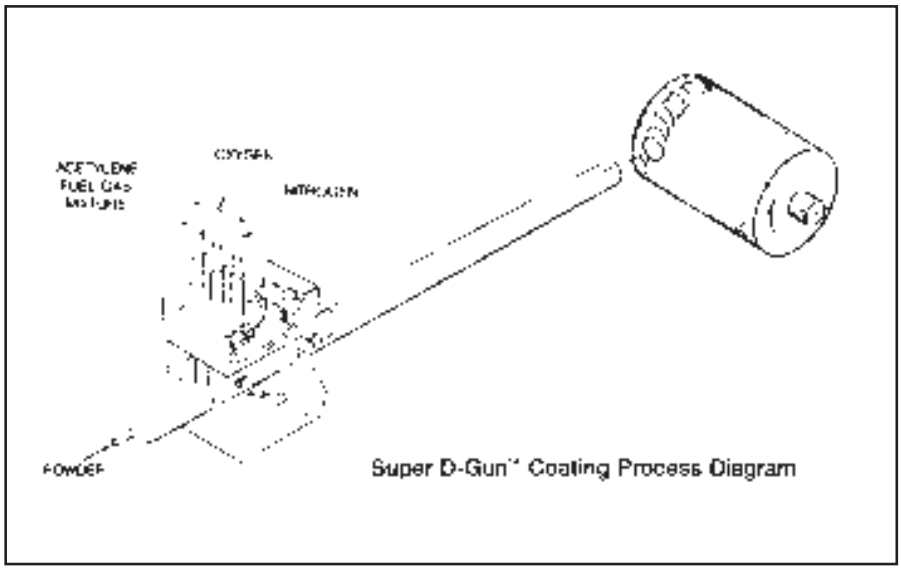
PRAXAIR
SURFACE TECHNOLOGIES

Super D-Gun™ Coating Process

HardFacts

The Super D-Gun™ process is the most advanced thermal spray method of coating. Super D-Gun coatings with extraordinary wear and mechanical properties are the result of heating fine powders of metals, ceramics, or cermets to near their melting points and projecting them at extremely high velocities against the surface to be coated. Particle velocities frequently exceed 3,000 ft/sec (900 m/s). The resulting coatings have a characteristic thermal spray lamellar microstructure, but with a density that is very close to theoretical.



Schematic of the Super D-Gun™ Process

The Coatings

The extremely high particle velocities of the Super D-Gun process result in significant advances in coating properties over those of other thermal spray coatings, even over comparable conventional detonation gun coatings. For example, using a modified Ollard test, tensile bond strengths in excess of 30,000 psi (210 MPa) have been measured. Abrasive wear, erosive wear, and impact fretting wear have all been substantially improved over comparable conventional detonation gun coatings as well as, of course, other thermally sprayed coatings.

Inherent in most thermally sprayed coatings is a residual tensile stress which may substantially reduce the strain-to-fracture of such coatings. This, in turn, may lead to a drastic reduction in the fatigue characteristics of coated components. For many of the Super D-Gun coatings, however, a residual compressive stress, in some cases as high as 50,000 psi (340 MPa), is achieved. As a result, the strain-to-fracture may be as high as 0.8%, while for most conventional detonation gun coatings it may be less than 0.4%. [A strain of 0.8% corresponds to a stress in a coated steel part of 240,000 psi (1,600 MPa) in the part itself.]

Even lower values are common to most plasma sprayed and other thermally sprayed coatings. The high strain tolerance of coated components permits greater load carrying capacity in both shock and severe service environments. This high strain-to-fracture also strongly influences the effect of Super D-Gun coatings on the fatigue strength of substrates. In some cases, no fatigue debit is measurable. In other cases, the fatigue debit is far, far lower than experienced with conventional thermal spray coatings.

The as-deposited surface roughness of Super D-Gun coatings vary with the type of coating from less than 100 to over 200 µin Ra (2.5 to 5.0 µm Ra). Although for many applications a coating is used as-deposited, most are either ground or ground and lapped. Because of the very high density and cohesive strength of Super D-Gun coatings, pit-free surface finishes as low as 0.4 µin Ra (0.01 µm Ra) can be achieved.

Typical coating thicknesses range from about 0.002 to 0.020 inches (0.05 to 0.5 mm), but both thicker and thinner coatings are used on occasion. Because of the unique control of residual stress, Super D-Gun™ coatings can frequently be used at much greater thicknesses than can be achieved with other thermally sprayed coatings.

The Process

The Super D-Gun process employs a D-Gun, as illustrated in the figure. Carefully measured gases, usually consisting of oxygen and an acetylene-fuel gas mixture, are fed into the barrel of the gun along with a charge of fine powder. The gas is ignited and the resulting detonation wave heats and accelerates the powder as it moves down the barrel. The gas velocity and density are much higher than in a conventional detonation gun. The powder is entrained for a sufficient distance for it to be accelerated to its extraordinary velocity. A pulse of nitrogen gas is used to purge the barrel after each detonation. The

process is repeated many times per second. Each detonation results in the deposition of a circle (pop) of coating material a few microns thick. The total coating, of course, consists of many overlapping pops. Precise, fully automated, pop placement results in a very uniform coating thickness and a relatively smooth, planar surface.

The Super D-Gun process is called "line-of-sight" because the gun must be able to "see" the area to be coated. This characteristic is true of all thermal spray coatings. For other thermal spray coatings, the best coating properties are achieved when the angle of deposition is close to 90 degrees to the surface. As the angle of deposition deviates from the optimum, the properties of the coatings begin to degrade. Because of the extremely high powder velocity of the Super D-Gun process, however, little degradation in properties is noted down to at least 45˚, much lower than for conventional detonation gun coatings and far lower than for other thermally sprayed coatings.

More Information

Complete information on specific coatings and design considerations are available from technical field representatives. Contact one of these headquarter locations for the name of your area representative.

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