frontline focus

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Lubrication Basics – The 5 R's

By Mike Johnson, Sr. Technical Consultant, Noria Corporation

A properly designed machine relubrication program may be the single most important factor leading to sustained machine reliability. Reliability is, of course, a critical factor in efficient, high quality production. This has been confirmed at several organizations pursuing incremental maintenance cost reductions that have rearranged job roles. This job rearrangement effectively eliminated machinery lubrication as a clearly defined job responsibility.

Sometimes it's the right decision to shift this key role from maintenance to production personnel. However I find it difficult to imagine a situation where it makes sense to quit doing planned relubrication. Fortunately, this decision is less common as the process industry shifts toward an operational focus to manage machine reliability.

What is common, however, is the sense that 'oil's oil and grease's grease'—and it doesn't matter what happens with lubrication based machine care. This orientation is less damaging to long term reliability than no program at all, but that's not saying much. Most operations settle for poor performance from their dollar's investment in lubricants, filters, lubricant analysis and the labor for their programs without even knowing this to be the case.

The Lost Art

It's not difficult to imagine how this condition exists. The old timers used to say that effective machinery lubrication was part art form and part science. That's right—to a degree. When you begin to study the science of lubrication you discover a complex field full of mechanics, physics, organic chemistry, and operations science. Consider the advanced complexities surrounding surface interaction and surface protection (the science of 'Tribology'). When you look at the current state of most machine lubrication programs it becomes obvious there's ample room for improvement from a rediscovery of the 'lost art'.

- **Lubrication:** Lubrication is the science of friction reduction by the application of a material to improve the smoothness of movement of one surface over another.
- **Tribology:** Tribology is the science and technology concerned with interacting surfaces in relative motion, including friction, lubrication, wear, and erosion. (ASTM G-2)

In This Issue

Grinding into Dust

Several microscopic factors influence the ultimate success achieved from the machine relubrication activity. In fact, the real battle to protect machine surfaces, and ultimately company survival, occurs at the point where two surfaces intersect. As **Figure 1** suggests, machine surfaces are rough. When the surface peaks collide the peaks rip and tear, generating wear debris. The destructive influences are invisible to us without the help of a powerful microscope. As such, the machines may be grinding themselves to dust with each passing day UNLESS special care is given to the act of machine relubrication. We cannot see, hear or feel the effect while it is occurring, but we can see the consequences: lubricated component replacement.

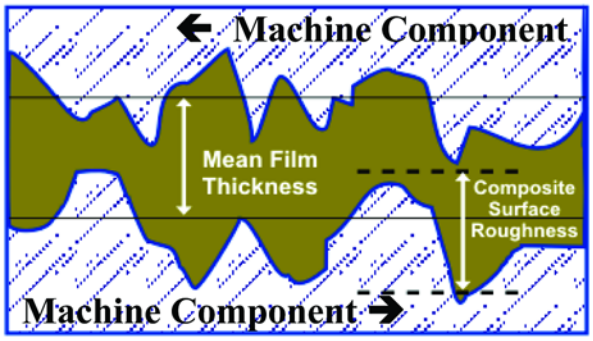

Figure 1.

Fortunately, given that the destructive forces are microscopic, just a little bit of forward progress goes a long, long way toward improvement in machine life. Literally, help can be right around the corner.

As machine surfaces come together a properly selected and properly cleaned lubricant forms a barrier film that coats the surfaces. When the film is squeezed by the intense machine loads the film becomes very dense (thick). If an operator or mechanic could take the lubricant out and handle it at this moment of extreme pressure the lubricant would seem nearly, if not completely solid. Once the pressure is removed the lubricant goes back to its original consistency. This phenomenon enables us to operate machines supporting many thousands of pounds of load, and to do so without destroying the interacting machines surfaces. That is, if the lubricant conditions are right.

The 5 R's of Machinery Lubrication

Some bristle at the notion that there is a 'right way' to lubricate a machine. Those of the 'oil's oil and grease's grease' group may especially have some difficulty because it just might mean that they've been doing it wrong for many years. There are in fact five 'rights' to consider!

Right Product: If you don't find the right product for an application then failure will eventually occur. As I said earlier, a lubricant film gets very dense (thick) as the pressure increases, right up to a point where it appears nearly solid. The unit pressures that create this effect are common to rolling contact components, such as element bearings and gears. Lubrication engi-

Lubrication Basics (cont.)

neers know that machines designed for high loads require thicker oil films before the pressure begins to mount. Unfortunately, as the machine works the lubricant, the oil begins to heat, and the oil also begins to thin. As a result, the warm, low viscosity lubricant will flow out of the contact space more easily. It is often at a very low viscosity (thickness) right at the point when the heavy loads require a higher viscosity lubricant to be effective. As you can see, it's not easy to select a lubricant at a given viscosity at room temperature that will also be the right viscosity at the machine's normal operating temperature.

Additionally, as lubricant viscosity ages it changes chemically. The rate of chemical change depends on a lot of things, including moisture concentration, wear debris (iron and copper), heat and air in the lubricant. When these 'contaminants' increase, the rate of chemical change increases and lubricant lifecycle decreases. If all these contaminants increase at the same time the lubricant degrades quickly. Additives are used to compensate for expected chemical change, but eventually the additives are consumed and the oil sours. Also, some additives have very special surface protection responsibilities. Once these particular additives are degraded or consumed the machine surfaces are at great risk of increased wear, regardless of the thickness of the oil at machine operating temperature.

When you look at the total system requirement for a set of lubricated components, and consider all of the complex interactions, it's easy to see why product selection requires special attention.

Right Amount: There's only a certain amount of space between interacting machine components. When the volume of lubricant is greater than the space between the machine surfaces—particularly if the lubricant is thick, as is the case with greases—the lubricant churns. This tends to generate high temperatures, which degrade the lubricant.

Right Time: Timely reapplication assures a constant, slight feed of lubricant to the machine load point. If the oil volume ever decreases to the point where there isn't enough oil to fill the gap between the surfaces—those surfaces begin to grind and wear. Lubricants must be replenished just often enough to supply the necessary amount, but not so often that excess lubricant accumulates at moving surfaces (see churning above).

Right Place: The OEM machine designer determines where the lubricant goes. In a few applications, such as the relubrication of open gears, the lubrication technician may have some influence. If the lubricant is supplied to the wrong location near the meshing machine components and the lubricant film is allowed to escape, the machine surfaces will collide. Most machine builders define the number and location of lubricated components that require attention in the machinery maintenance manual. Only a careful review of both the machine and manual will ensure that all the appropriate points have been identified.

Right Attitude: Once the correct product is selected, and the correct volume and frequency are calculated, and the location is established and tagged, and all of these details are plugged into a scheduling program—all that remains is the careful and consistent execution of the required activities. Not everyone is right for this job. An effective lubrication technician is self motivated to work the job until it's completely and properly done. This expert is driven by a thirst for knowledge, which leads to continuous study of the art and science of the field. As a result the technician brings an attitude of precision and excellence to work on a day to day basis.

The 5 R's of Lubrication

- Right Product
- Right Amount
- Right Time
- Right Place
- Right Attitude

What Else?

Lubricant contamination control and lubricant analysis are major fields of study by themselves, which I'll talk more about in future issues. Together, they give us a huge opportunity to improve machine dependability and reliability. Open the door to opportunity—it's free and rewarding! Check out www.machinerylubrication.com. **FF**

Mike Johnson is a Certified Maintenance and Reliability Professional (CMRP), is the Senior Technical Editor for Machinery Lubrication and Practicing Oil Analysis magazines, and is a Senior Technical Consultant for Noria Reliability Solutions.

Live Free or Die

Gene Canavan

We've been on the road again, this time for pleasure to see old friends and family in the Northeast. Do you know the State motto for New Hampshire? It's "Live Free or Die" and they mean it. It's on their auto license plate. Motorcyclists don't have to wear helmets in New Hampshire. I asked our friends why. They said, "Live Free or Die." Being a past motorcycle rider, I thought about the head injury chances without a helmet. I believe I'd wear one with or without a law requiring it.

On the job or at home safety is a lot like that—doing the right thing with or without rules. Much depends on us individually staying alert and making sound and safe decisions each minute of the day. I don't want to get morbid on you, but every single accidental serious injury or death I've been close to involved a momentary lapse of attention and poor judgement. Years of safe work habits were wiped out in a blink of the eye with devastating results—limbs lost, lives broken, or death.

This is why it is so important to think about safety every day, why we find safety reminders everywhere, particularly in the workplace, and why we have taken safety as an important topic in this magazine. Safety cannot be taken for granted, left to someone else to worry about, or forgotten. Safety must be an intensely personal subject to each of us—to you.

I want to know what you do to keep safety an important aspect of your life, on and off the job. Tell me so we can share it in these pages.

TROUBLESHOOTING 101 – Part 4

By William F. Hauserman, Principal Consultant, Application Solutions Group

Congratulations! You found the cause of that #%$&@ problem with the [motor / pump / valve / shower / line / Other: _____]. Now it's time to clean up your tools and equipment, put away supplies and materials, grab a cup of coffee, sit down and read the latest edition of *Field & Str…* uh *Frontline Focus*, right? Well, yes and no.

Now, don't put down *Frontline Focus* just yet. Keep reading and learn how good troubleshooters '**Think Beyond the Fix.**' They know the job isn't completely done just because the problem is fixed.

Extend the Most Likely Cause

Experienced troubleshooters know a deliberately installed fix for one problem could easily cause a second or third problem. When you are implementing a fix you are introducing a change into the machine, equipment, process or system—and we all know what change does! Even something as simple as removing a worn part and replacing it with the same new part is a change. Well intentioned change sometimes solves one problem, but creates unintended consequences elsewhere.

Before implementing a problem fix, it pays to stop and think for a minute about any future problems the fix itself might create. Where else and on what other equipment might you expect to see the same problem?

Ask yourself these preventive maintenance questions to 'Extend the Most Likely Cause of the Problem':

- **What new problems could this fix cause?** Could the excessive vibration caused by the damaged shaft we replaced on the pump cause other problems? Maybe loosened intake or outflow lines or damage to the mounting bolts?
- **Who will be affected by this fix?** Which individuals, functions, other departments, customers, etc. will we need to inform?
- **What can we do to prevent this problem from occurring again?** For example, do we need more frequent inspections or vibration monitoring?

Extend the Fix

Now let's look a bit further. Well-considered problem fixes should be applied elsewhere in the organization, on other pieces of equipment, machines or processes and with other customers to gain the maximum benefit. Your mill or plant has duplicate equipment, components and similar electrical and electronic configurations that can benefit by having the fix for one problem installed in other areas as a preventive maintenance tactic before a failure.

"Hold on a minute!" you say, "What about '*if it ain't broke, don't fix it*?'" Good point. After all, that's what torque wrenches are for, to keep you from ratcheting down too hard. Likewise for statistical process control—if the process is in control, don't fool with it! If it ain't broke, don't fix it!

We aren't suggesting you deliberately make changes which could cause problems (and additional work for you). Instead, we want you to think about preventing problems and saving time and effort.

Stop to think for another minute and ask these questions to 'Extend the Fix of the Problem':

- **Are there similar pieces of equipment that might have the same defect and need the same fix?** If you have three other pumps of the same manufacture at the same rating, it pays to take a look at them as well to see if they might be experiencing the same problem.
- **Could this problem fix be applied elsewhere?** Perhaps to dissimilar equipment, products, machines, processes or customers? For example, look at other pumps of different manufacture, even if a different rating but performing the same or similar functions. These are good targets of opportunity to extend your troubleshooting thinking.

Preventing fires is cheaper, safer and a whole lot easier than fighting fires, we know that. Practicing **Think Beyond the Fix** is just another way to enhance your preventive maintenance actions. (Remember cheaper, safer and a lot easier?) And while solving problems is your job and can bring a high degree of job satisfaction, the job satisfaction of knowing problems never happened because of your actions can be even greater!

You'll find an even more gratifying level of achievement and find more time for coffee and reading (… *Frontline Focus*, naturally). Try a little Think Beyond the Fix; we guarantee you'll like it! **FF**

For more information visit www.asgops.com.

Gene says:

Summer is in full-blast, and we need your summer vaction stories! Send us a story and a couple of photos and you could be the winner of a $200 gift certificate.

Downtime

Stay Fit After 50

by Steve Moore, Wausau Paper

A Baby Boomer turns 50 years old every 7 seconds. That's 4.5 million every year! I recently turned 53. Like most of you, my body has changed with the years—mainly, it wanted to add pounds. Pounds that I don't need!

I have been active in athletics all my life. About four years ago I discovered bodybuilding. The sport of bodybuilding has taught me a great deal about nutrition which I wish I had known many years ago. You see, I always battled to keep my weight down. As I got older, this struggle became harder and harder to win.

Earlier this year, I was fortunate enough to win the Masters Division (age 50+) of the 2005 NPC Wisconsin State Bodybuilding Championships. While getting into the gym and lifting weights is important, any bodybuilder will tell you that proper nutrition is 60-70% responsible for getting into condition to step on-stage in skimpy posing trunks. The average bodybuilder is less than 5% body fat while the average male is 18+% and the average female is 24+%.

Obviously, a bodybuilder has to know a thing or two about burning fat, and the best weapon in this battle is proper nutrition. Notice that I don't use the word 'diet'. When people hear 'diet' they think of reducing calories and being hungry most of the time. Diets have a beginning and an end—but proper nutrition is a lifelong process.

You don't have to be a bodybuilder or any other type of athlete to see dramatic changes in your health, appearance, energy level, and happiness. Just follow some basic principles:

- **Eat 5 or 6 smaller meals per day.** The key is to keep your metabolism stoked like a fire in a wood stove. If you restrict your calorie intake to lose weight, your metabolism will slow down and your body will attempt to store body fat. This is a natural defense mechanism from our prehistoric origins to protect us from starvation. Eventually, you will lose weight, but about 1/3 of the weight loss will be lean tissue, not fat. When the 'diet' ends you will most likely regain most or all the weight lost in the form of fat.
- **Each meal should be 50-60% protein, 25-30% carbohydrates, and 10-15% fat.** Your protein should mostly come from lean meats such as fish, chicken/turkey breasts, lean beef, and egg whites. You should be very careful to restrict carbohydrates to the low-glycemic type such as oatmeal, green vegetables (green beans, broccoli, asparagus, etc.), brown rice, and some fruits (grapefruit, apples). High-glycemic carbs burn quickly and are converted into fat. The good types of fat to eat are found in salmon and other fish, almonds, and flax seed.
- **Stay away from refined foods**, especially refined sugars and refined wheat products (white bread, noodles, pasta, crackers, white rice, etc.). These foods cause your insulin levels to rise and high insulin levels cause your body to store fat. The idea is to keep your blood insulin low and steady to keep your metabolism revved up.
- **Drink lots of fluids each day** (but not milk or alcohol). Water flushes the system of waste products and speeds up the fat burning process. Drinking a lot of water will not cause water retention (but you'll probably spend more time in the bathroom). You know you are drinking enough fluids when your urine is almost colorless.
- Forget the bathroom scales, forget 'dieting', forget Atkins. Instead, **focus on proper nutrition** and judge your progress by your appearance in the mirror and how you feel. Eventually, you will learn to adjust your nutritional habits by what you see in the mirror. You will look and feel better—I guarantee it!

My Typical Daily Menu

OK, this is a lot of food - but I weight train five days a week and play racquetball twice a week. You may need to eat smaller amounts, especially if you're a female.

Breakfast:	6 scrambled eggs (egg whites plus one yolk) 6-8 ounces chicken breast or other lean meat ½ cup oatmeal prepared in 1 ½ cups water
Mid-AM:	2 hard boiled eggs (whites only) 1 cup veggies 4-6 ounces lean meat
Lunch:	8-10 ounces lean meat 2 cups veggies One apple or grapefruit
Mid-PM:	Same as Mid-AM
Dinner:	Same as Lunch or Breakfast
Evening:	Fruit and ½ cup oatmeal

PLUS: I drink at least 1.5 gallons of fluids a day, mostly Sam's Choice® flavored water from Wal-Mart®. It's caffeine free, calorie free, and sodium free, but tastes great.

For more information on nutrition and bodybuilding, email me at gandydancerz@hotmail.com.