63-1-1

AID Report 62-139 — 19 September 1962

ITEM OF INTEREST

Prepared by

Aerospace Information Division

SUBJECT: Combustion of Propellants: Ammonium Perchlorate

SOURCE: Romodanova, L. D., and V. I. Roshchupkin. On the combustion of ammonium perchlorate. Zhurnal fizicheskoy khimii, v. 36, no. 7, Jul 1962, 1554-1555. (S/076/62/036/007)

The article contains data on ammonium perchlorate (AP) combustion compiled from experiments at the Institute of Chemical Physics, Academy of Sciences USSR, and is apparently intended to augment work done in the field by non-Soviet researchers. (All four sources cited in the article are from English-language publications.) Applications of AP in aerospace technology are implied by the consideration in the article of the lower pressure limit for steady AP combustion. In addition, these experiments may be related to Soviet studies of the thermal decomposition of salts of ammonia and hydrazine. (See AID Reports 60-42 and 62-90.)

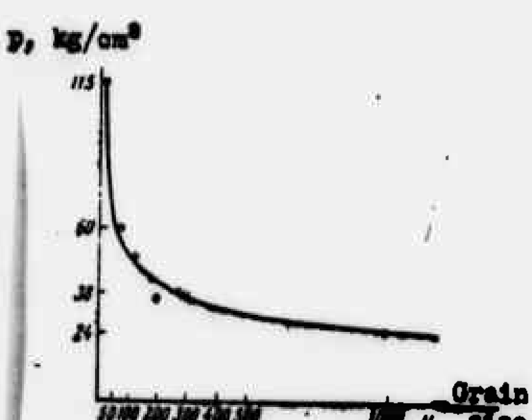

Fig. 1. Pressure limit versus grain size

AP heated in vacuum (~2 to 4 mm Hg) partially sublimed at ~200 to 210°C and after 30 to 40 minutes underwent partial endothermic decomposition (28 to 30%) without self-ignition. The 80 cm³/g of gaseous products formed consisted of NO, NO_2, N_2, N_2O, Cl_2, HCl, $HClO_4$, O_2, and H_2O. At 300°C NOCl was also evolved.

Lower pressure limit (p) for steady AP combustion and its variation with the moisture content, density (ρ), and grain size (3 to 3000μ) of the charge were given primary consideration. The effect of moisture on AP combustion was determined from AP samples moistened with water vapor and compressed to a density of 1.92 to 1.93 g/cm^3. Moisture content of 0.1 to 0.7% did not affect p, but when it exceeded 2%, the samples did not burn at all in the pressure range studied (0 to 150 kg/cm^2).

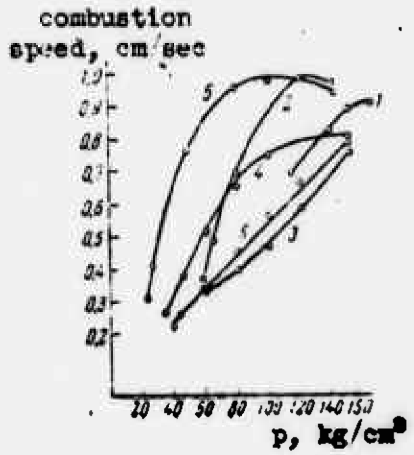

Fig. 2. Combustion speed versus pressure

1 - 3 to 7μ; 2 - 55 to 95μ; 3 - 5 to 250μ; 4 - 100 to 300μ; 5 - 250 to 400μ; 6 - 300 to 3000μ.

The lower pressure limit was found to decrease with increasing charge density. The following values of p were found for the grain-size fraction from 200 to 350μ:

at ρ = 1.50 g/cm^3, p = 53 kg/cm^2;
at ρ = 1.67 g/cm^3, p = 48 kg/cm^2;
at ρ = 1.92 g/cm^3, p = 38 kg/cm^2.

At constant density, values of p were inversely proportional to the grain size of the AP particles (Fig. 1). Steady combustion of large-crystal AP powders ($\sim$1000μ) was observed at p $\approx$ 25 kg/cm^2, whereas, fine-crystal AP powders ($\sim$5μ) burned steadily at 115 to 118 kg/cm^2. It was also found that p decreases inversely with sample diameter (at a charge density of 192 g/cm^3 and grain size of 200 to 350μ). For example at 8 mm sample diameter p = 38 kg/cm^2; at 12.7 mm p = 33 kg/cm^2.

Variations in combustion speed with pressure were also considered. (Combustion speeds in centimeters per second were measured optically by means of photographic recording.) The combustion speeds of various grain size fractions of AP powders at all pressures (up to $\sim$150 kg/cm^2) were dissimilar, but each fraction approached a constant combustion speed (Fig. 2).