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COMMUNICATION

EVALUATION OF PARTICLE SIZE DISTRIBUTION AND SPECIFIC SURFACE AREA OF MAGNESIUM STEARATE

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ABSTRACT

The geometric mean diameter and several other particle size distribution parameters of nine lots of magnesium stearate from Mallinckrodt Inc. and one lot from Witco Corporation were determined using a light scattering particle size analyzer. Similarly, the specific surface area of these lots was also determined using both single and multi-point B.E.T. methods. A regression analysis of the data indicated that there was a good correlation between the specific surface area and the geometric mean diameter of the various samples. Also, the volume mean diameter, the sauter mean diameter, the 10th, 50th and 90th percentile points, and the span values were consistent with the geometric mean diameter data. The results of this study indicate that the use of a light scattering particle size analyzer provides a quick, simple and reliable technique for evaluating the batch-to-batch variability in magnesium stearate.

INTRODUCTION

Magnesium stearate is widely used as a lubricant in pharmaceutical tablet and capsule formulations. Many studies have been reported on the batch-to-batch variation in the lubricant properties of magnesium stearate[1,2,3]. Frattini and Simioni[4] evaluated the lubricant properties of several magnesium stearate samples differing in their specific surface area values and reported a good correlation between the magnitude of the specific surface area and the lubricant efficacy of the various samples. Dansereau and Peck[5] evaluated the particle size of magnesium stearate from several sources using a Coulter counter and showed that the specific surface area decreased asymptotically with an increase in the mean particle size of the various samples. The objective of this work was to investigate the suitability of using a light scattering particle size analyzer to measure the particle size distribution parameters of magnesium stearate and compare the data with the specific surface area values obtained using the single and multi-point B.E.T. methods.

EXPERIMENTAL

Materials

Magnesium Stearate[6], Tween 21[7] and Isopropanol[8].

Methods

The particle size distribution parameters were determined using a Malvern droplet and particle sizer, series 2600[9] light scattering particle size analyzer. This instrument uses a low power helium-neon laser to form a collimated and monochromatic beam of light. The light scattered by the particles and the unscattered remainder are incident onto a receiver lens. A custom designed detector in the form of 31 concentric annular rings gathers the scattered light energy over a range of solid angles of scatter. The instrument is interfaced with a computer which reads the electronic output signal proportional to the light energy measured over 31 separate solid angles of collection and performs the time averaging by successively reading the detector over a period of time set by the operator. The fundamental instrument measurement is one of volume and all other outputs are numerical transformations of this basic output assuming spherical particles[10].

A 2 percent w/v solution of Tween 21 in isopropanol was prepared and used as the dispersion medium. Approximately 0.5 percent w/v dispersion of magnesium stearate in Tween 21 solution in isopropanol was prepared by adding 10 mL of isopropanol to a 50 mg sample of magnesium stearate in a test tube and vigorously shaking the test tube for two minutes. This dispersion was used in the particle size distribution measurement[11]. All samples were tested in duplicate.

The specific surface area was measured by single and multi-point B.E.T. methods using a Quantasorb Jr.[12] surface area analyzer. Samples were degassed using a Monotector[13] degassing apparatus at 40°C for 24 hours. The single point measurement was done using a commercially available 30 percent v/v mixture of nitrogen in helium. The multi-point analysis was done using 10, 20 and 30 percent v/v[14] mixtures of nitrogen in helium. All measurements were made in duplicate.

RESULTS AND DISCUSSION

A log-normal model was used in the calculation of the particle size distribution data. The computer software program generates several particle size distribution parameters such as the geometric mean diameter, the volume mean diameter, the 10th, 50th and 90th percentile points, the sauter mean diameter, and the span. The volume mean diameter is derived from the volume distribution. The sauter mean diameter is a measure of the ratio of the total volume of the particles to the total surface area. The span of the distribution measures the spread between the 10th and 90th percentile points of the cumulative undersize distribution scaled in terms of the 50th percentile point. The particle size distribution data on nine lots of magnesium stearate from Mallinckrodt and one lot from Witco are shown in Table I. As can be seen from these data, the diameter and percentile values for the Witco sample are markedly lower than the Mallinckrodt samples. It is to be recognized that these values may be somewhat different from the true values since magnesium stearate particles are not spherical but exhibit a plate-like structure.

The results of the B.E.T. surface area analysis are shown in Table II. The specific surface area values obtained using the single point method were slightly lower than the values obtained by the multi-point method. A

Table I
Particle Size Distribution Data for Various Magnesium Stearate Sample

Batch Numbers	GMD[1] (μ)	VMD[2] (μ)	SMD[3] (μ)	Percentile Points (μ) 10th	50th	90th	Span
Mallinckrodt							
2255B16	12.2	15.3	9.6	5.2	12.2	28.4	1.9
2255B21	11.1	13.5	8.9	5.2	11.1	24.0	1.7
BCB	11.4	13.3	9.3	5.6	11.4	22.9	1.5
2255B4	11.4	13.3	9.4	5.6	11.4	22.7	1.5
2255B5	10.3	12.6	8.5	4.8	10.4	22.6	1.7
2255A2	12.5	15.4	9.8	5.7	12.5	27.9	1.8
2255B4	10.7	13.0	8.7	5.0	10.7	23.4	1.7
2255X10	12.6	14.8	10.8	6.2	12.6	25.4	1.5
2255A8	13.0	15.2	11.1	6.4	13.0	26.3	1.5
Witco EC53817	8.2	10.3	6.6	3.6	8.2	19.1	1.9

[1]GMD - Geometric Mean Diameter
[2]VMD - Volume Mean Diameter
[3]SMD - Sauter Mean Diameter

Table II
B.E.T. Single and Multi-Point Specific Surface Areas for Various Magnesium Stearate Samples

	Batch Number	Single-Point	Multi-Point
Mallinckrodt	2255B16	5.6	6.2
	2255B21	5.7	6.4
	BCB	5.0	5.5
	2255B4	5.5	6.2
	2255B5	5.5	6.0
	2255A2	5.1	5.7
	2255B4	5.6	6.4
	2255X10	5.4	6.0
	2255A8	4.5	5.2
Witco	EC53817	7.0	8.2

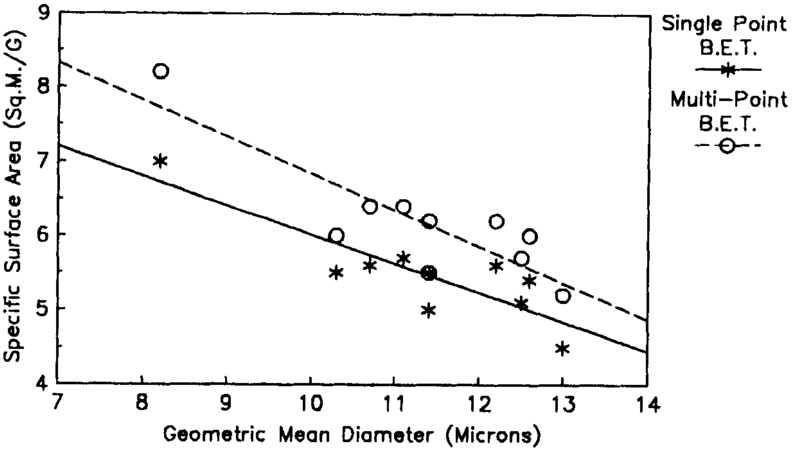

Figure 1
Single and Multi-point B.E.T. Specific Surface Area as a Function of Geometric Mean Diameter for Various Magnesium Stearate Samples

linear regression plot of the specific surface area values obtained by the single and multi-point B.E.T. methods as a function of the geometric mean diameter is shown in Figure 1. A correlation coefficient of 0.85 was obtained for both the single and multi-point specific surface area values. These results indicate a good correlation between the specific surface area and the geometric mean diameter values. The B.E.T. specific surface area analysis is time consuming and labor intensive, whereas the particle size measurement using the Malvern particle sizer is simple and very rapid requiring only a few minutes per sample.

CONCLUSION

The measurement of particle size distribution using a light scattering particle size analyzer provides a quick, simple and reliable method for evaluating the batch-to-batch variability in magnesium stearate. The results of this study indicate that the geometric mean diameter values generated by this method correlated well with the B.E.T. specific surface area values. The B.E.T. surface area analysis is a time consuming, labor intensive test method. It involves degassing the sample for several hours prior to the analysis. The surface area analysis can take two to three hours per sample. The particle size measurement using the light scattering particle size analyzer is very easy to perform and takes only a few minutes per sample. The computer software program generates several meaningful particle size distribution parameters which can be used for evaluation of magnesium stearate.

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