Background

In an effort to understand the potential benefit, we engaged in an effort in our lab last week to determine the potential kW, KVA, and Power Factor benefits that could be realized by implementing either a 3% or 5% reactor in front of your ASDs. Such chokes do have benefit in that they protect the drive from potential overvoltage faults from capacitor switching on the grid and they lower the harmonic content of the current feeding the drive. We want to better understand this, so we carefully conducted tests.

Test Setup:

We used a three-phase 1 HP ASD driving a 1 HP blower fan and established a base-line of kW, kVA, and power factor at full load without a reactor. In each case, we also ran the drive at various load levels by varying the speed in 15 Hz increments (15,30,45, and 60 Hz) and repeated the power measurements. We did the measurements using two separate calibrated meters to make sure our results were correct. In order to understand the potential I^2 * R savings in the conductoring, we utilized a 100 ft extension cord between the disconnect and the drive. The metering was done near the disconnect in order to fully understand any added benefit of reaping back the losses in the conductoring when we added the reactors in the circuit. Next, we utilized a 3% reactor installed in front of the drive and repeated the measurements. Finally, we repeated the work with a 5% reactor.

Base Line

An Example of the Base-Line measurements is shown in Figure 1 below for the 60Hz full load case. One can see the non-linear harmonic current in the lower left hand of the figure. The true power factor is 0.6081 and the drive requires 0.581kW, and 0.956kVA.

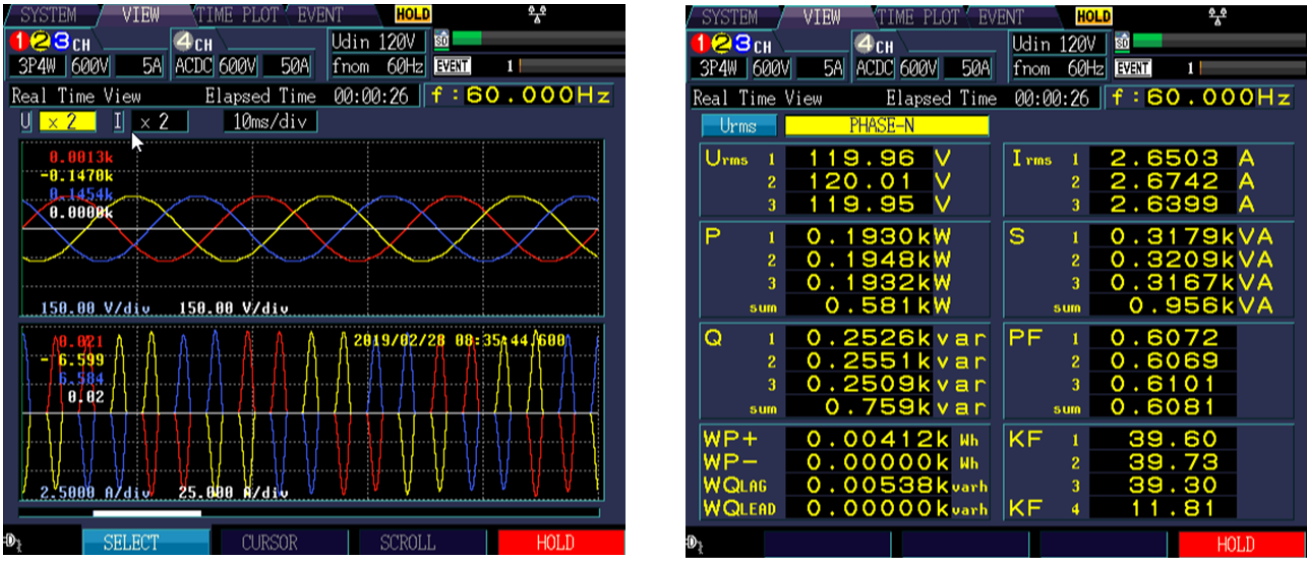

Figure 1. Base Line Testing at 60Hz

KVA Results:

As expected, the addition of the reactors lowered the harmonic content in the system. This is shown in Table 1 and Figure 2.

Table 1. % Apparent Power Savings (kVA)

Motor Speed (Hz)	No Reactor	3% Reactor	5% Reactor
15	0%	23%	32%
30	0%	23%	31%
45	0%	25%	33%
60	0%	27%	34%

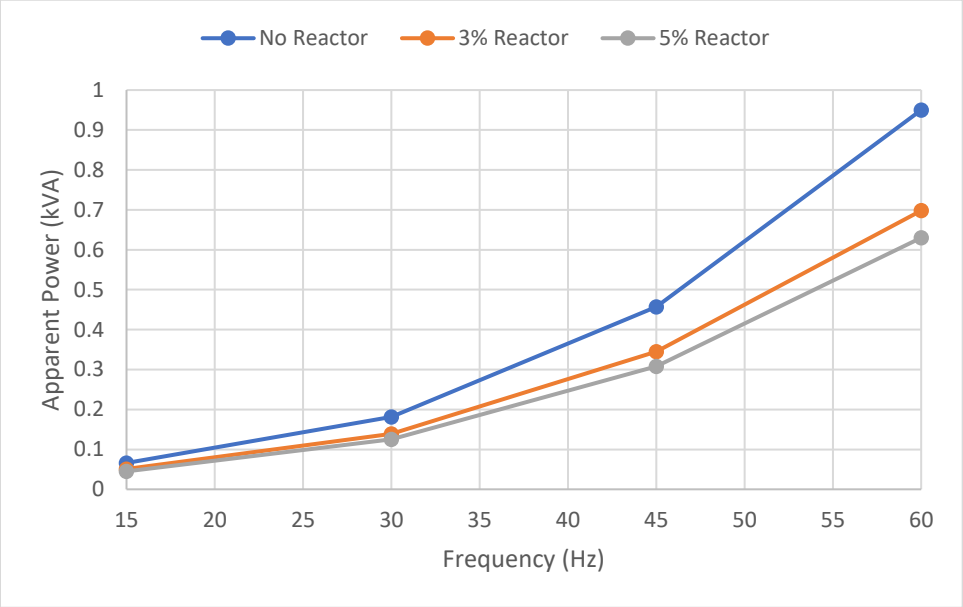

Figure 2. Apparent Power (kVA) Vs. Drive Speed

True Power Factor Results

As the kVA load was reduced for a given kW required to do work, the True Power Factor was also positively impacted. This is best understood graphically as shown in Figure 3. The most significant reduction was with the 5% choke at 60Hz speed.

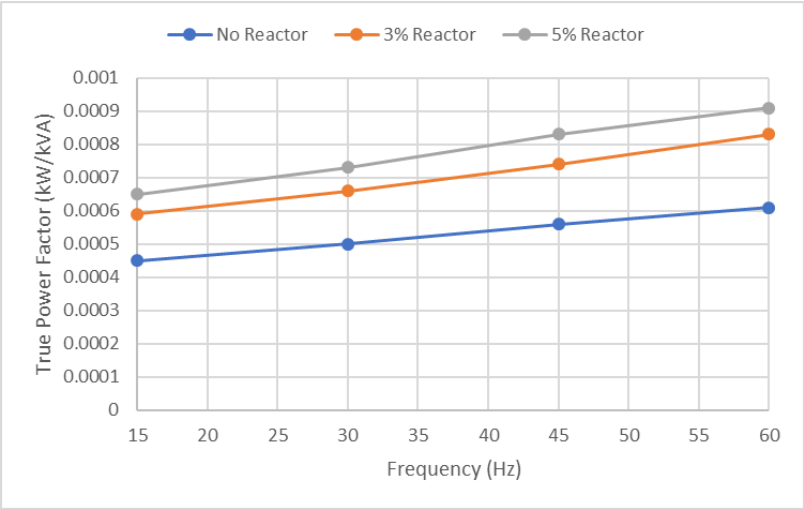

Figure 3. True Power Factor (kW/kVA) Vs. Drive Speed

Real Power Test Results

Both the kVA and the True Power Factor were positively impacted by the use of the reactors. However, as can be seen in Table 2 and Figure 4, the savings in kW were found to be extremely low. Furthermore, there were no savings or noted when the drive was operating at 30 or 45 Hz. As drives do not operate at full speed most of the time, the implementation of reactors at the drives to save kW does not seem to be significant.

Table 2. % Real Power Savings (kW)

Motor Speed (Hz)	No Reactor	3% Reactor	5% Reactor
15	0%	0%	3%[1]
30	0%	-1%	0%
45	0%	0%	0%
60	0%	-0.2%	0.9%[2]

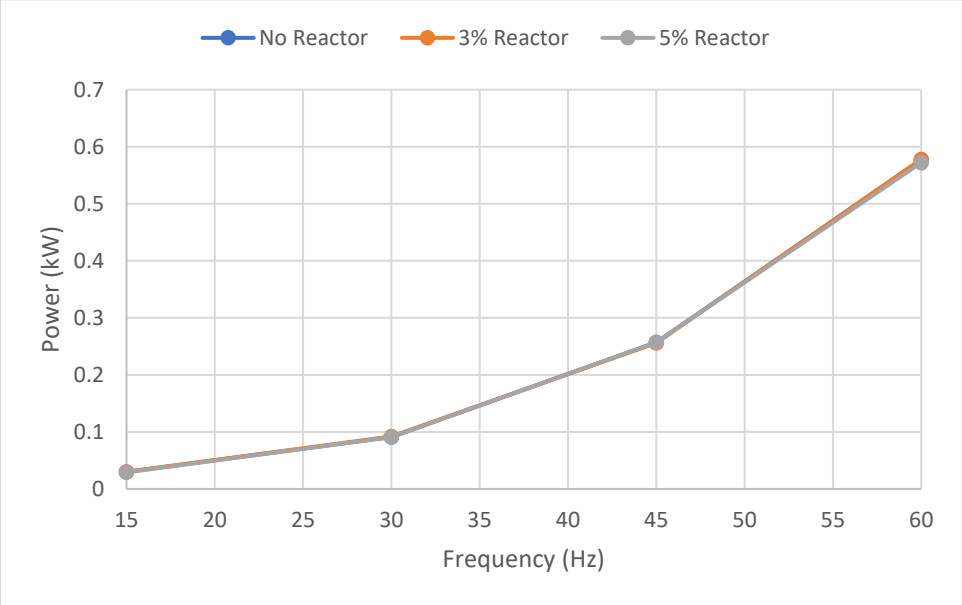

Figure 4. Real Power (kW) Vs. Drive Speed

[1] Note, although there was 3% energy savings at 15Hz for the 5 percent reactor, the actual amount of energy saved was only 1 watt per horsepower at this level. This may be within the error of the measurement equipment.

[2] For the 5 percent reactor 60Hz condition, only 0.9% or 6 watts were saved per horsepower. This is a very small amount.