Plasma Powders & Systems, Inc.

Introduction to HVAF Technology

Our HVAF systems provide a robust process for deposition of quality coatings from powders of metallic alloys and composite metal-ceramic materials.

Metals: The gun sprays a majority of commercial alloys very efficiently, from low-melting point metals, such as zinc, aluminum and copper to super-alloys and other high-temperature metals.

Metal-ceramics: Spray materials include tungsten carbide and chromium carbide-based powders, molybdenum boride-cobalt-chrome and intermetallic powders.

Other processes: Besides coating deposition, the HVAF guns perform high-pressure ***HVAF grit blasting*** with alumina grit for surface preparation, as well as ***work-piece cooling*** with air after or during coating deposition when fast cooling is advantageous.

Principle of operation

Heat and particle acceleration are produced by hot compressed air and fuel gas combustion. One difference HVAF has over other combustion heating methods is at what point the heating occurs, the time particles spend in the heat and how thoroughly and evenly particles are heated. HVAF employs a wide, pressurized and air cooled combustion chamber. The air circulates outside the chamber, absorbing heat. This heated air then flows back into the combustion chamber with the powder and fuels through hundreds of orifices of a ceramic insert (Fig.1). The result is very efficient, high pressure heating of the particles. This heated material then enters the nozzle where acceleration occurs.

Traditional combustion systems pass powder through a flame and immediately into the separate air stream in the air cap. The relatively short distance from flame area to air cap requires higher heat, and the material continues heating in the flame until or near point of impact. This process typically overheats the outer layers of the particles, than cools them entering the air stream, and re-heats in the flame outside the torch. It also carries excess heat to the coating and the substrate.

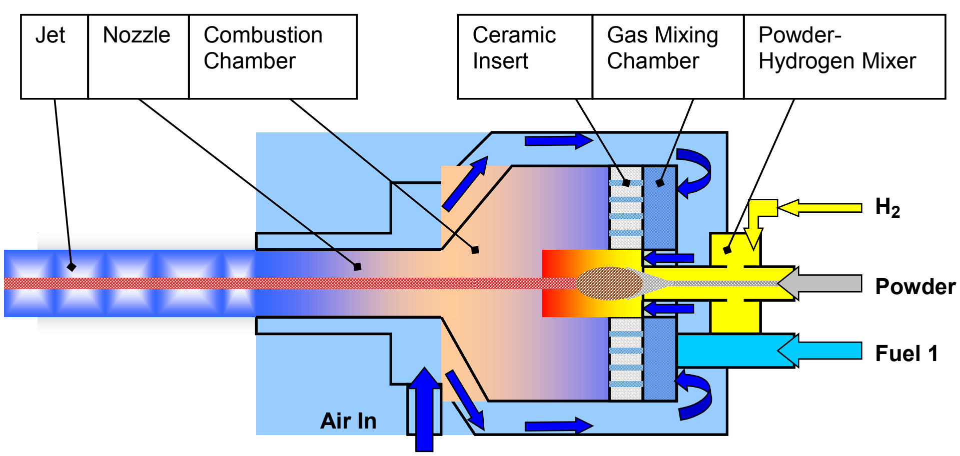


Figure 1: Schematics of HVAF gun

Specifics of HVAF

1. Relatively low temperatures of air-fuel combustion

Compared to combustion with oxygen (HVOF), combustion temperature of air-fuel mixtures is lower by almost 1000°C (Table 1).

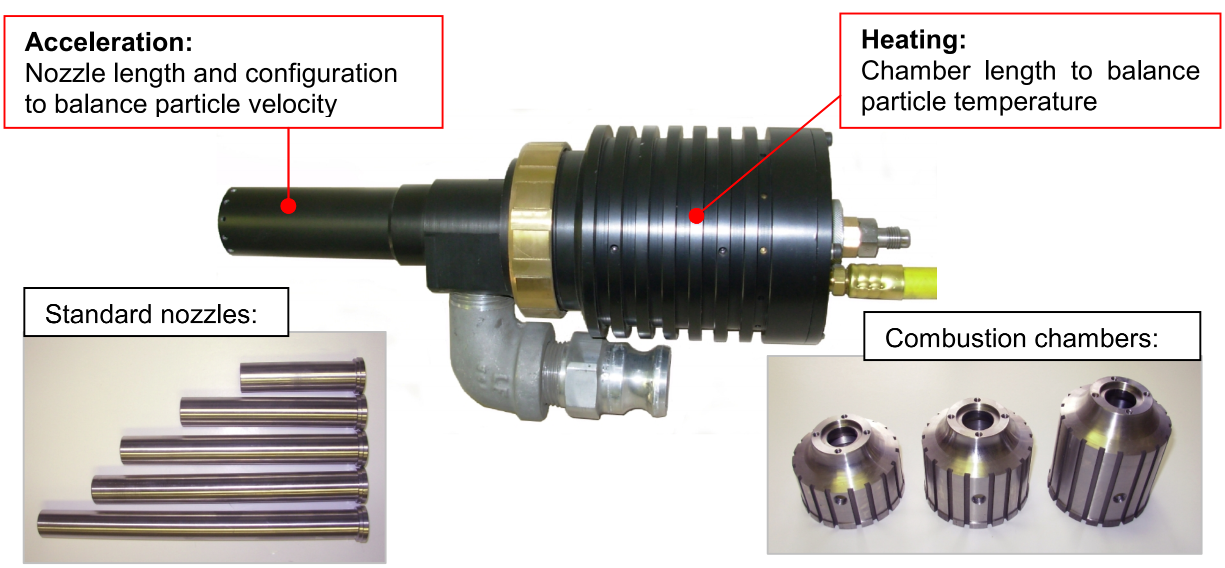
Table 1. Adiabatic flame temperature (°C) of common gases (@ α=1, 20°C, 1 Bar)

Fuel gas:	Combustion in oxygen	Combustion in air
Methane	2810	1950
Propane	2820	1980
MAPP	2927	2010
Hydrogen	3200	2210

Since air-fuel combustion temperature is only slightly higher than melting temperature of the majority of alloys, it is well suited for providing accurate and even heating of spray materials to near or slightly above their melting point. "Soft" heat transfer prevents excessive overheating of the particle surface when attempting to heat its core to the optimal "plastified" state for coating deposition. Overheating of the powder particle surface is responsible for excessive oxidation and thermal decomposition of sprayed materials, resulting in deterioration of coating properties. Typical pressure in the combustion chamber of the HVAF gun is controlled within 2.8-4.5 Bar (gauge pressure). Since heat transfer from gas to solids improves with increased pressure, heating of spray particles in the HVAF gun is extremely efficient. This approach has the strongest effect in suppressing of oxidation of metals and decomposition of carbides.

2. Separation of heating and acceleration

The large diameter of the combustion chamber slows the gas flow, providing time for spray particles to heat. Flows are quickly accelerated in the nozzle, reaching sonic velocity (super-sonic in de Laval nozzle). Standard hardware allows for a wide range of options by combining chambers and nozzles of different length and configuration, precisely targeting the necessary technological window for your specific coating deposition.



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New - Convertible HVAF-HVOF System

The new, Convertible HVAF-HVOF system has been designed to offer exceptional coating quality and the highest spray rates in the industry in either mode.

HVOF is used throughout the ***aircraft industry and in military depots*** where aircraft are repaired. New aircraft landing gear are designed with an HVOF coatings on the landing gear cylinder. Many other major components also use the same technology, including aircraft hydraulic actuators, engines, helicopter dynamic components and propeller hubs. Besides eliminating the problematic carcinogen, hexavalent chrome, from past processes used in repair and rework settings, HVOF coatings last longer and demonstrate less wear and corrosion. Note: though chrome is included in some of these coatings, hexavalent chrome is not produced in the process.

The convertible system provides a way to use a wider range of materials, encompassing the many manufacturer/end-user specifications for highly specialized coatings, with improved deposit efficiency and higher spray rates over standard HVOF systems. Material, finishing and production throughput time savings typically cover the cost of system upgrades in a short period of time.

In summary, the HVAF/HVOF system is the most reliable coating process that produces the highest quality and most economical coatings in the industry.

- HVOF mode delivers coatings that meet HVOF specs with high spray rates and high DE.
- HVOF mode delivers coatings of hard metals that are extremely dense.
- Per kilogram deposited cost can be up to half the cost of using a standard HVOF process.
- HVAF mode delivers higher quality than state-of-the-art HVOF with much higher spray rates and high DE.
- The equipment produces void free chrome replacement coatings as thin as .002" thick. We can achieve 0.4 RA on our 86-10-4 (WC-Co-Cr) coatings with only polishing.

This equipment employs state-of-the-art touch screen tablet technology with an accurate and easy to follow graphic user interface. Screens allow for system and spray parameter monitoring and modification, storing multiple recipes or programs, data logging with external storage interface, alarm screens and diagnostic information etc.

Contact your Plasma Powders representative today to find out more.

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