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# ANALYSIS OF FEED PARTICLE FINENESS

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**Abstract:** Savings for grinding of feed ingredients can mean a significant difference in the profitability of a feed manufacturing operation. Quantitative value of particle size analysis for ground feed material is "Modulus of Uniformity and Modulus of Fineness". Modulus of fineness system is somewhat intricate and involves the use of expensive equipments and considerable time. Modulus of uniformity indicates the proportionate amounts of coarse, medium and fine particles in ground feed. The modulus of uniformity is expressed the coarse, medium and fine particles.

## Introduction

In recent years, more attention has been given to the roller mill to function as a grinder. Several important factors have contributed to this including energy costs, product quality concerns, and environmental issues.

Energy costs have escalated dramatically in the last 20 years. As a result, energy savings for grinding can mean a significant difference in the profitability of a feed manufacturing operation. Product quality concerns have always been a part of feed manufacturing, and there are many quantitative methods for measuring feed quality. However the physical traits (appearance, feel, handling characteristics) will always influence the feed buying customer. Because roller mill grinders create fewer fines, less material is likely to be lost to the atmosphere. Additionally, high efficiency hammer mill installations require air assist to achieve the rated performance. Cyclones and bag filters are not 100% effective in removing the particulates from the air streams, so some emissions will occur. Whether or not these emissions are a problem will depend on widely varying local conditions and regulations.

The first attempt to assign a quantitative value of particle size analysis for ground feed material was made by American Society of Animal Science and the American Society of Agricultural Engineers. This resulted in the adaptation of a method defining "Modulus of

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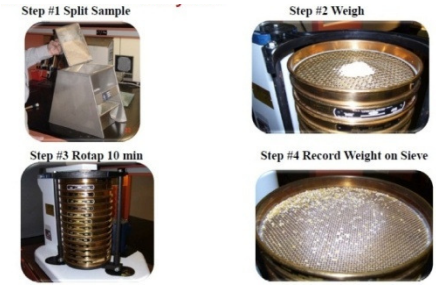
Uniformity and Modulus of Fineness" of ground feed and this was approved in 1940. The principle objection to the modulus of fineness system for determining and expressing the fineness of ground feeds for livestock, both from the engineering and animal production stand points has been that it gives no indication of the proportion of coarse, medium and fine particles in any samples of feed tested. While the modulus of fineness system is somewhat intricate and involves the use of expensive equipments and considerable time for each test, it is well adopted to scientific work such as studies of livestock feeds and feeding and testing of feed mills.

In addition to fineness, the relative uniformity of the different size of the particles in a ground feed sample. The modulus of uniformity is the results of these joint efforts. It expressed as a ratio of 3 figures, which indicates the proportionate amounts of coarse, medium and fine particles in ground feed. The sum of these figures must equal to 10 and may vary from a 10:0:0 to a 0:0:10 which provides 66 different combinations for expressing the proportion of coarse, medium and fine particles of materials.

**Modulus of uniformity**

Determination of uniformity shall be based on the percentage of a 250 gram sample of ground feed remaining on each of seven screens (3/8, 4, 8, 14, 28, 48 & 100 mesh) and in the pan following to 5 min. Test with Rotap or similar method of shaking. The modulus of uniformity is expressed by 3 figures representing the coarse, medium and fine particles the sum of which should always be equal to ten. For example the ratio of 1:6:3 represents the proportionate amounts of coarse, medium and fine particles, respectively in a particular sample of ground feed and thus expresses the uniformity of the sample.

The material remaining after a test on the 3/8, 4 and 8 mesh screens shall be designated as 'coarse' that remaining on the 14 and 28 mesh screens as 'medium' and that on the 48 and 100 mesh screens and in the pan as 'fine'. The following typical example illustrates the method of determining and expressing uniformity.



| US Sieve | Micron Size |
|---|---|
| 4 | 4760 |
| 6 | 3360 |
| 8 | 2380 |
| 12 | 1680 |
| 16 | 1190 |
| 20 | 840 |
| 30 | 590 |
| 40 | 420 |
| 50 | 297 |
| 70 | 210 |
| 100 | 149 |
| 140 | 105 |
| 200 | 74 |
| 270 | 53 |
| Pan | 37 |

**Determination of modulus of uniformity**

| A<br>Screen Mesh | B<br>% of material on each screen | C<br>Totals of column B | D | E<br>Figs. In col. D converted to nearest whole number |
|---|---|---|---|---|
| | Coarse | | | |
| 3/8 | 1.0 | | | |
| 4 | 2.5 | 10.5/10 | 1.05 | 1 |
| 8 | 7.0 | | | |
| | Medium | | | |
| 14 | 24.0 | | | |
| 28 | 35.5 | 59.5/10 | 5.95 | 6 |
| | Fine | | | |
| 48 | 22.5 | | | |
| 100 | 7.5 | 30.0/10 | 3.00 | 3 |
| Pan | 0.0 | | | |

The figures 1:6:3 from column E express the uniformity of the sample from the above determinations.

**Modulus of fineness**

The basis of modulus of fineness is the same as the modulus of uniformity and the following example illustrates how it may be found and expressed. The selection of the method used to describe the size of particles will depend upon the use, which will be made of the information. For checking the fineness of grind for plant quality control, a plotting method will probably be entirely adequate. For determining the effect of fineness of grind on

hammer mill efficiency it will be necessary to provide some type of quantitative values such as average particle size new surface area produced or similar values.

**Determination of modulus of fineness:**

| Screen Mesh | % of material on each screen | |
|---|---|---|
| 3/8 | 1.0 x 7 = | 7.0 |
| 4 | 2.5 x 6 = | 15.0 |
| 8 | 7.0 x 5 = | 35.0 |
| 14 | 24.0 x 4 = | 96.0 |
| 28 | 35.5 x 3 = | 106.5 |
| 48 | 22.5 x 2 = | 45.0 |
| 100 | 7.5 x 1 = | 7.5 |
| Pan | 0.0 x 0 = | 0.0 |
| | 100.0 | 312.0 |

Modulus of fineness = (312.0/100.0) =3.12

It is believed that methods presented provide for greater flexibility in the use of particle size data than do fineness of modulus (FM) and modulus of uniformity (MU).

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