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Performance Comparison Between Old and New Obron German Dark Aluminum

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In 1997, Obron Atlantic changed their German dark aluminum. (Their former product number was 5413; the new product was designated 5413 H Super.) We had published the results of a series of sound output tests of various salute powders,[1] which included the effect of using various aluminums, including Obron's old German dark. Because of our past work, and in response to a query on the Internet, we decided to conduct a brief investigation comparing the sound output of these two aluminum powders when used in a common flash powder formulation. This article presents those results.

To some extent, the sound produced by a salute or the forces developed by the break charge of a crossette, depends on the rapidity with which the salute (flash) powder burns. Many factors act collectively to control burn rates of pyrotechnic compositions; however, among the most important for salute powders is the particle size of the aluminum fuel. (For a more complete discussion of the factors controlling burn rate, see reference 2.) Accordingly, if the change in aluminums provided by Obron altered the size distribution of the aluminum particles, it is likely that salutes made with the new aluminum would produce different sound levels.

The color of fine metal powder generally depends on particle size, with finer particles tending to appear darker. However, this does not apply to German dark aluminums, because they contain a small percentage of carbon apparently as a result of the manufacturing process. The new German dark aluminum is noticeably lighter in color than the older material. It is unknown whether this is primarily an indication that less carbon is present. In simply handling the aluminums, it also seemed that the older German dark aluminum was slightly more free-flowing than the newer material.

Bulk density of a powder can be an indication of particle size, with smaller particles tending to produce a less dense (fluffier) powder because of an increased ability to entrap air between the particles. Another factor affecting the bulk density of powder is the range of particle size, with wide particle-size distributions tending to pack more densely than powders with more nearly uniform particle size. (The smaller particles tend to fit into the otherwise wasted space between larger particles.) However, this seems to be less true for flakes than for granular particles.

The bulk density of the two German dark aluminums was measured. This was accomplished by first violently shaking samples of the powder in a closed container to entrain as much air as possible. Then 5 grams of the powder was weighed into a graduated cylinder (chemistry glassware) and placed on a vibrating platform for 30 seconds, thus consolidating the powder to a somewhat standard condition. It was found that the newer German dark aluminum had a bulk density of 0.74 g/cc, which is effectively the same as the older aluminum's bulk density of 0.75 g/cc.

An attempt was made to determine the aluminum's average particle size using light microscopy. This is a difficult task and the results are fairly subjective, not because it is difficult to measure individual particle sizes with a microscope, but because it is difficult to estimate which individual particles are of average size. The results suggest that the newer German dark aluminum has an average particle size of approximately 9 microns, whereas the older material seems to be on average closer to 6 microns. (A micron is one millionth of a meter, or 0.00004 inch.) Although it is difficult to be certain, it seemed that the newer material also has

Table 1. Average Salute Test Results.

Aluminum Type (Obron Atlantic)	Peak Pressure (psi)[a]	Relative Pressure	Sound Pressure Level (dB)	Relative Loudness
5413	5.93	≡ 100%	186.3	≡ 100%
5413 H Super	5.32	90%	185.3	93%

(a) To convert to kPa, multiply by 5.89.

a wider range of particle size, than the older German dark aluminum.

For the tests reported here, the salute powder test compositions were 70:30 potassium perchlorate[3] and German dark aluminum by mass. The compositions were well mixed, using a combination of sieving, diapering, and tumbling. Each test device consisted of a 50-g (1.8-oz) charge of salute powder confined in a 3-ounce polyethylene bottle. This method of construction was chosen to achieve a fairly high degree of consistency in confinement of the salute powder and because it duplicates that used in earlier testing. For each type of aluminum, three separate tests were performed and the results averaged. The air blast output was measured using a free-field blast gauge at four feet from the center of the test salute. (For more information about the methods and equipment used, see reference 1.)

The average results from the three tests of each aluminum are reported in Table 1. Peak pressure is the maximum pressure (in pounds per square inch) measured in the air blast when the test salute exploded. For the relative pressures reported in the table, the value for the older German dark aluminum was defined as 100%. The sound pressure level (*SPL*) produced was calculated from the peak pressure (*P*) using the equation:

$$SPL\ (\text{dB}) = 170.8 + 20 \log (P)$$

Loudness values (*N*, in sones) were calculated using the equation:

$$\log (N) = 0.03\ SPL - 1.2$$

Again, in Table 1, the relative loudness for the older German dark aluminum was defined as 100%. (For more information and references regarding these calculations, see references 1 and 4).

As can be seen in Table 1, the new German dark aluminum, in this brief experiment, was a little less effective than the older material. Peak pressures produced by salutes using the newer aluminum were reduced by 10% and their loudness was reduced by 7%. While this difference is sufficient to be fairly certain there is a real difference (and not just a statistical accident), it is not certain that these results are universally applicable. Each of the two aluminum samples were taken from a single production lot of aluminum powder, and it is not known to what extent there is variation between production lots of the same aluminum powder. In addition, testing was only done under conditions of weak confinement, and these results may not apply to other degrees of confinement.

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References

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