Thermal spray cooling technology

The nozzle for Air Products' thermal spray cooling technology is mounted to the thermal spray gun on the robotic arm. During your spray application, the cryogenic vapor jet follows the spray plume to maintain the part's temperature within the specified range.

New technology. New solutions.

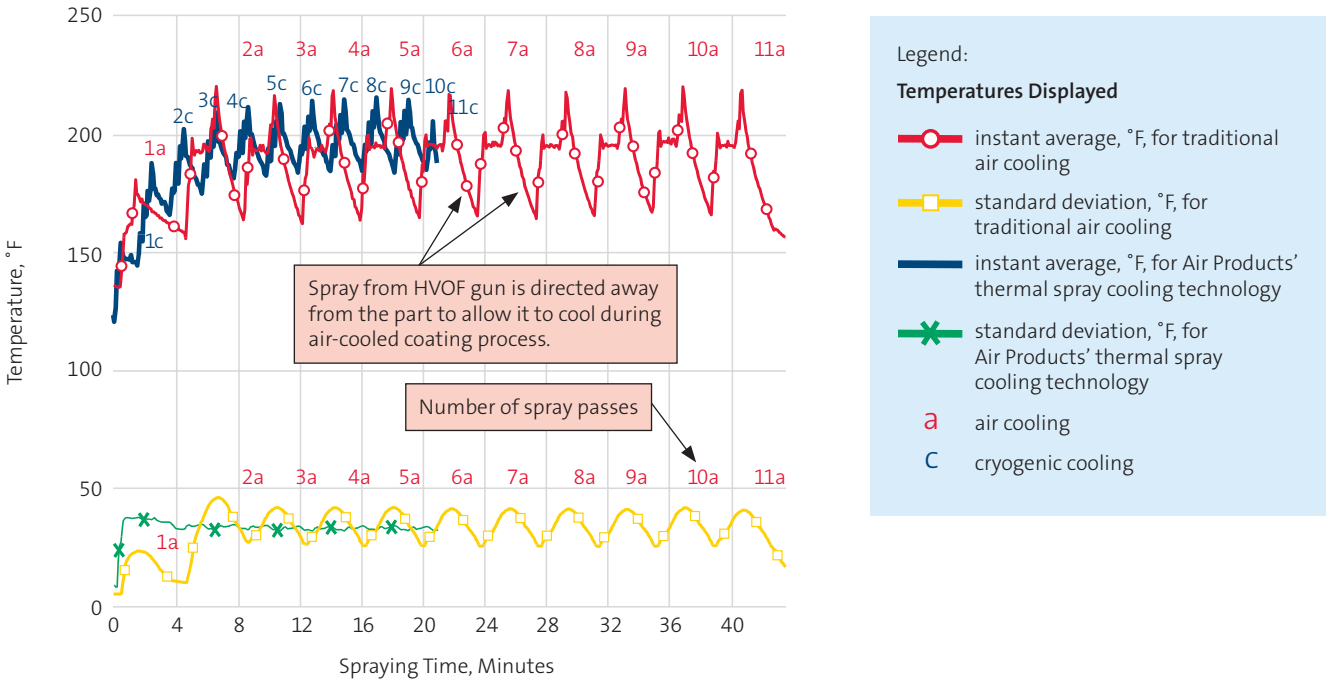
For many thermal spray coating applications, it's crucial that parts do not experience temperatures outside of a closely set range. Otherwise you run the risk of producing off-spec products that have been exposed to too much heat for too long, negatively impacting coating adhesion, part and coating hardness, fatigue life, corrosion resistance and dimensional tolerances. To maintain specified part temperature, forced air cooling combined with inter-pass breaks are currently used to allow a part to cool before starting the next coating pass. This mode of operation leads to reduced productivity, wasted feed powder and wasted process gases.

Recognizing the need for something better, Air Products has drawn upon our 50+ years of experience in gas application technologies to develop new solutions to help you succeed.

Patented technology

Air Products' thermal spray cooling technology uses cryogenic nitrogen vapor and nitrogen aerosol spray (–320°F) for high quality thermal sprayed coatings—including tungsten carbide cobalt—faster and at a lower cost than with traditional cooling methods. Our novel technology can cool your parts more than two times faster than you can with shop air alone. Plus, with the advanced version of our thermal spray cooling system, you can maintain part temperature within a +/–20 degree range during your thermal spray coating application (see Figure 1). The result is lower costs due to the elimination of inter-pass cooling breaks, reduction in powder and gas waste, and better utilization of the thermal spray equipment and booth.

Figure 1: Traditional Air Cooling vs. Air Products' Thermal Spray Cooling Technology for Coatings Deposited in 11 Spray Passes



Air Products' novel thermal spray cooling technology delivers exceptional results. This graph shows actual process data for spraying aircraft landing gear with traditional air cooling compared to our nitrogen cryogenic vapor cooling system. With the Air Products thermal spray cooling technology, the part's temperature was maintained within a much tighter range during the spray operation. In addition, it halved the spraying time and the amount of powder and process gases consumed—plus improved productivity.

Options to meet your needs

Advanced thermal spray cooling system

Air Products' advanced thermal spray cooling system takes process control to a new level. The system uses liquid and gaseous nitrogen as the cooling media. The cooling nozzle is mounted on the robotic arm so it trails behind the spray gun to cool the part during the spraying process. Through the closed-loop temperature feedback system, you can achieve optimal part cooling and maintain the coating temperature within a user-defined temperature range. Our temperature monitoring and control software uses proprietary cooling algorithms to determine the appropriate cooling intensity based on the thermal imaging camera and/or infrared sensor inputs.

Plus, multiple cooling lines provide set-up flexibility for parts with complex geometry. The advanced cooling system offers:

- Variable cooling intensity based on actual temperatures and user-defined inputs
- Flexible temperature signal acquisition through infrared sensors and/or a thermal imaging camera
- Real-time temperature display
- Data and image storage
- Data retrieval capabilities for quality control post-inspection
- Unrestricted cooling configuration and operating mode selection (liquid nitrogen, gaseous nitrogen, forced air, and hybrid)

These features provide real-time vital characteristics of the coating process, such as instant and time-averaged temperature of the part, temperature distribution in various part areas, and standard deviation of accumulated thermal data. This data can be tracked, recorded and stored for audit purposes. Compared to our standard system, this system provides a wider range of control plus all of the monitoring and data collection required for critical spraying operations.

Table 1: Thermal Spray Cooling System Comparison

Features	Advanced System	Standard System	Monitoring System
Compatible with existing thermal spray systems	●	●	●
Easily installed on robotic arms for precision cooling	●	●	
Variable cooling modes	●	●	
– Precision spot cooling	●	●	
– Diffuse, wide-area cooling	●	●	
Automatically controlled by preset commands (minimal operator input)	●		
High-efficiency, cost-effective liquid nitrogen usage	●	●	
Options:			
Infrared sensors or 2D thermal imaging system	●		●
Up to 5 additional liquid nitrogen hoses per unit for additional cooling	●	●	
Temperature calibration system	●		
Data management system—ideal for quality assurance purposes	●		●
Numerous, cost-effective nitrogen supply options available worldwide	●	●	

Standard thermal spray cooling system

Air Products' standard thermal spray cooling system uses liquid and gaseous nitrogen as the cooling media. This system's cooling nozzle is also mounted on the robotic arm, trailing the spray gun. The system can deliver one of several predetermined mixtures of liquid nitrogen vapor and gaseous nitrogen based on operator input. Your part cooling can be optimized by selecting any of the five user-defined cooling modes, ranging from room temperature nitrogen gas to 100% cryogenic liquid nitrogen. This system provides flexibility in selecting a desired cooling capacity for the part you're spraying, in a less sophisticated control package than our advanced system.

With our thermal spray cooling technology's advanced system, you can monitor your spray operation from the control room. The temperature profile for your operation will be displayed on your computer screen and captured for future analysis, playback and audits.

Temperature monitoring of thermal spray processes

When liquid nitrogen cooling is not required but temperature monitoring of the spraying process is, Air Products' thermal spray monitoring system is a valuable tool. This system can monitor and record data from measurable inputs during the thermal spray process—especially substrate temperature monitoring. The monitoring system provides temperature signal acquisition through infrared sensors and/or thermal imaging cameras, real-time thermal data display, thermal data and image storage, and data archiving playback for quality control post-inspection. While cooling is not provided with the monitoring system, you can integrate cooling modules at a future date if you want to add that option.

Real results

Consumable savings:

Air Products' advanced thermal spray cooling technology allowed a major aircraft maintenance, repair, and overhaul facility to halve the spraying time and the amount of powder and process gases consumed in the coating of its aircraft landing gear. They used high-velocity oxy-fuel (HVOF) to apply tungsten carbide cobalt chrome (WC-CoCr).

The cryogenic vapor cooling system reduced the thermal gradients that are normally created during the conventional spray operation. Based on microstructural and compositional analysis, microporosity, bond strength, hardness, and as-sprayed roughness measurements, the quality of the cryogenically vapor-cooled WC-CoCr coatings was as good as or better than the quality of the air-cooled coatings.

Setup savings:

Our system can eliminate the need for traditional, rigid protective masking that must be rugged and resistant to high temperatures. With our technology, you can use inexpensive, flexible masking tapes that are easy to apply and remove, resulting in radically reduced setup and cleaning times. This is a result of cryogenic nitrogen's unique ability to cool the masking tape quickly, preventing its thermal breakdown.

For more information, please contact us at:

To learn more about our cooling technology and how it can help your thermal spray application, give us a call.

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