

What is Ripple ?

Ripple is the AC component that rides on the DC output of a Rectifier.

Most DC power supplies (rectifiers) used in the metal finishing industry are AC to DC converters. After the AC is converted to DC, there is always an amount of AC that is not converted, and is passed to the output of the rectifier. *The only device that puts out pure DC is a battery !*

Some DC power applications do not react favorably to high amounts of ripple. The amount of ripple that could be present on the output of a rectifier will vary depending on the type of rectifier circuit, and what level of output you are operating at (rectifiers that have variable outputs).

Most rectifiers are 3-phase (6-pulse) systems. These may have a fixed output voltage rating, or they may have a variable output, or they may be variable and provide voltage or current regulation. All of these systems will deliver about 4.2 to 5% ripple only when operating at full rated voltage and current levels.

The variable and regulated rectifiers are most typically controlled by SCR's (Silicon Controlled Rectifiers) devices. When these SCR devices are used to lower the output voltage or current levels of the rectifier (phase controlling), the AC ripple content increases. In some applications this is detrimental to the application process, and results in poor metal finishing results.

A L/C ripple filter (L stands for inductor and C for capacitor) circuit can be used to lower the ripple content to 5% or less when operating through a typical operating range of 25% to 100% of the DC rating. Additional filtering can be provided to allow 1% or less throughout a operating range also. Most metal finishing applications work well with only 5% ripple filtering.

L/C ripple filters can be provided for existing rectifier systems. It is a simple matter of inserting the filter between the output of the rectifier and the load. These usually come in free-standing enclosures, and take up little floor space.

Applications that require ripple filtering:

E-Coat	Plating	Anodizing
Most E-coat	Chrome, Hard-chrome	Some Hardcote

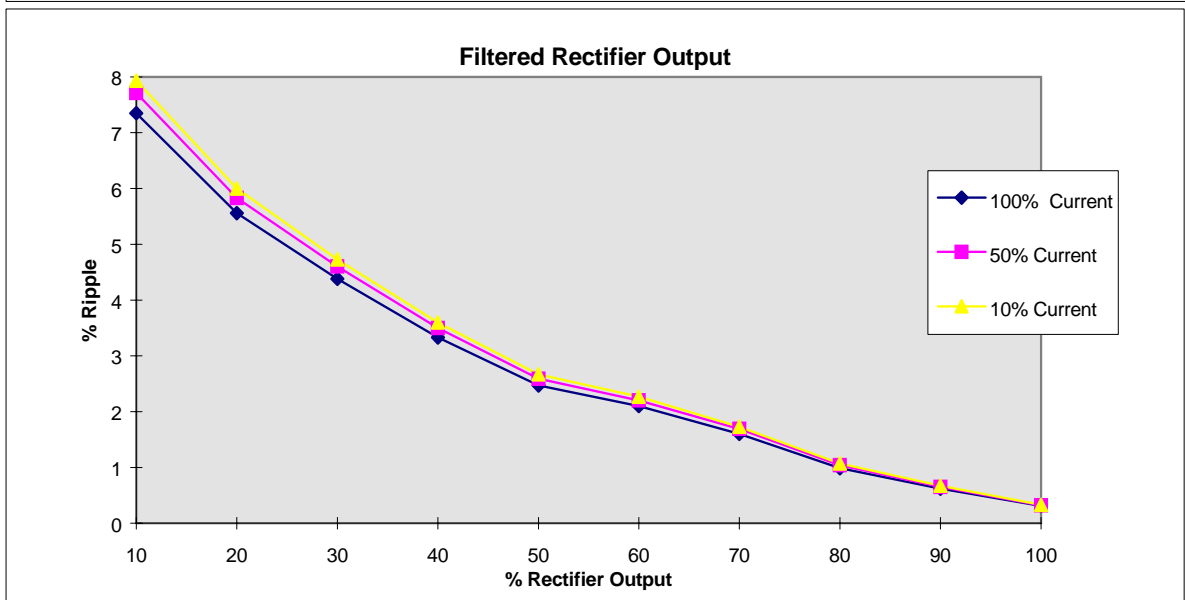
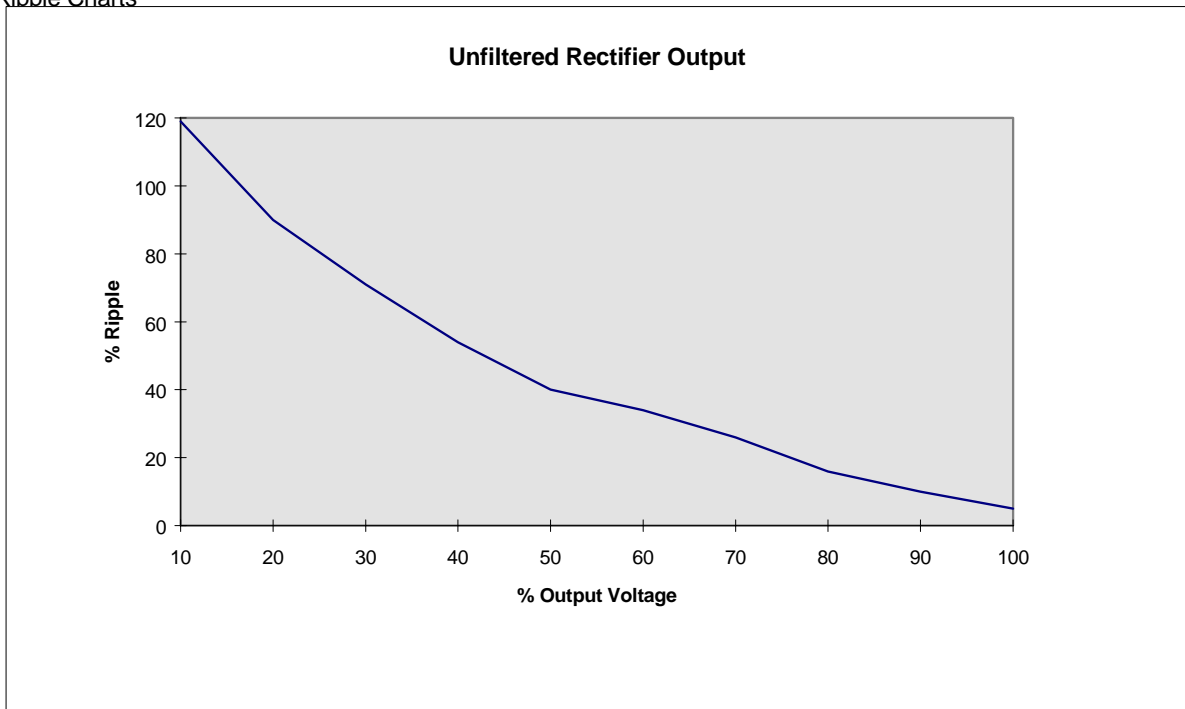
Specialty applications usually require some form of low ripple, and needs to be addressed.

Other means of obtaining low inherent ripple are 12-pulse circuits, and tap switch rectifiers that are primarily low voltage units used for plating.

Attached are graphs that show ripple content at various levels for 6-pulse rectifiers with and without filtering. Rectifiers without filtering can exceed 90% ripple content when operating at reduced output levels.



Ripple Charts



Measuring Ripple

Ripple can be easily measured by using a "True RMS" Digital meter. Some DMM's (Digital Multi-meter) are peak responding- do not use these as they will not give a true AC reading.

It is preferable to measure your ripple at the tank connections. If this is not possible, measure at the output of the rectifier.

With your finishing system operating at typical loads and voltage levels, read the AC voltage on the output of the rectifier and record. Next, set your DMM to the DC scale, and record the DC voltage.

Use the following formula to calculate your percentage of ripple:

$$\% \text{ Ripple} = \frac{\text{AC rms volts}}{\text{DC volts}} \times 100$$

On rectifiers with High voltage outputs (100 to 600 volts DC), filtered rectifiers should not exceed about 5 volts AC. Any reading higher than 5 volts AC could indicate a problem with the capacitors in the filter circuit, or a bad diode, SCR or SCR firing board.

Excessively high ripple on certain metal finishing applications will cause poor finishing results such as irregular coatings, mapping, craters, veins, and pinholes.

For applications that require a smooth DC Wave form, The L/C filter reduces the ripple which is a sinusoidal (AC) component.

All non-filtered 3-phase SCR/diode type converters contain about 5% RMS ripple when operating at FULL voltage and current levels. Since most users over-size their rectifiers, your typical rectifier system is operated at reduced voltage and/or current levels.

AS THE OUTPUT IS REDUCED, RIPPLE INCREASES

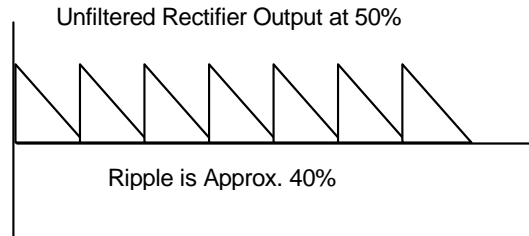
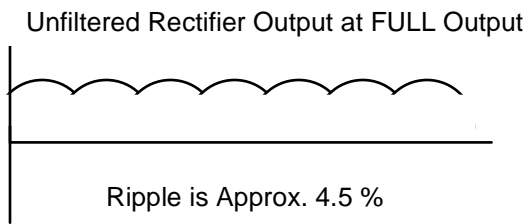
Filtering the output of a rectifier, will reduce the ripple throughout a common operating range of 25% to 100%.

5% ripple filter will reduce the output to 5% or less when operating as low as 25% of the DC rating.
1% ripple filter will reduce the output to 1% or less when operating as low as 25% of the DC rating.

Without filtering, an SCR rectifier can produce 40% ripple when operating at 50% output.



Waveforms for an Unfiltered Rectifier



Waveforms for a Rectifier with 5% L/C ripple filtering

