APPLICATION NOTE - 1014

Topic: NEW TYPE OF DC POWER SUPPLY
IMPROVES PLASMA SPRAY COATINGS

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INTRODUCTION

Plasma Spray Coating is used in many applications all over the world. These include architectural glass, semiconductors and metals to mention only a few. For example, on a high-rise Office Building the colored glass often used is made using a Plasma Spray. Another example is the Turbine Tip Blades use in jet aircraft engines, which are coated with a Plasma Spray.

WHAT IS PLASMA SPRAY COATING?

Plasma Spray Coating is a process of thermally spraying one substance (usually in a powder form) onto another. In the case of architectural glass it could be spraying copper or aluminum onto the glass. A Jet Engine's Turbine Tips are Plasma Spray Coated with a High Temperature Ceramic Coating that ultimately serves as the bearing surface.

Figure 1 - Example of Plasma Spraying
(Photo courtesy of White Engineering Surfaces Corp.)

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The Coating uniformity, ease of using different coating materials, better deposition rates and the increased efficiency in time and materials are a few of the advantages as seen by many of HDR's clients using HDR's new PWM Plasma Power Supply.

POWER SUPPLY TYPES

There are two types of DC Power Supplies used in most Plasma Spray Coating applications: 1) SCR Control and 2) PWM Control. Both have advantages and disadvantages over the other. See Chart 1 for comparative information.

CHART 1
Advantages/disadvantages of
SCR/PWM DC Power Supplies

Advantage/Disadvantage	SCR	PWM
Output Ripple	more	less
Power-Factor	lower	higher
kVA Requirements	higher	lower
Open Circuit Voltage	higher	lower
Circuit Complexity	lower	higher
Harmonics	higher	lower
Size	smaller	slightly larger
Cost	lower	higher

Figure 2 – Typical SCR Plasma Power Supply
(Rated for 400 VDC @ 600 ADC Output)

The SCR based DC Power Supply is the most common in use today. Many are simply modified welding power supplies. These are certainly less expensive due to the massive quantities the welder manufactures build and the circuit simplicity. Welding Power Supplies typically have a low Power-Factor (PF) because the typical operating voltage is about half of the open circuit voltage, which equates to an approximate Power-Factor of 0.5. This higher open circuit voltage requirement is the main reason for the higher kVA requirements.

Figure 3 – Typical PWM Plasma Power Supply
(Rated for 100 VDC @ 2000 ADC Output)

The PWM (Pulse-Width-Modulated) DC Power Supply is steadily increasing in popularity. The lower kVA requirements help reduce the incoming power requirements and the high Power-Factor of about 0.9 is significant enough to help reduce overall electrical operating costs. The decreased Harmonic currents are becoming more important due to the IEEE 519 Standard. The reduced output ripple helps create a smoother coating.

Note: IEEE 519 titled “IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems” is a standard slowly being adopted by industries trying to minimize harmonics in their electrical power distribution systems.

Both the SCR and PWM Plasma Power Supplies from HDR provide higher Power Factors and require less power source kVA than the typical Welder Power Supply. This is the result of HDR using the electronics for regulation more than the magnetics as a Welding Power Supply does.

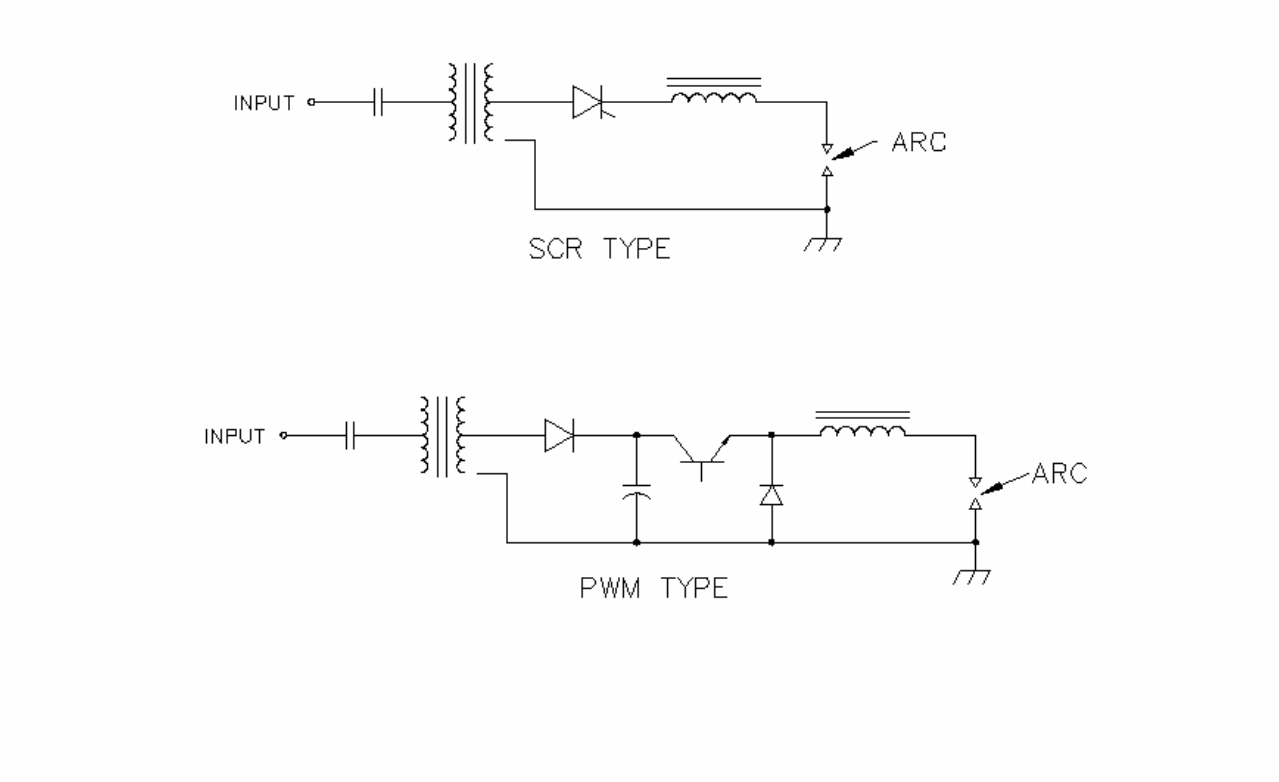

Figure 4 – One-Line Diagrams of SCR and PWM Plasma Power Supplies

When comparing the SCR and PWM one-line diagrams, note the only real difference is the addition of a DC Capacitor Bank and a Transistor. On the SCR type, the SCR actually does the control. On the PWM type, the SCR is used to charge the DC Capacitor Bank and the Transistor regulates the DC current.

Results at HDR's Clients

Several HDR Clients have installed new HDR PWM Plasma Power Supplies (similar to that shown in Figure 3). The results have been fantastic. Clients have reported smoother coatings, reduced rework, higher yields, etc. However, the most amazing improvement is the reduced powder coating material requirements. We have reports of reductions as high as 20% or more. This is significant because the powder coating material is one of the highest cost items.

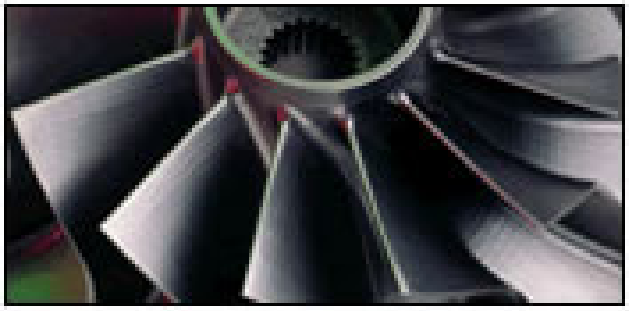


Figure 5 – Examples of Turbine Tip Blades
(Photo courtesy of TTL)

Conclusion

The PWM Plasma Power Supply has a higher initial cost, however; the overall operating cost is lower than the conventional SCR controlled Plasma Power Supply. This lower operating cost is significant enough to offset the additional cost. Additional benefits such as reduced ripple that helps reduce electrode wear; helps increase production yields and lowers product cost. Payback periods of three months or less have been reported to HDR. In addition, the extra benefit of reduced harmonic currents helps minimize the potential for plant power distribution problems.

HDR Power Systems, Inc. designs and builds both standard and custom Plasma Power Supplies for many applications including Thermal Spray Coating, Metal Cutting or Welding, Steel Melting/Remelt, Waste Remediation, Tundish Heating, Super Heating and Research & Development.