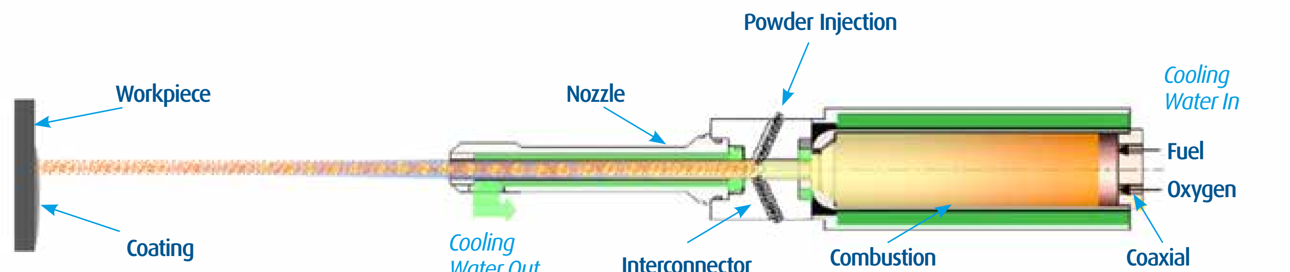
Thermal Spray Process | High Velocity Oxy Fuel

The high-velocity oxy-fuel (HVOF) process uses an internal combustion system to generate a supersonic flame jet for heating and accelerating powders to form a coating on the workpiece. A schematic of an HVOF torch is shown in Figure 1. It consists of a coaxial stabilizer for oxygen and fuel injection, a combustion chamber, an inter-connector for powder injection and a nozzle.

Either liquid or gaseous-based fuel is used in the HVOF process. The gaseous fuel is usually propane, propylene or hydrogen, while kerosene is normally used in a liquid fuel HVOF system, although other hydrocarbons can also be used. Carefully metered oxygen and fuel are introduced into the combustion chamber where a spark ignites the mixture and continuous combustion occurs. The resulting high-pressure hot gas is allowed to expand through converging-diverging orifices and accelerated to supersonic speed in the nozzle. A carefully measured flow of fine powder (5-50 µm) is injected into the nozzle, either axially or radially. The powder is heated and accelerated by the products of combustion, usually to temperatures close to or above its melting point and to velocities approaching or exceeding 1,800 ft/sec (550 m/sec). leading to oxidation of the powder. The degree of these gas-powder reactions depends on the specific device, operating parameters and material being deposited. In general, the HVOF process is less detrimental to carbide materials compared with other thermal spray processes.

Praxair's unique control of all of these variables results in coatings of high density, well bonded to the part, with precisely controlled compositions and repeatable structures and properties.

Typical coating thickness ranges from 0.002 to 0.020 inches (50 to 500 µm), but both thicker and thinner coatings are used on occasion depending on the specific application. The as-deposited surface roughness of HVOF coatings may vary with the type of coating, but may exceed 100 µin (2.5 µm) Ra. Although for many applications the coatings are used as-deposited, most are either ground or ground and lapped.



High Velocity Oxy-Fuel Coating Process

The most frequently used coating compositions are carbide-based cermets, metals and alloys, and some oxides with sufficiently low melting points.

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, precise control of gas flows, relative torch/part motions, stand-off distance, nozzle length, angle of deposition and part temperature. Since 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 pulled into the gas stream as it exits the nozzle,

Like any other thermal spray, HVOF deposition is a line-of-sight process. The best coating properties are usually achieved when the angle of deposition is close to 90 degrees to the part surface. As the angle of deposition decreases to less than about 45 degrees, significant changes occur in the coating microstructure and properties. Nonetheless, coatings made at lower deposition angles may be useful and are highly reducible.

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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 our scientists before the company became known as Praxair Surface Technologies. The company 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 that quickly solidify on the surface withmany 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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