

## Use of 3.78 (227Hz) Reactors vs. 4.2 (252Hz) or 4.7 (282Hz) Reactors, Low Voltage

# Automatic Power Factor Correction Installed in a Harmonic Environment

## Key industries that benefit from Harmonic Mitigation Products

- Automotive
- Food/Beverage/Brewery
- Municipal Water and Wastewater Treatment
- Paper Processing/Printing/Publishing
- Petrochemical
- Pharmaceutical
- Rubber and Plastics
- Semiconductor Manufacturing
- Steel
- Textiles

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**STACO ENERGY**  
**PRODUCTS CO.**

Your tailored power solutions provider

### **PROBLEM:**

**Capacitors provide a low impedance path** that will absorb the higher 60Hz currents and voltages from harmonics. Inductance shared by capacitors can create parallel resonance, which will magnify existing currents and voltages which may damage the power factor correction and other power distribution equipment.

### **SOLUTION:**

The use of 3.78 (227Hz) reactors vs. 4.2 (252Hz) or 4.7 (282Hz) reactors, offer greater protection of power factor correction systems. The 5th order harmonic (300Hz) is commonly found in many power systems with harmonic content. De-tuned equipment (L-C circuit) typically allows proper operation of power factor correction equipment, with some filtering capability. Tuned equipment is more application engineered and is typically used for optimum harmonic mitigation (filtering), with little or no power factor correction. Both applications typically use iron-core reactors; however, the tuning point designs are much different. A lower tuning point “appears” capacitive and will more effectively support corrected power factor, controlling any potential adverse interactions (increase of harmonic amplification) of switched capacitors. In theory, when the tuning point is outside of the target harmonic order by 10% or higher, only limited filtering takes place—approximately 50% or less. When the tuning point is inside 10% or less of the target harmonic, the filtering is more effective, 60% or higher. A higher tuning point “appears” inductive and can minimize resonance; however, the tuning point here is critical as resonance may actually be induced.

Use of iron-core reactors, coordinated with capacitors de-tune the power factor correction equipment to a value under the predominant harmonic order, again most cases the 5th order (300Hz). Many apparatus focus on the 5th order and use a reactor designed at 4.7 (282Hz) or 4.2 (252Hz), which accomplishes a sufficient amount (plenty) of harmonic correction for that specific order. StacoVAR systems with reactors utilize a design sized at 3.78 (227Hz), for maximum equipment and power system protection. With the potential for overload conditions from harmonics in “real operating” conditions, the resonance curve can shift slightly upwards to a point where a dangerous condition, (amplification from the 5th order) may occur, off-setting any of the additional/avail-

able intended mitigation from reactors of other tuning points. Reactors designed to accomplish higher levels of mitigation, may then function as a resonance generator.

The linearity of the reactor and the tolerance of the capacitors are not parameters which are always fixed, regardless of the operating conditions.

Use of a 3.78 design assures a safe operating area, while still helping to filter a proportional amount of harmonics principally at the 5th order, with some filtering occurring at the 7<sup>th</sup>, 11<sup>th</sup> and 13<sup>th</sup> orders. Every operating environment is different, thus the amount of filtering will be different—the higher the current the higher the mitigation and potential for resonance for example. As previously indicated, the main purpose of the iron-core reactor in a de-tuned system is to minimize harmonic current magnification.

The StacoVAR reactor is designed for Class H standards (maximum total temperature 180 degrees C, maximum ambient temperature 40 degrees C). Delta T (difference between ambient and reactor temperatures) maximum is 120 degrees C. The difference between the maximum total temperature and the maximum ambient temperature (plus the Delta T) is a safety tolerance, which is 20 degrees. Reactor materials utilized in the StacoVAR apparatus allow operating temperatures to “run” cooler than Class H standards, with a lower Delta T. A lower Delta T, as above, is preferred when the reactor is operating in an overload condition, allowing the reactor to withstand large overloads with less inherent overheating. This will provide extended endurance and life while maintaining a high level of safety.

In addition, StacoVAR de-tuned equipment utilize 690Vac (480Vac system example) rated power factor correction capacitors for additional system integrity, coordinated with our iron-core reactors. Other providers of equipment may incorporate 525, 550 or 600Vac capacitors, which have a lesser tolerance for voltage and current stresses placed upon the capacitors during operating life, especially when considering a harmonic environment.