

FST

# THE NEXT STEP

in HVOF technology



HP-HVOF  
**eGun**

## eGun™ System Ethanol-fueled HVOF Technology

When Flame Spray Technologies (FST) began investigating the proposition of developing and introducing a new thermal spray gun (technology) of our own manufacture, we asked ourselves the following question: how can we reduce operational costs and increase application efficiency without compromising coating quality?

To develop our own technology, we analysed the key points of coating formation and particle parameters. We found that spraying "hot and fast" doesn't necessarily result in a quality coating. The optimal balance between particle kinetic and thermal energy is needed. Of the two, kinetic energy is the more flexible tool. Kinetic energy is proportional to combustion chamber pressure (high pressure = high kinetic energy).

After an intensive development program, FST is pleased to announce the eGun™ System. The eGun™ is a liquid fuel HVOF gun that utilizes ethanol as its fuel. The eGun™ is capable of imparting higher particle velocities due to its ability to achieve higher combustion chamber pressures of up to 13 bar (188 PSI). There are many advantages to using ethanol as compared to kerosene which will be discussed in some detail as we proceed through this document.

The eGun™ System, with the unique High Pressure HP-HVOF eGun™ represents the latest liquid fuel HVOF technology. With this system we are bringing a new and unique coating technology to market. Numerous spray trials have demonstrated that the eGun™ produces coatings of equal or higher quality compared to conventional HVOF or HP-HVOF torches.

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*e*thanol

*e*nhanced

*e*fficient

HP•HVOF  
*e*GUN

*e*cological

*e*conomical

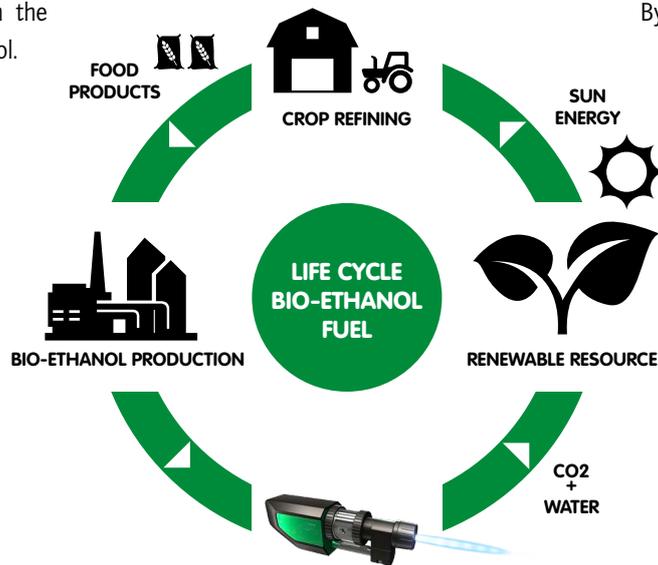


## The cleaner liquid fuel HVOF alternative

Ethanol (C<sub>2</sub>H<sub>5</sub>OH) is a low cost non-petroleum based fuel. It is produced globally and is easy to obtain. Ethanol is a consistent fuel providing repeatable and reproducible coatings in contrast to kerosene which consists of a varying mixture of different hydrocarbon chains.

Burning ethanol results in 30% less toxic emissions than kerosene. Ethanol doesn't have side effects related to ash formation. There is no potential for contamination of a coating by carbon even if fuel-rich mixtures are used.

Using ethanol fuels instead of other alternatives has environment benefits. It is renewable, domestically produced and produces less greenhouse gas emissions than kerosene. The carbon dioxide released when ethanol is burned is balanced by the carbon dioxide captured when the crops are grown to make ethanol. This differs from petroleum, which is made from plants that grew millions of years ago. On a life cycle analysis basis, corn-based ethanol production and use reduces greenhouse gas emissions (GHGs) by up to 52% compared to gasoline production and use. Cellulosic ethanol use could reduce GHGs by as much as 86%.



Ethanol is considered a relatively safe industrial fuel and unlike kerosene ethanol fires can be extinguished using water (not recommended). Ethanol is also one of the few fuels considered safe enough to be used indoors by consumers e.g. fireplace, indoor table burner or cooking stove. Overall ethanol is considered to be less hazardous than kerosene. Ethanol is clean with minimal odor resulting in a clean and operator friendly environment. No more dirty hands and smelly parts and tools.

Since combustion of ethanol does not produce soot, the eGun™ System can be operated with neutral, oxygen-rich or fuel-rich parameters. This large operating window provides the opportunity to develop unique coating microstructures using conventional powders. For example, by using radial powder injection in combination with a fuel-rich combustion mixture a unique reducing flight path is created. In effect the eGun™ gives better control over the balance between the kinetic and thermal energy.

The combination of pre-combustion chamber along with an optimized (smaller) combustion chamber provides more efficient combustion resulting in more heat transfer to the powder. By burning a portion of the ethanol in the pre-combustion chamber, heat is provided to the specially designed evaporation cartridge that provides a highly efficient fuel mixture to the combustion chamber.

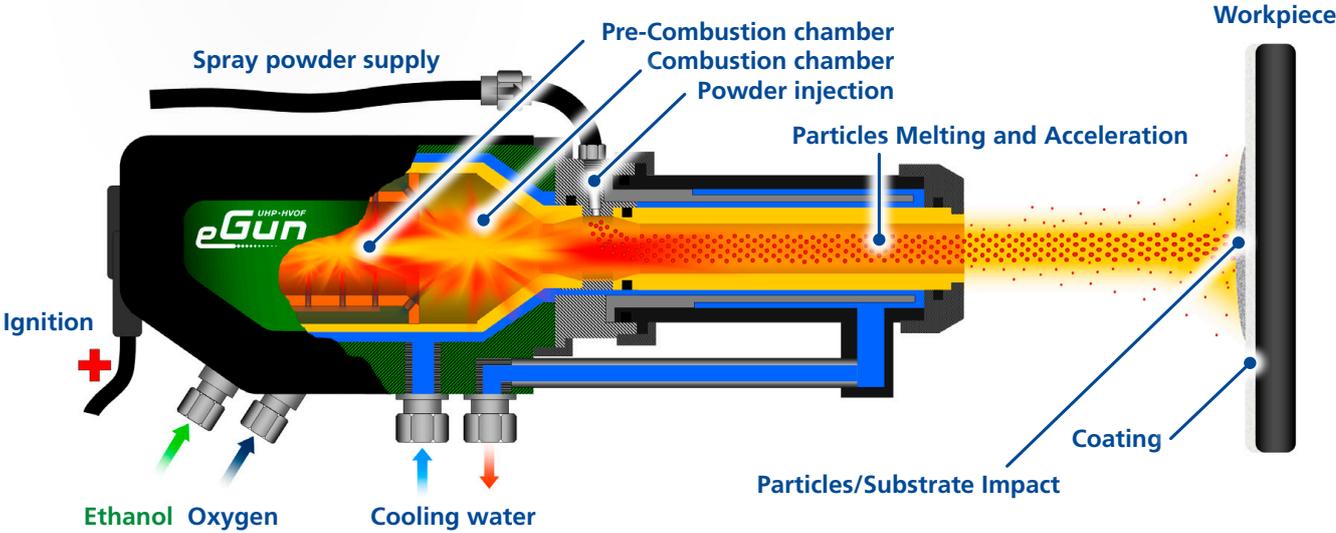
By introducing this multi-stage combustion module concept a significantly smaller main combustion chamber is required. This contributed to the reduction in the overall size and weight of the eGun™.

By reducing the size of the combustion module, the energy required for gun cooling has been reduced by as much as 50% when compared to conventional kerosene processes.

By reducing the required cooling capacity more energy is available to heat the powder particles. This also has the positive effect of reducing coating costs by requiring a smaller less expensive chiller along with lower power consumption. It may even be possible to use your existing plasma cooling unit to cool the eGun™.



Comparison of combustion chambers



**The eGun™**

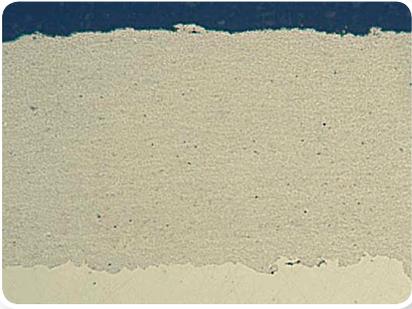
The eGun™ is capable of operating at combustion chamber pressures up to 13 bar (188 PSI). This is 3 to 5 bar (43 – 73 PSI) greater than conventional kerosene HP-HVOF systems. It has been shown that higher combustion chamber pressure generates higher flame velocity which in turn generates higher particle velocity. Higher particle velocity results in improved coating density and better overall coating integrity. It is also very easy to run at low flame velocity for slow and hot parameters to produce very good bonding (rough) flash coats.

Harsh starting explosions during system ignition, common with kerosene guns, is not an issue with the eGun™. Ramping-up the eGun™ System from a very slow idle mode flame to full flow is smooth and efficient.

The eGun™ schematic shows the basic design of the gun. Ethanol and oxygen are injected, mixed and atomized in the pre-chamber and then ignited. The mixture partially burns creating a fully atomized and very combustible fuel oxygen mixture. This mixture enters into the combustion chamber where efficient, stable, clean, uniform and high pressure combustion occurs. The efficient combustion of ethanol allows for low oxygen consumption. In comparison with conventional kerosene processes oxygen consumption is reduced by 30% to 50%.

After exiting the combustion chamber the gasses pass through a carefully engineered nozzle creating a supersonic flame. At the end of the combustion chamber the powder is radial injected into the interconnector. Optimizing powder injection reduces barrel loading in addition to creating optimal powder heating. After injection into the barrel, the powder is uniformly mixed, heated and accelerated to very high speeds.

By accurately monitoring fuel and oxygen flows, pressures, and cooling water temperatures the combustion process can be precisely controlled. Controlling the condition of the flame also means controlling the coating quality.



Microscopic cross section of an eGun™ sprayed WC-NiMoCrFeCo layer  
 - Micro hardness 1228 HV0.3  
 - Porosity 0,2%



**The eGun™ System**

Flame Spray Technologies has introduced a state-of-the-art mass flow controlled HVOF coating system with unique performance. The touch screen operated system brings flexible and accurate process control to your fingertips. Only premium components and the latest available technology have been used in the manufacture of the **eGun™ System**. This guarantees the highest possible up-time and safety.

The **eGun™ System** separates fuel, gas and electrical components into distinct modules. Flow, pressure and temperature sensors have been integrated to monitor the process and provide warnings when the system is operating outside of its specified limits.

In addition to controlling FST's eGun™, the system is also capable of operating the **JP-5000®** Model 5220 kerosene HVOF torch. This allows the customer to use either the new eGun™ or conventional JP-5000® technology. The JP-5000® feature is optional.



JP-5000®



Mobile eGun™ System

The standard eGun™ System is supplied with a **PF-50 Powder Feeder**. However, the system supports most commercially available powder feed units. This flexibility gives the customer the opportunity to select the preferred feeder without compromising the overall system quality or performance.

The **eGun™ System** is also available in a mobile version, allowing the system to be moved from location to location. A water pump is integrated into the system; greatly improving the mobility of the system.

The eGun™ System uses an operator friendly full color **touch screen** that allows for easy programming and process monitoring. The system can store up to 256 recipes.



Touch screen operating system

**PF-50 Powder Feeder**

The PF-50 utilizes proven technology and electrical controls, making it reliable day in, day out. The PF-50 is an inexpensive but reliable feeder that has proven its performance in many different applications. The heart of the electrical controls is the digital closed-loop controller. This allows for precise and consistent wheel speed control. To set the wheel speed, simply enter the desired speed into the controller. When the PF-50 is switched to Feed Mode, the powder wheel will ramp up to the set speed, holding that speed very accurately. Speed is displayed in revolutions per minute (RPM).

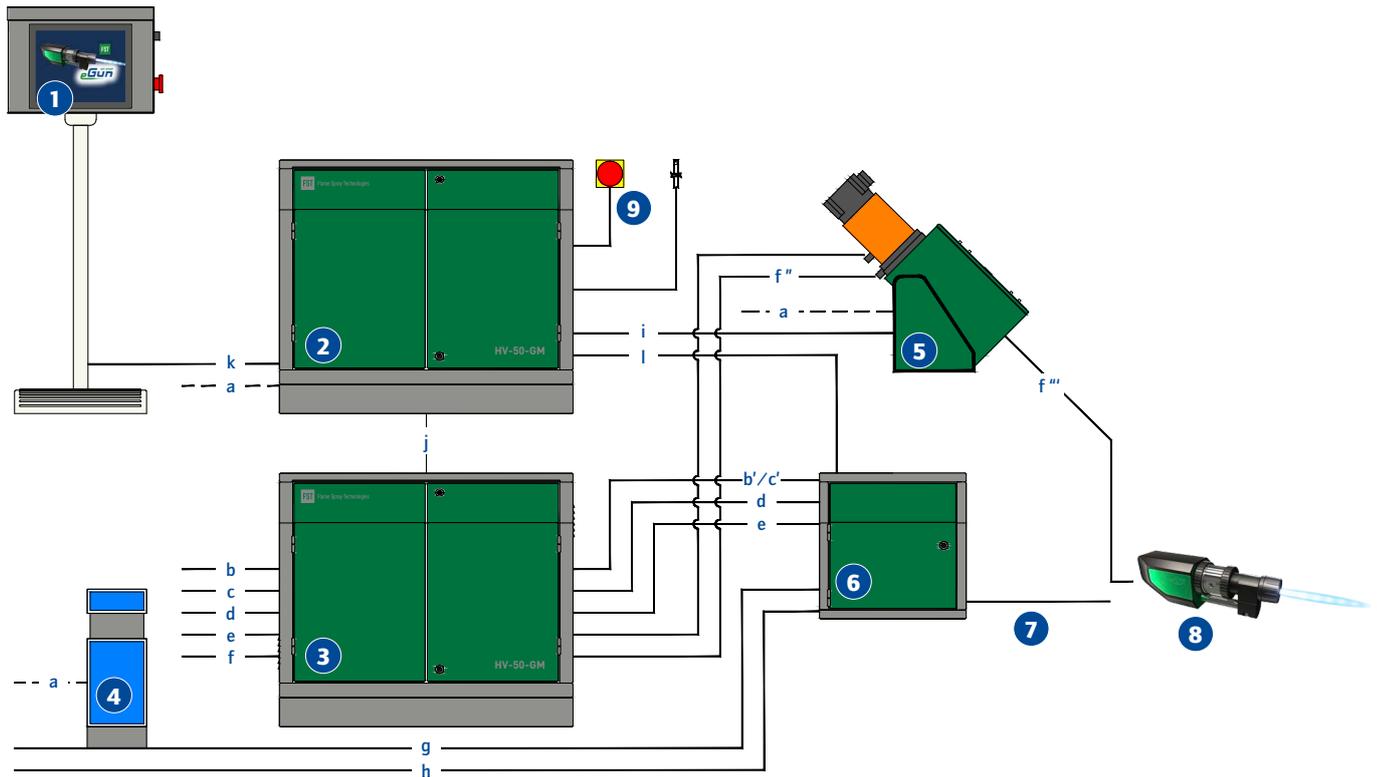


PF-50

The PF-50 offers a variety of other features, including:

- Heater Blanket On/Off
- Plasma/HVOF Mode
- Remote/Local Feed On
- Remote/Local Wheel Speed

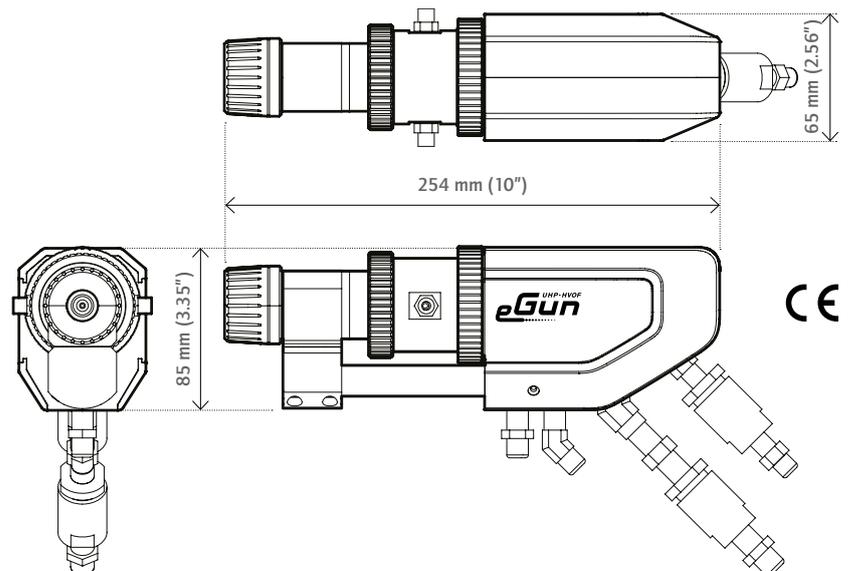
JP-5000 & JP-5220 are trademarks or registered trademarks of Praxair S.T. Technology, Inc. in the United States and/or other countries.



A standard eGun™ System consists of the following components:

1. Touch Screen Panel (TSP)
2. Electric Control Module (ECM)
3. Gas/Fuel Control Module (GFCM)
4. Cooler
5. PF-50 Powder Feeder
6. Jam Box (JB)
7. eGun™ Hose and Cable Package
8. eGun™ HP-HVOF
9. E-Stop and Exhaust Flow sensor

- a. Electrical power AC supply
- b. Oxygen
- c. Carrier gas (N<sub>2</sub>)
- d. Cooling air
- e. Fuel supply
- f. Fuel return
- g. Water supply (from chiller)
- h. Water return (to chiller)
- i. Electrical cable EM to PF
- j. Electrical cable EM to GM
- k. Electrical cable EM to TS
- l. Electrical cable EM to JB



## Main features of the eGun™ System

- Modular construction for easy service and maximum safety
- PLC based process controller for maximum reliability and flexibility
- Data acquisition/trending with storage on memory stick
- Easy to use touchscreen with full colour graphical operator interface
- Storing up to 250 recipes
- Metric or Imperial unit display
- Multiple languages
- Multiple voltages for worldwide usage
- Built-in remote access (eWon) allowing for troubleshooting and software updates.
- Small footprint space saving cabinets
- Closed-loop monitoring and control of all parameters including gases and fuels
- Full and detailed alarm registration and history
- Monitoring and safe guarding of water flow and temperature.
- Monitoring and safeguarding of back pressures.
- Automatic high-voltage spark ignition
- Full powder feeder integration with the PF-50 or FST-10C/FT powder feeder
- Interfaces for exhaust unit, chiller, spray booth, powder feeder and gun/part manipulation system
- Master/Slave Integration\*
- Compressed air on/off control for gun air jets.

\* This is an optional feature.

## Safety features

- Password login with variable user levels
- Multi-level warning/alarm system with safe shutdown in critical situations
- E-stop system designed for integration with peripheral equipment.
- Flow Sensor in exhaust ducting
- Modular construction separating combustible media from electronics
- CE and UL\* conformity
- The use of premium components and high quality build

## eGun™ (ethanol based liquid fuel HVOF) benefits

- Larger window of operation vs kerosene, thus better control over the balance between kinetic and thermal energy of the particles.
- No ash formation
- Less toxic fumes
- Environmentally friendly
- Consistent fuel
- Easy smooth system starts and ramp-ups
- Ability to run very fuel rich, creating new coatings and application opportunities
- High coating integrity and uniformity.
- Higher combustion chamber pressure results in higher particle speed.
- 30%-50% reduction in oxygen usage
- Up to 50% reduction in required cooling power

Systems

Consumables

Coatings

www.fst.nl



# Flame Spray Technologies

Added value through know-how | [www.fst.nl](http://www.fst.nl)



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