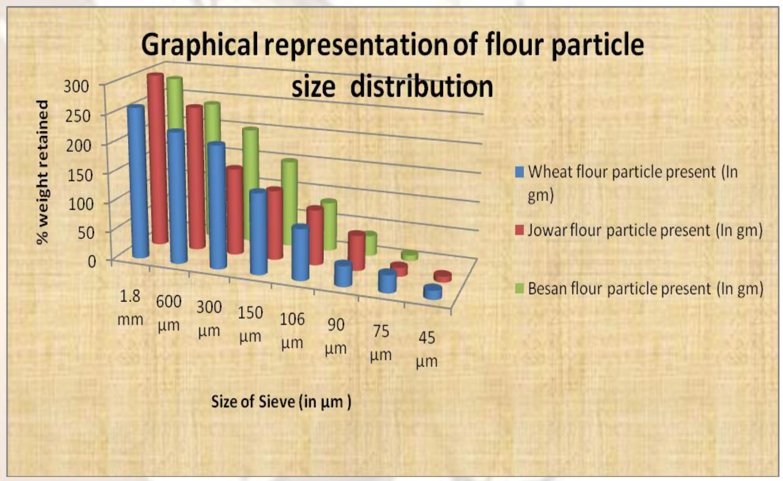

Figure- c: Graphical representation of particle size of different flour

Based on the above observation quantity of flying organic dust can be estimated. For estimation of this quantity maximum micron size of 90 µm is considered. And average production based on input data is considered.

Table-III :
Production of light weight weight particles of different flour on daily basis

Particle retained	Wheat particle (In gm) / kg	Jowar particle (In gm) / kg	Besan particle (In gm) / kg
90 µm	35	60	35
75 µm	30	15	10
45 µm	15	10	-
Total	80	85	45

Therefore, quantity of flying wheat particle produced - 80 x 90 = 7200 gm/day.

Quantity of flying jowar particle produced - 85 x 45 = 3825 gm/day.

Quantity of flying besan particle produced - 458x 35 = 1575 gm/day.

Total quantity of flour dust produced = 12600 gm/day

Working area of flour mill =2 m x2 m x3.3m =13.23 m3

Thus, 0.952 mg/m3 flying flour dust produced per day.

III. CONCLUSION:

This study was performed for a flour mill with typical occupational health problems. The American Conference of Governmental Industrial Hygienists (ACGIH) defines flour as a complex organic dust consisting of different eatable material, which have been processed or ground by milling. Inhalation of flour dust can produce allergic reaction, shortness of breath, eye problem and chronic respiratory disorders, including sensitization and asthama. The threshold limit value (TLV) of 0.5 mg/m3 recommended for reparable dust, ACGIH. [5]. Whereas, the concentration of total flour dust in the identified SME is found to be 0.952 mg/m3. This is very much alarming situation. Therefore, the emission sources of the particulate should be of the most special attentions and needed to be highly controlled by means of using more powerful system that control the emitted flour dust.

REFERENCE:-

[1.] IRANI R.R. and W.S. FONG, Measurement of the particle size distribution of flour. *(1961) Chem. 38: 67-75.*

[2.] PAUL D. KOMAR, The analysis of grain-size measurement by sieving and settling-tube techniques, *Journal of sedimentary petrology, Vol.54, No.2 June, 1984. 0603-0614.*

[3.] WILSON J.T. and D. H. DONELSON, Comparison of Flour particle size distributions measured by electrical resistivity and microscopy. *(1962) Chem. 47.126.*

[4.] BETTY SULLIVAN, W.E.ENGEBRETSON, and MERLIN L. ANDERSON, The relation of particle size to certain flour characteristics.*(1960) 436-455.*

[5.] H Kakooei1 and H Marioryad, Exposure to Inhalable Flour Dust and Respiratory Symptoms of Workers in Flour Mill in Iran. *Iranian J Env Health Sci Eng, Vol. 2,No.1,* 2005, *pp. 50-55*

[6.] Karpinski E A Exposure to inhalable flour dust in Canadian flour mill. *Appl Occup Environ Hyg; 18:1022-30. (2003).*