Crushing Strength of Aluminum Oxide Agglomerates

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Abstract: Aluminum oxide, which is formed during combustion of aluminum-based solid propellants, condenses and solidifies in the exhaust flow to form sub- micron-size particles, which may then adhere together to form agglomerates. Particle sampling, which is required for motor performance or environmental impact investigations, is usually done using a probe placed in the supersonic exhaust flow field. The bow shock at the sample probe inlet will decelerate the gas flow which introduces a large velocity differential between the gas and particulate, This differential will result in a sudden increase on the aerodynamic drag on the agglomerates which may cause them to shear apart, thus altering the sample size distribution. In this effort, aluminum oxide agglomerates were formed and then crushed in order to estimate the magnitude of the interparticle forces binding the agglomerate together. The agglomerates were formed by tumbling commerically available aluminum oxide powder in a container, and strength was determined by measuring the load required to crush the agglomerate between two flat plates. Analysis indicated that rough, uniformly- shaped particles formed the strongest agglomerates. The experimentally-derived particle bonding forces were in agreement with values predicted by the van der Waal force equation for closely-spaced spheres. Rocket exhaust particulates collectedd from a test facility exhaust processing system proved to be unstable because of impurities.

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