A Simplification of the Method for Obtaining Mean Aperture and Coefficient of Variation of Granulated Sugars

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It is well known that the particle size distribution of granulated sugar may be expressed in terms of mean aperture and coefficient of variation.

The method was first described by Powers (1)[2], who credits Philip Lyle with its development.

Johnson and Newman (2) were probably first in the USA to use the MA-CV method as described by Powers and also presented a method for obtaining MA and CV from tables when only two sieves are used with a sample of 100 grams of sugar.

The above mentioned authors examined numerous samples of sugars and found that the cumulative particle size distribution normally follows a straight line when plotted on arithmetic probability paper.

Variations from this rule are principally due to partial removal of coarse and fine particles through selective screening. Classification in moving equipment is also a factor. Such variations generally occur only in the 0 to 10% and the 90 to 100% cumulative fractions.

After plotting the cumulative fractions on the probability paper the best fitting straight line is drawn through the points represented by the largest fractions. The mean aperture (MA) may then be established at the point at which the line crosses the 50% abscissa. The coefficient of variation (CV) is found by multiplying by 100 the following: (Aperture corresponding to 15.87%) minus (Aperture corresponding to 84.13%) divided by (mean aperture $\times$ 2) or, as illustrated in Figures 1 and 2, (DE/DG) $\times$ 100 = CV.

The calculation may be eliminated and the value of CV may be found by extending the plotted line to a scale constructed on the zero base line.

The CV scale is constructed from the following formula:

$$(DE/DG) = CV/100 = EF/GH$$

$$GH = (EF/CV) \times 100$$

For CV = 25 and EF = 1

$$GH = 100/25 = 4$$

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[2] Numbers in parentheses refer to literature cited.

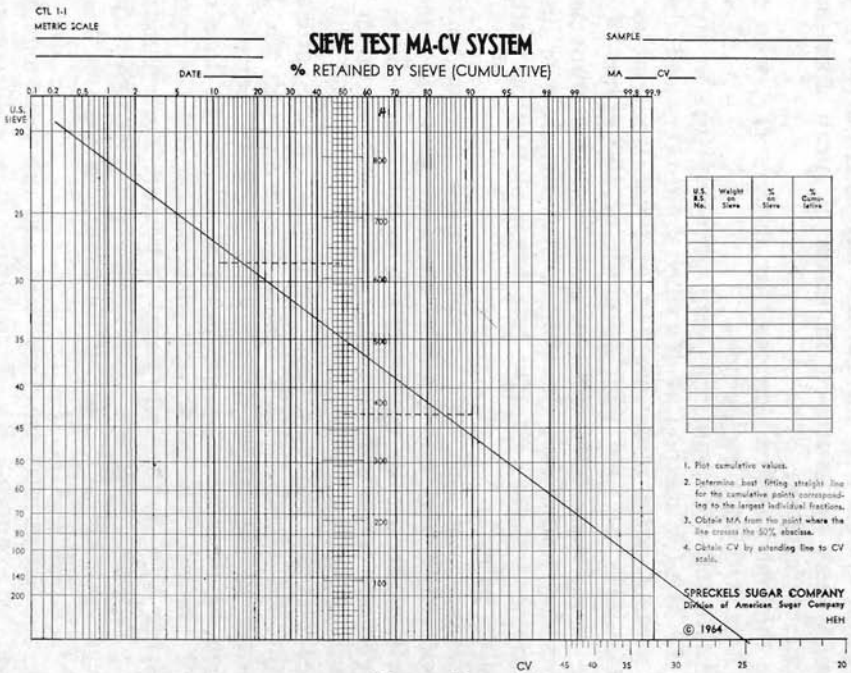
CTL 1-1
METRIC SCALE
SIEVE TEST MA-CV SYSTEM
% RETAINED BY SIEVE (CUMULATIVE)
DATE
SAMPLE
MA CV
U.S. SIEVE
CV
U.S. S. No.
Weight on Sieve
% on Sieve
% Cumulative
1. Plot cumulative values.
2. Determine best fitting straight line for the cumulative points corresponding to the largest individual fractions.
3. Obtain MA from the point where the line crosses the 50% abscissa.
4. Obtain CV by extending line to CV scale.
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Figure 1.

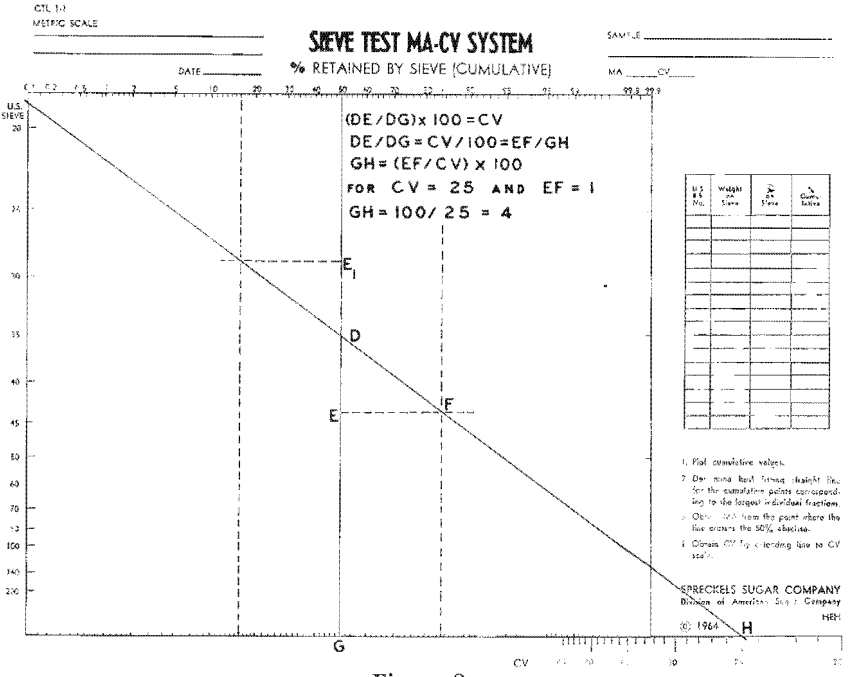

Figure 2.

Points for each number of desired CV may be determined in a similar manner.

The nominal openings, as marked on sieves by the manufacturer, differ frequently from the effective openings. It is, therefore, desirable to make proper corrections. Sieves may be standardized by different means. Pilgrim (3) evaluated five methods of standardization and found all to have certain disadvantages. However, on the basis of the evaluations, he concluded that the merits of the glass bead standardization method proposed by Carpenter and Deitz (4) appeared to outweigh its demerits.

A simple method for the correction of sieve fractions obtained by nonstandard sieves may be accomplished by a scale shown in Figure 3.

Draw horizontal lines corresponding to the effective openings of the sieves used. Place under the MA-CV chart and plot the cumulative fraction values on the lines visible through the chart. Obtain MA and CV.

Figure 3.—(Shown in reduced size), Figure 3 would be placed under Figure 4 in actual use.

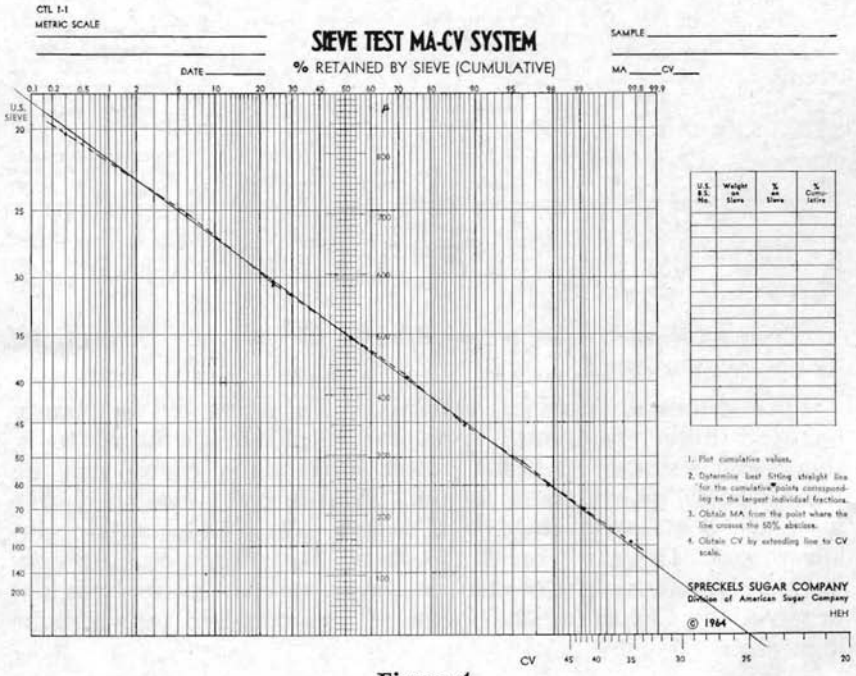

Figure 4.

To obtain the cumulative fractions, which would be obtained if sieves with nominal openings were used, connect all plotted points with straight lines. Obtain the corrected, cumulative values where these lines cross the lines on the chart, which represent the nominal openings.

If the coarsest sieve used has an effective opening smaller than the nominal or, if the finest sieve has an effective opening greater than the nominal, extend the connecting lines so that they cross the lines representing the nominal sieve openings. See Figure 4.

Summary

A scale for the coefficient of variation of granulated sugar is constructed on standard probability paper.

The mean aperture and the coefficient of variation may be obtained directly when the cumulative sieve fractions are plotted. Means for correcting for nonstandard sieves are provided.

Literature Cited

(1) POWERS, H. E. C. 1948. Determination of the grist of sugars using the mean aperture and coefficient of variation numbers. The International Sugar Journal 50: 149-150.

(2) JOHNSON, JULIAN R. and JOHN L. NEWMAN. 1954. Standardization and determination of grain size of granulated sugar. Analytical Chemistry 26: 1843-1846.

(3) PILGRIM, R. F. 1958. Department of Mines and Technical Surveys, Ottawa. Mines Branch Information Circular, IC 106.

(4) CARPENTER, F. G. and V. R. DEITZ. 1951. Glass spheres for the measurement of the effective opening of testing sieves. Nat. Bur. of Stds. J. Research 47, 139-147.