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"Fire in the powerhouse." "Explosion near the air compressor." These words have been and will be heard more often than many realize. This paper explores some aspects of this fearsome problem.

After selection of the compressor and its accessories and with normal operation of that compressor, lubrication and planned maintainence are the next most important factors in successful operation. Successful operation here means doing the job it is designed to do without unplanned downtime. Those who have seen excessively carbonized valves, pitted cylinders, red hot air lines, blocked intercoolers, clogged collectors, oil downstream in instruments and tools, fires and explosions know that just pushing the off-on switch is not enough to operate a compressor.

The compressor status in a company ranges from tender loving care to abject neglect. Some companies will put their compressors in a hidden dirty corner with no attention (until they break down or cause a fire) while other companies will provide a powerhouse that is roomy, well laid out, and kitchen clean. Some companies will put full-time engineers in charge of their compressors while some will make it a part-time low priority matter for a low-level maintainence man. Thus, there is no hard and fast way to approach the question of compressor maintainence and a most important factor of maintainence, i.e., lubrication.

Perhaps the best way to start is by asking: "Why lubricate a compressor?" You who have so-called no-lube compressors and are satisfied with the results (output, downtime, and maintainence problems) should be comewhat smug because you are lucky. We have seen these successful operations, but usually where the compressor is significantly larger than is appropriate, operated for flow capacity and in a friendly environment. No-lube is a great concept but in practice it will work only in few places where things are just right.

However, if you are like most, management won't approve oversize capital expenditures, we generally get to capacity sooner than we planned and we have an environment that is corrosive, wet, hot or dirty or maybe all of these. When metal rubs against metal in these environments, a lubricant is needed to minimize metal wear. It's just that simple, lubricants prevent wear. That is their purpose and their reason for being.

At present there are three broad classes of lubricants -- hydrocarbons, esters and silicones.

Hydrocarbons are the most widely used. They are cheap, effective in many applications, and widely available. But they like other materials have limitations. A fire requires three elements -- heat, fuel and oxygen. A compressor provides hot oxygen which is 2/3 of the requirement while the hydrocarbon provides the third component, i.e. fuel. Hydrocarbons are also unstable in the presence of oxidizing agents, that is, they chemically modify in the presence of hot oxygen. Thus, if a hydrocarbon oil has a flash point of 500°F when introduced into the compressor it might have a flash point of 350° F two weeks later and as low as 250° F in four to six weeks. Thus, a compressor which is safe on start-up at 350° F may be a potential pipe bomb some two to four weeks later.

Oil in a compressor can collect in static areas of the flow, usually traps or bends in pipes or collectors. When hydrocarbon oils collect this way they are continuously undergoing chemical change and continuously being most susceptible to fire or explosion.

Another fact is that oil going into a

compressor must come out. It comes out sometimes by leaks, but usually downstream. Since some compressors use as much as a gallon per day of oil and sometimes much more, this oil is either collecting downstream or is contaminating the compressed product, usually both.

We have seen compressors operate satisfactorily with hydrocarbon oils and when they work, stick with them. They are cheap. But, if there are any indications of problems, look to alternatives.

Phosphate esters are a combination of hydrocarbon and phosphoric acid. They do not burn at most temperatures seen in a compressor, they are 2-5 times as expensive as hydrocarbon oils, and if really pure phosphate esters in some applications do an excellent job. But they have one serious limitation; that is, in the presence of water they will hydrolyze to phosphoric acid. If there is water in the intake air stream (from the moisture in the air or other intake material) phosphoric acid or a derivative is usually formed. Phosphoric acid will chew up metal, such as cylinders, wipers, pistons, rings, valves and pipes. However, in a dry environment, and where downstream can stand these esters, they have proven satisfactory.

Silicones are the third broad class of compressor lubricants. Because of product history, silicones have received a bad reputation. These negatives include paintability, compatibility and price. Let's examine these one at a time.

Paintability: Some silicones are paintable, some are not. Unfortunately, those that are not are very bad actors, being anti-paint at very small concentrations. On the other hand, some silicones act just like hydrocarbon oil as far as paintability is concerned. Of course, it is these paintable silicones that have been selected for compressor lubricants.

Compatability: Some silicones are immiscible with hydrocarbon oils. Here again, proper selection of the particular silicones will provide a lubricant completely miscible with hydrocarbon oils.

Price: The first widely-used silicone lubricant for compressors was a fluorosilicone material selling at $300 per gallon. In some applications it was and is cost effective but these applications are few in number. However, with modern silicone materials having lubricity factors which are 10-50 times as high as hydrocarbon oils, prices which are only 3-20 times the price of hydrocarbons are directly cost effective without considering all the other factors such as safety, pollution, downtime, excessive maintainence and the like.

At this time it is appropriate to discuss the criteria for the selection of a lubricant for a compressor. The first and foremost criteria is: will the compressor run? Here the sole consideration is: does the proposed lubricant lubricate? While this question is so basic as to be sometimes overlooked, many materials go into a compressor intake and some of these will react with the lubricant in a manner such that the lubricant will not lubricate. But, let's assume that is not a problem. Then the next question is: Will the compressor run safely? This question needs more than cursory study. We have seen the results of compressor explosions -- walls blown out of buildings, ½ inch steel plate bent into 90° scrap iron, valves blown over 100 feet, roofs displaced, flanged pipe where before it was not flanged, and the like. Just one of these and a previously ignored compressor (and compressor manager) received more attention than they really wanted (before or after). Any lubricant for any compressor needs to accumulate within the compressor, leak out or come out with the product stream. And what comes out may not come out as it went in (remember the chemical change of hydrocarbons in a hot oxygen stream). This safety question can only be answered in each individual case depending upon the compressor, the temperature, the pressures, the intake gas stream, the route of the downstream product, materials of construction, and the volume and type of lubricant contemplated.

The next question is: Will the compressor run safely, and economically? The economics of compressor operation are overwhelmed by unplanned downtime. This is the single most important factor to be considered since an inappropriate unscheduled outage can cost thousands or maybe hundreds of thousands of dollars in production. Even without shutting down the plant, unscheduled downtime and the overtime or pulling people off other jobs can greatly outweigh the cost of the lubricant. Thus a risk factor must be included in the equation. Next to be considered is the cost and timing of a scheduled maintainence program. Are new valves required, does the intercooler need reaming, is there excessive carbonization, has there been acid attack, corrosion or erosion, and what is the expected life of the machine and allied equipment.

After all of these considerations comes the question regarding the specific lubricant and its cost. And the cost of the lubricant is quite minor compared to all of the above factors.

One solution to the above questions and problems is the Synthamics system of using very small quantities of an inert oil having a relatively high lubricity factor. The Synthamics oils have lubricity factors as high as 40 to 50 million square feet of swept area per pint of oil, compared to typical hydrocarbon oils having lubricity factors of 1-2 million square feet of swept area. Swept area here is calculated as being that area that the periphery of the piston travels. The calculation is straightforward, being the diameter of the piston times pi times the length of the stroke. When the number of strokes per unit of time is introduced then the swept area per unit of time can be readily calculated, and using the 40-50 million number the quantity of Synthamics lubricant per unit of time can be readily calculated.

Since a typical hydrocarbon oil is effective at rates of about 1 pint per million square feet of swept area, it can be readily seen that the quantity of Synthamics ES oils is greatly reduced when compared to hydrocarbon oils. While actual results are somewhat less than theoretical, primarily because of a "wash effect", that is the lubricant is washed out before it wears out, and because most of our clients are reluctant to go all the way down to the small quantities that are theoretically possible, we usually see reductions in oil useage from 80-95% over hydrocarbon oils.

When these small quantities are used 2-20 pints per month (½-2½ gallons/month) instead of 3-50 gallons/month on a particular compressor, the method of lubrication becomes very important. With a typical Manzell or McCord lubricator these very small quantities cause the lubricator to become erratic. Further, we have found it important that lubricant be added on at least 5 minute intervals. In view of these two parameters, Synthamics has devised two units to deliver the lubricant, one an adapter for the typical lubricator and the other a self-contained lubricator.

The self-contained lubricator is Synthamics Model 820 which has a reservoir, pump, filter, blow out assembly, divider lights, timer, divider blocks, fault lights and a fault alarm system. Up to 12 lubrication paints can be served with quantities as low as ½ pint per month, with each lube point being lubricated at least every 5 minutes. This unit sells for about $1300.

The adaptor unit is Synthamics Model 120 and essentially takes the output from one pump of a Manzell, McCord, Madison Kipp or other lubricator, divides the input into various streams through a divider block, delivers the proper amount of lubricant to each lube point and returns the remainder of the input to the reservoir. This unit sells for about $600.

Synthamics has two oils, ES-100 at $8.75/pint and ES-190 at $3.13/pint. ES-190 is useable in less severe conditions than is ES-100. These materials and equipment have shown outstanding results which will be demonstrated by the following vignettes.

Case I - At a waste treatment plant operating the Zimpro process, a PPC air compressor two stage (6" and 2½" diameter piston) operated at outputs of 400-450 psi and 370° F. When the valves carboned up such that they were carboned shut or open about every six weeks, the operator was upset and unhappy. But, when the output steel line glowed red from heat, the operator got scared. Oil useage was hydrocarbon oil at a rate of about 2 gallons per month. Synthamics was called in, recommended ES-100 oil, installed a 120 adaptor and reduced the oil useage to an ultimate of 3 pints per month of ES-100. Extensive cleaning of carbon from inside the compressor was noted during the first six weeks of operation, the output air was significantly cooler, the valves were slightly glazed (removable by a fingernail) and no downtime was needed until the normal scheduled maintainence 9 months later.

Case II - A local compressor service company reported that its toughest problem compressor was at a major spring fabricator in the midwest. These 100 horsepower Gardner Denver single stage double-acting compressors had seen several fires, excessive carbonization of the valves and intercoolers, and many unscheduled downtimes. Using 30 pints/month (3-3/4 gallons of hydrocarbon oil, and operated in a dirty environment, some of these downtimes had caused plant shut-downs. Upon installation of a Synthamics adaptor unit and ES-190 the oil useage was reduced to 4 pints/month, and no downtime has been recorded.

Case III - At a major automobile manufacturer in the midwest, a serious explosion and fire caused the powerhouse manager to call in Synthamics. It was determined that their Ingersoll Rand 2 stage (30 inches and 18 inches diameter) 22-inch stroke was using about 160 pints (20 gallons) per month of hydrocarbon oil. Annual maintainence required replacement of the valves because of excessive carbonization. Upon installation of a Synthamics 120 adapter and ES-100 oil, the rate of lubrication useage was reduced to 15 pints per month. Valves were clean and maintainence program returned to a one-year schedule.

Compressor lubrication and operation are not simple, but with adequate investigation and evaluation can be made effective, safe and relatively inexpensive. Synthamics would be pleased to answer your questions.