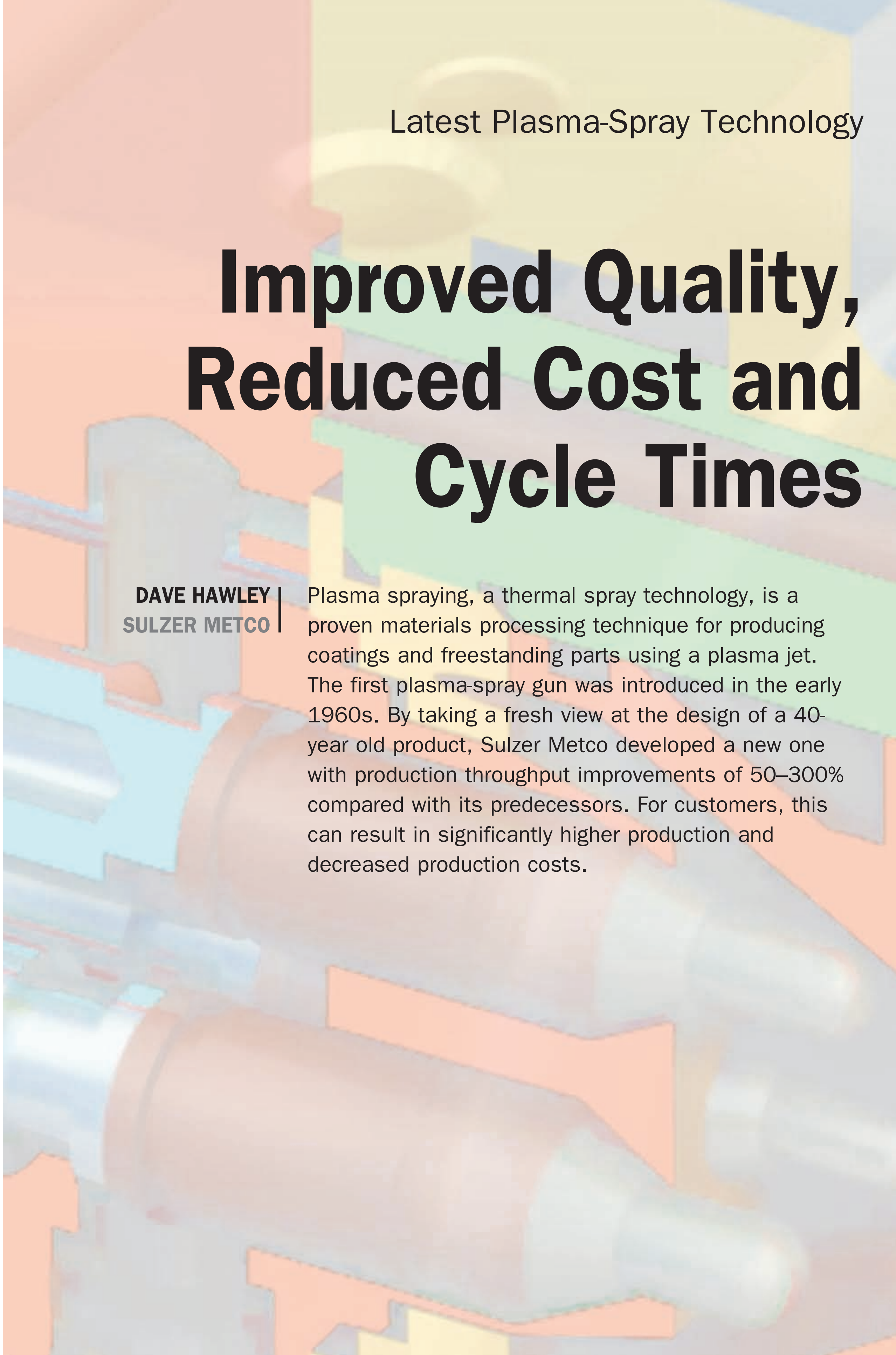

Latest Plasma-Spray Technology

Improved Quality, Reduced Cost and Cycle Times

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Plasma spraying, a thermal spray technology, is a proven materials processing technique for producing coatings and freestanding parts using a plasma jet. The first plasma-spray gun was introduced in the early 1960s. By taking a fresh view at the design of a 40-year old product, Sulzer Metco developed a new one with production throughput improvements of 50–300% compared with its predecessors. For customers, this can result in significantly higher production and decreased production costs.

At its launch, plasma-spray technology was hailed as an innovative method to melt and apply coatings of ceramic and other high-temperature melting materials. As such, it gained rapid success for critical coating applications in the space program, commercial aviation, military, and other industries.

Over the next 40 years, the design of plasma-spray guns changed little, with only small improvements to extend component life and increase power output. In fact, the overall layout remained largely the same as in the original Metco type MB gun (Fig. 1). In a business environment where plasma coatings represented a minor component of the total cost structure, there was very little pressure for improvements in yield and throughput, considerations that are typical of other manufacturing processes.

Today, the situation is quite different. Many plasma coatings are applied by coating job shops where the costs of applying plasma coatings constitute a major part of the overall operating costs. As the number-one supplier of plasma-spray guns and equipment, Sulzer Metco has invested heavily in research and development over the last 10 years, focusing on the future customer need to reduce costs.

Technology Description

The plasma process uses a combination of heat and velocity to cause fine, powdered material feedstock to form a coating. All plasma guns use heat transferred from a high-current electric arc to heat the process gases, which in turn heat the material injected into the resultant spray plume. Therefore, control over the material temperature is the primary factor that determines the coating result, especially for materials that do not achieve a significant level of plasticity unless they are at high temperatures.

Focused Research

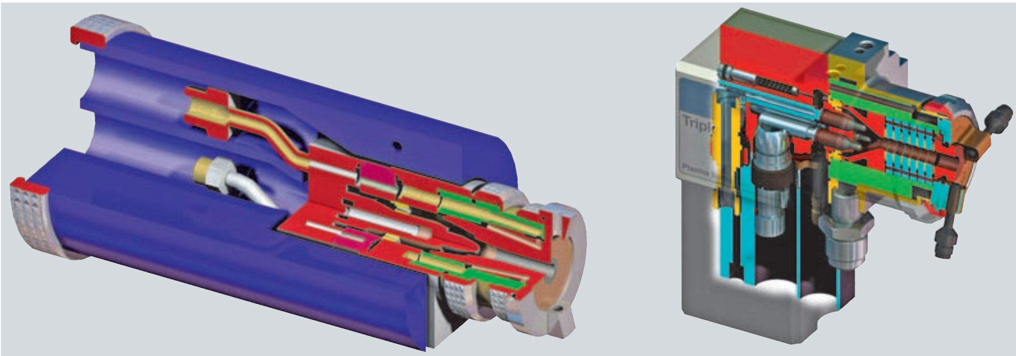
The focus of Sulzer Metco's research has been to study and understand the effectiveness of the heating method to improve gun performance. The use of major enabling technologies, not available 40 years ago, provided new insight into the relationship between the state of the electric arc and particle behavior. These technologies, such as the ability to analyze temperature and velocity of the individual feedstock particles in real time, and computational fluid dynamics (CFD), allowed Sulzer Metco to observe effects that had never before been properly characterized (see STR 2/2006, p. 12). The outcome of this work is the TriplexPro-200—a new plasma spray gun with very stable and defined arc behavior, which results in extremely uniform powder heating and significant improvements in gun performance (Fig. 2). The TriplexPro-200 meets industry demands by increasing yields by up to 50% and, in some cases, increasing throughput by 300% as compared with traditional guns.

2 TriplexPro™-200 plasma-spray gun. With its recent introduction, Sulzer Metco achieved notable reductions in both costs and coating times.

Cost Benefits

Like with all fabrication technologies, total material costs and cycle times largely drive total costs. A fair way to assess the actual benefits of the TriplexPro-200 coating

1 Metco type MB plasma-spray gun (circa 1960). Plasma-spray coating technology has been in use for over 40 years. Sulzer Metco significantly improved this technology thanks to focused research.



3 Cross-section of a traditional plasma-spray gun (left) and the TriplexPro-200 plasma-spray gun.

system is to consider the relative costs to apply 1 kg of coating to a substrate using both a traditional plasma gun and TriplexPro-200 (Fig. 3). In this example, a yttria-stabilized zirconia coating material is applied to meet common industry-wide coating specifications, at a cost of USD 35/kg. The improvement in yield provides the first significant cost reduction, with a 8% change in yield saving more than USD 10 per kilogram of applied material (Fig. 4).

4 Influence of yield (deposit efficiency) and feed-rate on material coating rate.

	Feed Rate (g/min)	**Yield** (%)	**Coating Rate** (g/min)	**Material Cost** (USD/kg applied)
Traditional	65	48	31.2	72.92
TriplexPro	125	56	70.0	62.50

The improvement in spray rate can be a complex cost calculation based on many variables, but it can be simply expressed as the burdened cost of the spray facility for each hour of operation, which is stated here as USD 250/operational hour (Fig. 5).

It can be appreciated that improvements in gun technology can create large cost savings for the typical applicator. For some other materials, the cost benefit is even more dramatic (Fig. 6).

5 Total comparative cost of applying 1 kg of material with facility and labor costs included.

	Facility Cost (USD/kg)	**Material Cost** (USD/kg)	**Total Cost** (USD/kg)
Traditional	133.55	72.92	206.47
TriplexPro	59.52	62.50	122.02

Long Component Life

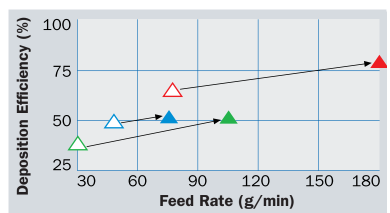
Unlike arc welding, where the cathode is continuously consumed in the process, the plasma arc is contained within the gun. The intense energy densities of the arc in traditional plasma guns begin to degrade the internal elements from the moment the gun is started, and while considerable improvements have been made to control the erosion of internal components, these guns suffer from continually drifting process parameters.

With the TriplexPro-200 system, the operational voltage is increased by a factor of 2, and the arc is divided into 3 individual arcs. Each TriplexPro-200 arc operates at 100–200 ampere (A), as compared with traditional plasma guns, which would operate at 500–1000 A for the same power levels. With this new system, the industry can adopt fixed parameters for the first time, as there is no process drift, and life expectancy of the gun consumables exceeds 200 hours for the majority of parameters, which is an order of magnitude better than traditional guns.

Longer Operating Times

Fixed parameters and no process drift also mean longer up-times for the spray system, in terms of quickly and reliably achieving the spray process window each time a parameter set is run.

The TriplexPro™-200 is rapidly proving itself a valuable tool for spray shops in a variety of industries. Thanks to its high coating efficiency, TriplexPro™-200 is a very attractive solution as currently both production-efficiency goals and raw-material costs are reaching historic highs. ◀



	9MB	Triplex Pro-200	
601NS	△	▲	+280%
71VF-NS-1	△	▲	+ 50%
Chrome Oxide (AMDRY 6415)	△	▲	+391%

6 Comparison of productivity gains (feed rate and deposit efficiency) for the Sulzer Metco 9 MB plasma-spray gun vs. TriplexPro-200 for 3 materials.

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