Reducing compressor costs and improving reliability

Ion exchange acid adsorption and ultra-fine particle filtration

Compressed air is often referred to as the “fourth utility” and, like electricity, water and natural gas, is vital to most manufacturing facilities. The most prevalent type of air compressor used to produce this essential utility is the oil-lubricated rotary screw. These compressors are favored for their low capital cost yet are expensive to operate and maintain due to their high energy consumption, expensive replacement fluids and parts, and labor intensive maintenance and repairs.

Shaw Industries Inc., the world’s largest carpet manufacturer, is keenly aware of the high cost of producing compressed air and the importance of an efficient and reliable compressed air system. In one of Shaw’s fiber extrusion facilities located in Dalton, Ga., they operate and maintain more than 4,400 hp of high pressure oil-lubricated rotary screw compressors. Constantly searching for ways to lower operating costs and improve compressor reliability, Shaw implemented a new proactive maintenance practice made possible with an innovative oil purification device specifically designed for oil-lubricated rotary screw air compressors.

The Compressor Oil Purifier (COP) by Fluid Metrics, LLC, is a low cost bypass oil purification system that combines ion exchange acid adsorption with ultra-fine solids filtration to proactively remove catalytic contaminants that accelerate oil degradation, internal wear, corrosion, and fouling in these compressors. The COP installs easily onto any rotary screw air compressor in a bypass loop to the compressor’s main oil circuit to prevent acids and clearance-size solids from accumulating in the oil. By continuously removing these harmful contaminants, the COP controls fluid oxidation preserving its protective additives and significantly extending the service life of expensive synthetic compressor fluids. The COP also reduces air-oil separator fouling, its pressure drop/energy consumption, and replacement frequency.

Prior to implementation of this new proactive maintenance practice, Shaw followed the compressor manufacturer’s recommendations for preventative maintenance. This practice relied on the time-based replacement of expensive synthetic fluids, separators, and filters, not the actual service condition of these components. Preventative maintenance proved to be costly and labor intensive while ignoring the root causes of oil degradation, wear, corrosion, and fouling which are responsible for most compressor maintenance and repairs. Shaw realized that if they could proactively reduce the accumulation of harmful acidic and ultra-fine solid contaminants in their oil, they could improve compressor reliability; extend the service life of their fluids, separators, and air-ends; and drastically reduce their compressor operation and maintenance costs.

For their trial, Shaw engineers selected a compressor that operates 24 hours a day and is known for its high levels of contamination and reduced fluid service life (only 6,000 hours vs. 8,000 hours rated).

The subject compressor was last serviced with new OEM oil and separators in October 2003 and Shaw began the COP Proactive Maintenance trial in February 2004 with a baseline of 2,322 hours on these components.

During the trial, regular fluid samples were taken at least every 2,000 hours and sent off to an independent oil laboratory for analysis. Similarly, the Fluid Metrics' COP cartridges were replaced at approximately 2,000 hour intervals and the compressor's oil level was monitored and make-up oil added to maintain compressor fluid level as recommended by the compressor manufacturer. Finally, compressor operating conditions also were monitored with particular attention paid to separator pressure drop.

Per Dow Chemical, the manufacturer of the polyglycol based compressor fluid, the best indicator of the oil's remaining useful life and a leading indicator of the fluid's oxidative state is the its acid level or TAN (Total Acid Number). Dow recommends changing this fluid when the TAN value exceeds 1.0 mgKOH/g.

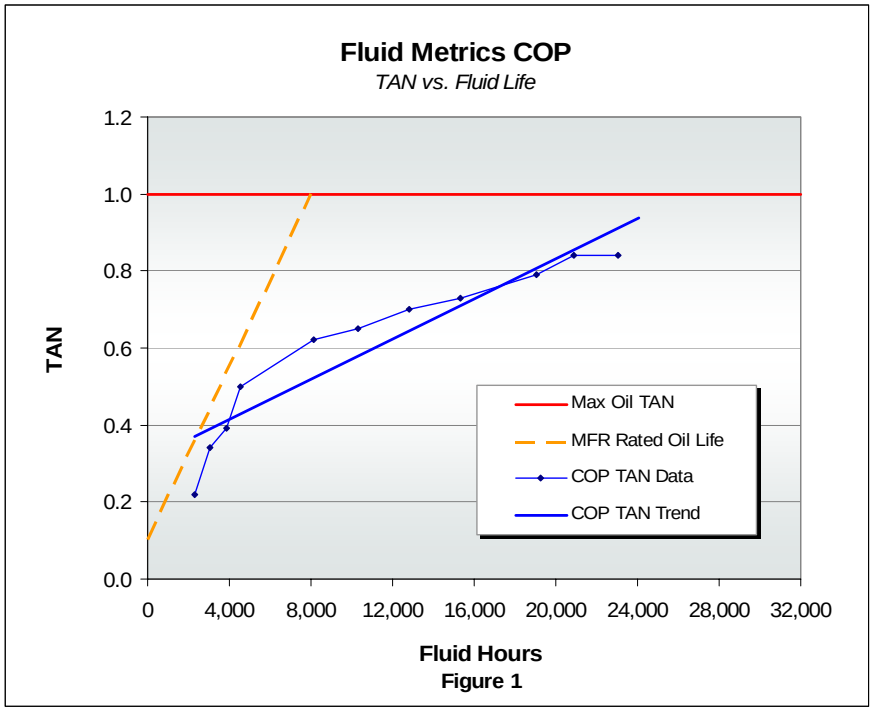

Figure 1

After more than 2-1/2 years of continuous service and evaluation, the trial produced dramatic results. With more than 24,000 hours service time on the oil, independent oil analysis confirmed that proactive oil maintenance with the Fluid Metrics' COP controlled fluid oxidation and maintained the oil's acid level below the manufacturer's recommended change point. A plot of the oil's TAN versus Operating Hours shows that fluid life of the compressor using the COP was increased by more than three times that of the manufacturer's rated oil life and by more than four times Shaw's previous experience with this compressor.

Field data collected relating to fouling rates and separator pressure drop also produced impressive results. At the time the COP was installed, the separator already had a pressure drop of 5.5 psig. Since installing the COP, and more than 18,000 hours of additional service time, the separator pressure drop only increased another 2.5 psig. Comparing these fouling rates to the normal 8,000 hour separator change interval, the COP produced a pressure drop that was approximately 6 psig lower, or 3% lower power consumption, than the projected pressure drop without the COP.

The COP's ability to reduce solids and thus minimize fouling and wear was also confirmed by the ISO Particle Counts performed as part of the oil analysis. ISO Particle Counts provide a measure of fluid cleanliness by counting the number of solid particles across a varying range of micron sizes. To evaluate the COP's performance at removing solids, a baseline oil sample was taken from the compressor prior to commissioning the COP along with a sample of brand new oil that was taken directly from its container. One week after the COP was put into service, a second oil sample was taken from the compressor and all three were analyzed for number of solids and particle size distribution. The results showed a 97% decrease in the most destructive clearance-sized particles less than 15 microns in size. Remarkably, after just one week the in-service oil had fewer solids than the brand new oil sample. The relationship between

bearing life and lubricant contamination particle size is well known. A study by a leading bearing manufacturer showed that reducing solids filtration from 25 microns absolute (standard OEM oil filter performance) down to 3 microns absolute (COP performance) can extend bearing life by a factor of four.

In summary, the results of the 2-1/2 year COP Proactive Maintenance trial conducted by Shaw Industries demonstrated:

- Compressor fluid life was extended by more than three times.
- Compressor separator life was extended by more than 2-1/2 times.
- Compressor energy consumption was reduced an estimated 3%.
- Maintenance and repair labor was significantly reduced.
- Compressor bearings and internals were better protected as a result of lower concentrations of corrosive acids and high wear solids.
- Oil handling and disposal costs were significantly reduced.
- Total O&M savings from reduced fluid and separator usage, energy consumption, and maintenance labor exceeded $2,200 per year yielding a 125% ROI and a payback of less than 10 months.

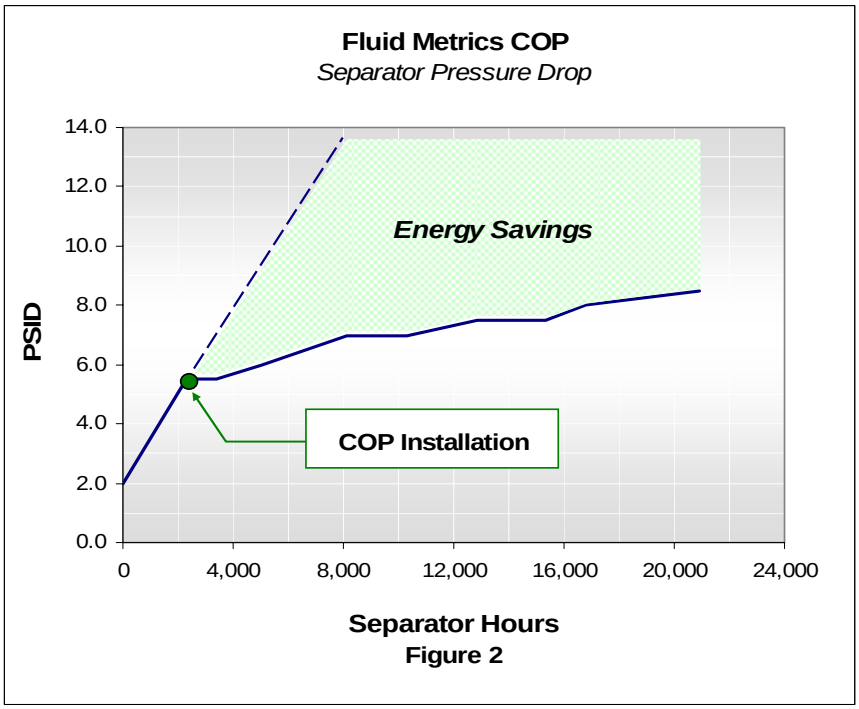

Figure 2

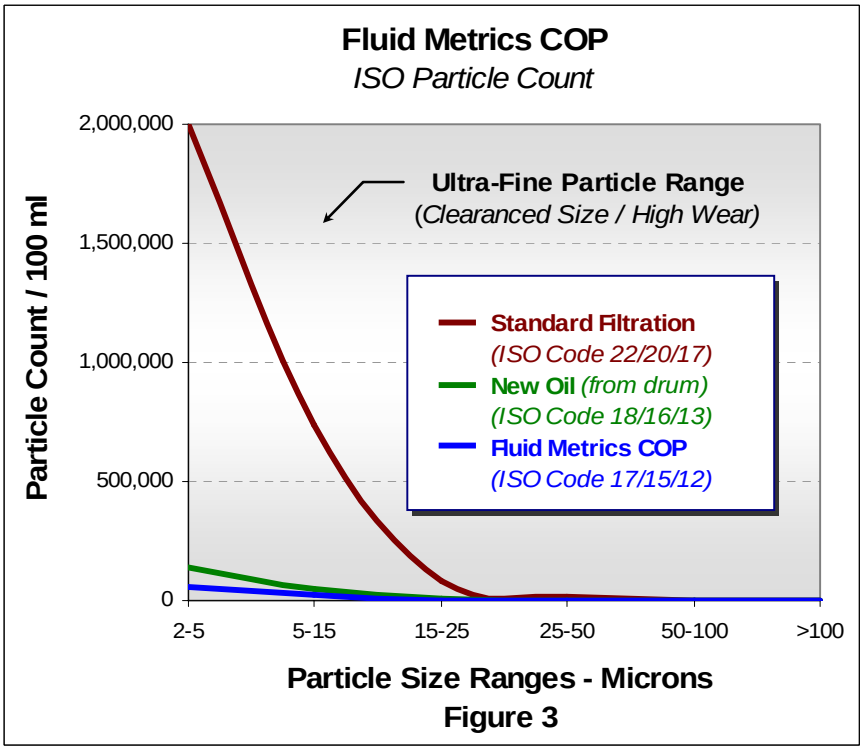

Figure 3

These successful findings led Shaw Industries to expand their Proactive Compressor Maintenance practice to ten other facilities using the Fluid Metrics COP. With an estimated 80 rotary screw compressors targeted, Shaw anticipates this practice will generate more than $120,000 per year savings to their bottom line. In conclusion, Shaw's findings demonstrated that Proactive Maintenance with the Fluid Metrics' COP is currently the best practice for rotary screw air compressor maintenance.