PRAXAIR SURFACE TECHNOLOGIES

HVOF Thermal Spray Process

HardFacts

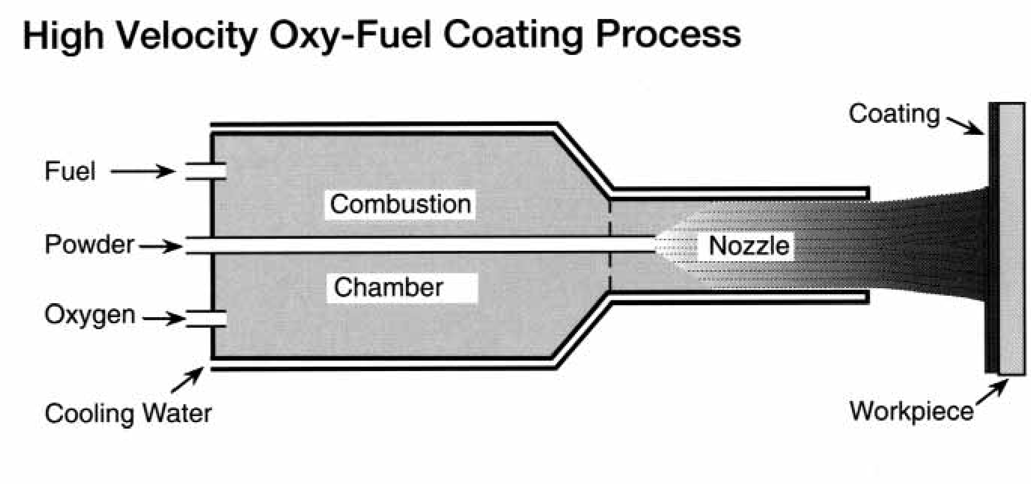

Figure 1

A simplified schematic of a high velocity oxy-fuel (HVOF) torch is shown in Figure 1. It consists of a combustion chamber and a nozzle with connecting orifices and a tube that allows injection of the powder into the nozzle. Carefully metered oxygen and fuel gas are introduced into the combustion chamber. The fuel gas is usually propane, propylene, or hydrogen, although other hydrocarbons can be used. Continuous combustion of the oxygen and fuel gas occurs in the combustion chamber and the resulting hot, high pressure gas is allowed to expand and accelerate through orifices into the nozzle. A carefully measured flow of powder is introduced axially into the nozzle, allowing sufficient heating and acceleration of the powder particles. The powder is heated and accelerated by the products of the combustion, usually to temperatures above its melting point and to velocities approaching or occasionally exceeding 1800 ft/sec (550m/sec).

The most frequently used coating compositions are probably of the tungsten carbide-cobalt family, but most cermets and metals, as well as some oxides with sufficiently low melting points, can be deposited by HVOF.

The properties of HVOF coatings are highly dependent on a number of parameters including the preparation of the part surface, composition, morphology, size distribution and feed rate of the powder, and the precise control of gas flows, relative torch/part motion, stand-off angle of deposition and part temperature. Moreover, since the powder particles are being heated and accelerated in a stream of combustion products, the surrounding atmosphere may be either oxidizing or carburizing. In addition, air may be inspirated into the gas stream as it exits the nozzle, leading to oxidation of the powder. The degree to which these gas-powder reactions occur depends, of course, on the specific device, operating parameters, and the material being deposited.

Praxair Surface Technologies' unique control of all of these variables results in high density, well bonded coatings with precisely controlled compositions.

The as-deposited surface roughnesses of Praxair Surface Technologies HVOF coatings may vary with the type of coating, but may exceed 100µ in Ra. Although for many applications the coating is used as-deposited, most are finished, e.g., ground or ground and lapped. Typical coating thicknesses range from about 0.002 to 0.020 inches (50 to 500 µm), but both thicker and thinner coatings are used on occasion. HVOF deposition is, of course, a line-of-sight process. The best coating properties are achieved when the angle of deposition is close to 90 degrees to the surface. As the angle of deposition decreases to less than about 60 degrees, significant changes occur in the coating microstructure and properties. Nonetheless, coatings made at lower angles may be useful and are highly reproducible.

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

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Most materials that melt at a reasonable temperature without decomposing can be used to make high velocity oxy-fuel coatings. HVOF deposition was invented by Union Carbide scientists before the company became known as Praxair Surface Technologies. They also invented the plasma spray and detonation gun deposition processes. In all of these processes coating material in the form of powder is heated and accelerated in a high temperature, high velocity gas stream and projected against the surface to be coated. The molten or semi-molten droplets form thin, overlapping platelets which quickly solidify on the surface; many layers of platelets forming the coating.

A major attribute of this technology is the ability to apply coatings with high melting points to substrates (workpiece or part) without significantly heating the substrate. Thus, coatings can be applied to fully heat-treated, completely machined parts without danger of changing the metallurgical properties or strength of the part and without the risk of thermal distortion inherent in high temperature coating processes.

Standard production coatings include pure metals and metallic alloys such as nickel or nichrome, cermets such as tungsten carbide-cobalt, and many ceramics. These coatings are used in virtually every type of industry, ranging from the space shuttle to submarines, from steel mills to medical instruments, and from gas turbine engines to diesel engines. Their purpose is usually to combat wear (abrasive, erosive, or adhesive), often in very corrosive environments.

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