A SIFCO White Paper

SIFCO®
SELECTIVE PLATING
DIVISION OF SIFCO INDUSTRIES, INC.
ISO 9002 Registered Quality System

Power Generation: Generators and Turbines

Design, Production, & Maintenance Challenges

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Executive Overview

There are numerous challenges facing power generation and production facilities as they relate to operation and maintenance of generators and turbines. Issues of wear, corrosion, fretting, and conductivity all must be faced in some manner.

While there are various methods available for addressing these issues and meeting these challenges, selective ‘brush’ plating is often overlooked.

Selective plating is a time-, and cost-effective method of applying an integral metal coating to repair or enhance components on generators and turbines. Some examples are presented.

SIFCO Selective Plating is the premier provider of the technology, products, and services of selective ‘brush’ plating.

The Challenges

The majority of industrial and municipal electric power production is produced by generators which are driven by steam or gas turbines. The normal mechanics of rotating equipment, high heat, on-going corrosion, and a wide range of operating conditions all contribute to a variety of maintenance challenges in both generators and turbines.

Some problems are common to both generators and turbines. Wear or scoring damage can occur on bearing journals or shaft seal areas due to poor lubrication, contamination, or overheating, thereby requiring repair of the shaft. Various atmospheric contaminants and the galvanic potential of dissimilar metals may cause corrosion problems, often accelerated by heat, on a variety of faying surfaces.

Certain problems are more common in the gas turbines. Corrosion of high-strength, high-cost forged steel components is common over time. Operating environments in a coastal marine atmosphere or airborne sulfides from pollution accelerate the corrosion process. Corrosion may attack turbine shafting or other turbine components in critical areas and eventually weaken a shaft, for example. Corrosion and subsequent erosion of metal results in increased “bucket rock” and out of tolerance clearances between bucket and turbine wheel fits. Peak- load GenSets are particularly subject to additional stresses due to cycling from on-line to off-line service. During off-line periods of low-speed turning-gear rotation, the

bucket-rock wear problem occurs due to impact and erosion of precision bucket fit-to-wheel tolerances.

Other critical interference fit or shrink-fit tolerances on shafting and wheels may require some method of tolerance restoration which can withstand high compressive loads. Similar areas may be candidates for a permanent barrier coating for corrosion prevention.

Steam turbines may have wear, corrosion, or steam cut problems unique to the steam system designs.

On the OEM side of Generators, design, production, and maintenance areas also face unique challenges. Static mechanical joints carry huge current loads throughout the generator design. The conductivity and long term integrity of these joints is essential to generator output efficiency. Copper and aluminum conductors and other critical grounding locations are commonly electroplated with silver or tin, and in certain applications, nickel. Many generator components are large in size, heavy, and awkward to handle, eliminating the possibility of traditional bath or tank plating.

Dynamic joints, which are subject to fretting, may also be candidates for special electroplating processes, particularly when dissimilar metals and galvanic potential are considered in design.

Heat sinks present a different set of challenges. Depending on geometry, electroplating of an entire component may not be practical for long-term efficiency and heat sink life. Specific areas of the heat sink may best be electroplated with silver, tin, or nickel with the balance of the surface area remaining bare or other paint-like coatings applied.

Collector rings and exciter components may have design requirements where electroplated components or specific surfaces of the component, will enhance conductivity and extend service life.

Generator retaining ring inside diameters, and the shrink fit mating area (body fit / mortiser bars) on the rotor/field forging, often require enhanced surface treatments to ensure electrical joint long-term integrity, current carrying capacity, and proper fit dimensions.

Production and Repair Options

There are a variety of common methods used for mechanical tolerance rebuilds and improvement and protection of current-carrying surfaces. These include:

- weld overlay,
- metal / thermal spray,
- mastics and plasticized metals powders
- off-site immersion tank plating
- selective “brush” plating

All of these processes have their niches. Welding is used where heavy buildups are required. Sprays are used where fast application is desirable and impact resistance requirements are low. Mastics are used when speed is needed for temporary fixes. When time and freight considerations allow, tank plating can be very cost-effective. But selective “brush” plating is often overlooked as an option that is fast, performed on-site, requires minimal disassembly or masking, provides for exact buildups, does not overheat the part, results in an integral bond with the part, and is very cost-effective.

What Is Selective Plating?

Selective plating is an electrochemical process in which metal ions are deposited on a metallic surface. This process is the answer to the situations described above. Selective plating can be used to repair shafts, housings, and journals with low buildup requirements in a much faster and cost-effective way than traditional welding or spraying methods. On-site selective plating provides a much improved method for plating bus bars and other electrical connections.

Selective plating involves bringing chemical cleaning and plating solutions in small volumes to the part that needs plating, isolating the area on the part that requires the buildup, and applying the deposit metal with the use of electricity. It is all based on simple electrochemical principles. Using Faraday's law, it is possible with this process to control the thickness of the deposit to within 0.0002", thereby eliminating post-machining requirements in many cases.

Selective plating is best suited economically for applications where the required buildup is <0.010" overall dimensional change. In these situations the need for post-machining is usually eliminated. However, selective plating can also be used economically in situations where the buildup requirement is up to 0.060", but minimal mid- and post-process grinding or finishing may be required.

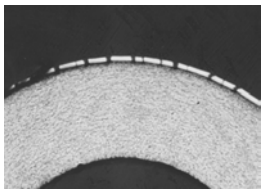
Examples of Selective Plating

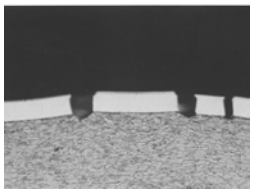
- **Generator Rotor/Field Tolerance Rebuild; Retaining Ring Body Fit:** The outside diameter of a generator rotor/field forging was dimensionally undersized, preventing acceptable shrink fit installation clearance of the retaining ring. The mortiser bars in the body fit area were dimensionally restored by the SIFCO Process of selective plating. The materials and methods used were in accordance to repair procedures outlined in MIL STD 865C.

- Retaining Ring Silver Plating

- **Retaining Rings of a generator rotor/field were removed for rewinding of the rotor:** Silver plating on inside diameter of the retaining rings, which was specified on this design drawing, was found to be damaged. The silver plating was re-applied on site by SIFCO Selective Plating to original design specifications.

- **Generator Main Output Flexible Coupling, Silver Plating:** Inspection of the generator main output leads revealed high resistance connections, resulting in excessive heat in the bus conductors. Silver plating was specified as the appropriate repair, and was applied on site at the power plant by SIFCO Selective Plating. These cross-sections show a 0.0003” thick silver deposit that was selectively plated onto a copper test panel and then subjected to a tensile bend test. The deposit has fractured in the bend area but shows excellent adhesion to the substrate, as well as cohesion. Such an integral deposit of silver results in a long life, free of oxides, for power generator connections. Many manufacturers of generator equipment utilize the SIFCO Process of selective plating on their OEM equipment.





The SIFCO Process®

SIFCO Selective Plating has provided this high quality metal finishing and repair process of selective plating to industry for over 40 years. Known worldwide as the SIFCO Process, it is a true electro-deposition capable of providing sound metallurgical deposits on components. With over twenty metals that can be deposited, the SIFCO Process can find many uses in the repair of power generation equipment such as generators, engines, and turbines.

The SIFCO Process meets many specifications, including AMS 2451, MIL STD 865c and MIL STD 2197. In addition, many companies such as Siemens Westinghouse Power Corporation, Alstom Power, and GE Power Systems have used and specify the SIFCO Process.

With six service shops in North America, SIFCO Selective Plating can be on-site at your location within a few hours to selectively plate your components. Its technical sales staff, spread throughout the U.S., and the SIFCO R&D and Technical Support staff at its headquarters in Cleveland, OH, are ready to help analyze the technical and economical aspects of your repair requirements to evaluate whether selective plating is a viable alternative for your specific application.

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DIVISION OF SIFCO INDUSTRIES, INC.

ISO 9002 Registered Quality System

World Headquarters
5708 Schaaf Road
Cleveland, OH 44131, USA
Ph: (216) 524-0099
(800) 765-4131
Fax: (216) 524-6331
Email: info@brushplating.com
Website: www.brushplating.com/gtr.htm
FAA Repair Station #SOXR680K