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Tapswitch Rectifiers

Tapswitch rectifiers have long provided an inexpensive and reliable option for DC power to the electroplater. Because of their simplicity of design and operation, they have a lower initial cost and fewer components to fail. When they are sized and selected appropriately for the operation, they will provide many years of faithful service.

Design

A typical tapswitch rectifier consists of these components:

- A cabinet—painted steel and PVC are the usual choices.
- A cooling system—either a high velocity fan for air cooling, or a water cooled system that requires thermally operated switches to activate a solenoid, and allow water flow through the cooling components.
- A contactor that engages when the start button is pushed, allowing power to flow from the three-phase incoming lines through the tapswitches and into the main transformer.
- "Start/Stop" pushbuttons and a "Power On" light to energize the unit and indicate the status.
- A small step-down transformer to reduce the voltage of the 230 or 460 VAC to 115 VAC for use in energizing the control buttons and contactor, as well as ancillary systems such as thermal overloads.
- Meters to monitor the voltage and amperage being generated by the rectifier.
- Overloads that protect the rectifier in case the incoming power exceeds the rated capability, or the cooling fan should seize up.
- Overtemp thermals that shut the unit off when selected components exceed the designed operating temperature.
- A shunt to generate a signal proportionate to the outgoing amperage for use by the ammeter.
- Three tapswitches—one for each phase—to transfer the incoming power to the main transformer. This is what makes a tapswitch rectifier work. Each of the eight positions takes the 230 or 460 VAC line feed and transfers that voltage to an individual winding on the main transformer. By turning each knob to the required level, the desired voltage output is achieved. Each switch should be kept within one position of the other two. For example, switches should be set at 1-1-1, 2-2-2, 3-3-3, and so on for optimum balance on the components, although this only provides eight voltage settings. For interim values, switches may be set in such a way as 2-1-2, or 1-1-2 (2-1-1 gives the same output as 1-1-2). The total combination then becomes 23 settings from a low of 1-1-1 to a high of 8-8-8. By dividing the range of output voltage possible, the size of the increments can be determined. (With a 3-12-volt rectifier each setting becomes slightly less than half a volt of adjustment.)
- The main transformer, which by virtue of the eight separate ratios of primary to secondary windings, converts the high voltage to a range of output voltages usable by the plater.
- A bank of diodes to convert the AC volts to DC volts (rectification). This bank will be sized proportionally to the output amperage of the rectifier.

Advantages

The tapswitch rectifier offers several advantages over other designs and control methods:

- Cost—Fewer components and simpler design add up to lower initial cost. This cost differential is greatly reduced in reconditioned or used units.
- Reliability—Fewer components also translates to fewer failures.
- Simplicity of operation—Start the unit up and turn the taps until the desired voltage is attained.
- Low Ripple—Less than 5 percent from low to high output. No choke is required for ripple-sensitive solutions.
- Efficiency—Depending on size and the manufacturer, a tapswitch rectifier is usually more efficient than other methods of control.

Disadvantages

Because this control design is simple, it means there are several things that are less desirable in a tapswitch rectifier:

- Cannot go to zero volts—By design, a tapswitch rectifier cannot go lower in voltage than its lowest winding. For example, a 2-9-volt rectifier cannot go lower than two volts, and for some processes these lower settings are necessary.
- Transformer cost—Although this is offset in initial purchase price by fewer components, if the transformer should fail and need to be rewound, the complexity of the multiple windings will make this cost considerably higher.
- Taps must be kept in balance—As discussed previously, the taps must remain within one position setting of each other to avoid overheating and premature failure.
- Precision—Because there are a finite number of set-points, it may not be possible to achieve the precise voltage setting desired.

- Constant voltage/amperage—This type of control does not allow setting either voltage or amperage to a desired level and maintaining that level as conditions within the bath change. This is a necessity for some operations.
- Mechanical wear—Because the tapswitch is mechanical, it will eventually wear out, depending on how often it is turned. A related issue is the need to keep tapswitches from seizing up by turning them all the way up and down periodically.
- Remote control—A tapswitch rectifier cannot be easily adjusted anywhere but at the rectifier. Motorized tapswitches are available, but add cost and reduce reliability. Adjustment via PLC is generally not possible either.
- Size restrictions—Because of the need for larger and larger tapswitches as the amperage of the rectifier increases, the use of a tapswitch rectifier for large amperage draw is restricted. The increased size of the switch makes them difficult to turn and maintain, and minimizes their use in such applications.

Like any other selection of "the right tool for the right job," the tapswitch rectifier has and will continue to have a place in the plating shop. As plating becomes more sophisticated and programmable controllers make greater inroads, however, the size of that place may become less significant. *P&SF*

Advice & Counsel

(Continued from page 28)

was observed in fungi, yeast or bacteria. Acid pH caused depurination of isolated DNA.

Evaluation

There is sufficient evidence that occupational exposure to strong-inorganic-acid mists containing sulfuric acid is carcinogenic.

Overall Evaluation

Occupational exposure to strong-inorganic-acid mists containing sulfuric acid is carcinogenic to humans (Group 1).

The above confirms that the MSDS is conveying the proper health hazard information to you, Mr. Vitriol. Be sure to train all of the employees with a potential of exposure in accordance with the OSHA Hazard Communication Guidelines. If your plant is in California, refer to Proposition 65 for guidance and additional requirements. You may want to investigate a change to hydrochloric acid. *P&SF*

References

1. IARC information was obtained from IPCS INCHEM's home page on the Internet (www.inchem.org).
2. ACGIH, 1330 Kemper Meadow Dr., Cincinnati, OH 45240-1634; www.acgih.org.