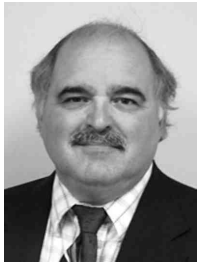
Rectifier Clinic



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Rectifier Ripple

There often seems to be some confusion concerning ripple in a plating, anodizing or coating environment. What is it? Where does it come from? Does it cause problems? How do we deal with it? The answers will vary based on the type of rectifier, how the rectifier is used and the process in which it is used.

What is Ripple?

Simply stated, ripple is the percentage of AC current that is passed through by a rectifier on the way to the process. For example, if the voltage at the tank measures 10 VDC (volts DC) and 3 VAC (volts AC) the ripple is 30 percent. If you measure 6 VDC and .5 VAC the ripple is 8.33 percent, and so on. Because the primary function is to produce a controllable DC current for the propagation of ions within a tank, the more AC that is passed the less effectively the rectification becomes.

It is important to measure the voltage as close to the load as possible, because there is usually less ripple at the tank than at the rectifier. Plus, you really want to know how much AC is at the load.

The voltages can be measured with a device as sophisticated as an oscilloscope or as simple as an analog multi-meter. For accurate readings, be sure that the meter has been calibrated and you have a clean connection where you measure. If you are measuring a high-voltage operation, such as e-coating, be *very* careful not to touch the voltage source with your body, as serious injury or death can occur.

Where Does Ripple Come From?

Different types of rectifiers pass different amounts of ripple. If you have a single phase rectifier you can expect to have ripple of 50 percent or more regardless of the type of rectifier or the level of output.

Because most platers and coaters use three phase rectifiers of 220–240 VAC or 440–480 VAC, we will look at the predominant types in use:

Tapswitch Rectifiers—These rectifiers will usually produce ripple of 5 percent or less for the full range of output as long as they are in good repair and the three tapswitches are set at the same level.

Powerstat Rectifiers—These rectifiers will also usually produce ripple of 5 percent or less for the full range of their output.

While both the tapswitch and powerstat rectifiers are durable, they are limited in their use due to size and sophistication restrictions. If you want to keep your voltage and/or amperage constant during the length of a cycle or control the rectifier with a computer, then an SCR rectifier will be your choice.

SCR Rectifiers—The amount of ripple at low voltage outputs may be 100% or more, but as the voltage is turned up ripple decrease to 5% at full rated output. Since so few platers or coaters run their rectifiers at full output for the entire cycle, ripple will be higher during those times of lower voltage output.

Switchmode Rectifiers—These high-speed switching rectifiers are built to provide low ripple across the full range of voltage output. Unfortunately, they are currently limited in size to around 1000 amps and 12 VDC.

Malfunction Rectifiers—Regardless of type, a component failure or other malfunction can cause any rectifier to exceed the specified levels of ripple.

Does Ripple Cause Problems?

If you are an electro-coater, or if you plate chrome, nickel, or precious metals, you are probably already aware of the susceptibility of your processes to problems associated with ripple. Inconsistent coating, burning, rupture, or reduced deposition rates may all accompany high levels of AC and be causing you scrap, rework, and unhappy customers.

In addition to quality related problems, the efficiency of the process is reduced proportionately to the level of ripple. This means you spend more on energy to get an equivalent level of plating or coating without ripple.

How Do You Reduce Ripple?

Assuming you need or prefer an SCR rectifier and do not run it at full output, you will need to add some sort of filter choke to reduce the ripple. To obtain the proper size filter choke it will be necessary to determine the range of your voltage output.

For instance, if you have a 12 VDC rectifier, and you operate between 2 and 12 VDC you will need a larger filter choke than if you operate between 7 and 10 VDC, because you will be compressing a larger segment of the AC that is passed through.

In addition, if your process is extremely ripple-sensitive and you require a ripple level below 1 percent through most of the voltage range of the rectifier, you will need a larger and more expensive filter choke.

The choke portion is typically a wound steel coil, elliptical in cross-section, that fits over the rectifier bus and reduces a portion of the AC sine wave inductively. If your process typically runs between 20–100 percent of the full output of the rectifier and you can accommodate a ripple level of up to 5 percent, the choke may be sufficient.

The filter portion is comprised of a capacitor bank sized to the output voltage and amperage of the rectifier. If you require low ripple for all levels of output in your process, you will need this filter in addition to the choke portion. Very small rectifiers may often get by with only a filter.

How Can I Keep Track of Ripple?

Many rectifier manufacturers, as well as after-market suppliers, provide ripple meters to obtain constant feedback, often with alarms, to track ripple levels. These meters allow you to monitor the status of your process and the operating condition of your rectifier. This will prevent the creation of defective product as well as alert you to immediate or impending failure of your rectifier. ***P&SF***