producingresults

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Keep Your COOL

Improve performance without overheating

Everybody pushes their equipment. Every production manager wants more: faster production, higher speeds, heavier gauge, higher strengths. You know the mantra: Give me more! This is usually accompanied by very specific budget information: We won't give you more!

A typical question is, How do I size a heat exchanger to reduce the mill gearbox oil temperature? Although this is a specific question, it's part of a more general strategy: getting more work out of existing equipment. Implementing this strategy means that much of the equipment will run hotter than it did before. You can't do much about management's insistence to get more out without putting more in, but you can develop a plan so you—and the equipment—don't have to take so much heat.

Too Hot to Handle

The No. 1 enemy of machine components such as gearboxes, hydraulic pumps, and valves is heat. When we work out we want to feel the burn. This builds muscles. In your mill gearboxes or hydraulic system, excess heat causes lubricants to thin and lose their lubricity, which causes seals, bearings, and gears to burn up. Can you hold your hand on the gearbox, hydraulic valve, hydraulic reservoir, or motor comfortably? If you can't, take action!

Tips for Battling Heat. Several tactics can help you keep heat under control.

1. Every tube mill has numerous heat exchangers–that is, surfaces that dissipate heat. Clean them. This means mill bases, gearboxes (especially cooling fins), hydraulic tanks, piping, valve body manifolds, electric motor air inlets and outlets, and electrical cabinets. Hydraulic tanks should be off the floor so air can circulate around all sides and the bottom. Get rid of the buildup of scale, dirt, dust, oil, grease, and filth. These surfaces should be so clean you can see your reflection on them. Comb condenser fins to restore air passages, and flush them with the proper solvents to eliminate oil and dirt coatings. Replace air filters on electric motors and cabinets, and maintain ductwork so cooling air goes where it is supposed to go.

It sounds simple, and it is, but it's an important first step. In fact, some tube production facilities have suddenly been restored to cool and efficient production after initiating good housekeeping habits.

2. Clean every heat exchanger's internal passages. Heat exchangers can become clogged with sediment or lime deposits if the cooling water is not properly maintained. Use a cleaning rod to clean tube units or disassemble plate-and-fin units to get rid of the buildup so flow is restored and heat can be absorbed and transferred. Sediment and lime are insulators; they don't transfer heat well.

3. If you have oil-to-air heat exchangers, add cooling fans to increase heat exchange efficiency.

4. Switch to higher-temperature-tolerant lubricants.

5. Increase the ΔT (difference in temperature between two conditions) of the working fluid versus the cooling fluid (whether its air or liquid) to extract the maximum amount of heat. Consider alternatives to the typical cooling tower, especially if your facility is in an extremely hot or humid climate. Refrigerated cooling can produce 40-degree-F chilled water rather than the ambient-temperature water that a cooling tower provides, which can be 90 degrees F or higher.

6. Try to maintain the turbulent flow of the cooling stream over the hot surface to maximize heat rejection. Laminar flow (smooth, continuous airflow) creates boundary layers that slow heat transfer.

7. Add heat exchanger capacity to handle the heat load.

Strategies That Can Backfire. Some seemingly logical approaches can actually cause a greater heat buildup.

Be careful not to increase the flow of work or cooling fluids to the heat exchanger to the point of diminishing return. Opening the water flow valves all the way to increase coolant flow actually may reduce the amount of cooling. Imagine walking slowly past an air conditioner on a hot day, or racing past it. If you race past it, you won't cool down much. It's the same with coolant flow in a heat exchanger. To get the best performance from a heat exchanger, you need to know the flow rate of the work fluids and cooling fluids and their change in temperature after passing through the heat exchanger.

Every fluid, whether it's water or oil, and air, should be monitored by a flowmeter and temperature probes to measure the transfer rates. Oil should enter the heat exchanger at less than 160 degrees F and exit the heat exchanger at or below 140 degrees F. This achieves a minimum 20-degree Δ T (change in temperature).

For tube-type heat exchangers, the water flow should be about one-half that of the oil and not hotter than 90 degrees F at entry. Flow rates for oil and water should be between 2 and 5 feet per second. The ideal balance extracts the maximum heat with the lowest water flow rate. It costs money to pump and treat the water, so a lower flow rate is better than a higher one for overall plant efficiency.

Sizing the Heat Exchanger

OK, you tried everything mentioned previously but the gearbox temperature is still pushing 200 degree F or more. What do you do? For this example, we will consider the sizing section of the mill as the candidate for additional cooling. Our example has four sizing passes.

1. Measure the air temperature in the room far enough away from the mill so that the gearbox temperatures do not affect the reading. Let's use 75 degrees F for the air temperature.

2. Measure the average temperature of the gearboxes. We'll say it's 205 degrees F.

3. Estimate the surface area of a single gearbox in square feet. For this example, it is 7.47 sq. ft. per gearbox.

4. Calculate the heat radiating from the gearbox reducer in British thermal units (BTU) per hour. The technical term for this is the *current radiant load*. Use this formula:

BTU per hour = 2.545 × Area × TD (temperature difference between the air and the gearbox)

Therefore,

BTU per hour = 2.545 × 7.47 × (205 – 75) = 2,471 BTU per hour per gearbox.

5. Do the same calculation for the desired operating temperature for the gearbox. Let's use 120 degrees F. The desired radiant load at this temperature would be

2.545 × 7.47 × (120 – 75) = 855.5 BTU per hour per gearbox

6. The difference between the current radiant load and the desired load is therefore 2,471 BTU per hour minus 855 BTU per hour = 1,616 BTU per hour. This is the heat load per gearbox the new heat exchanger must absorb to reduce the overall operating temperature to 120 degrees F. The total heat exchange for the four gearboxes is 6,464 BTU per hour.

7. To convert BTU per hour to horsepower, divide the quantity of BTUs by 2,545. For our example, this is 1,616 divided by 2,545 = 0.63 horsepower per gearbox, or 2.5 horsepower in total.

Some Like It Hot

This example is a simplification of the overall problem in that it assumes that all will be well when the gearboxes are operating at the desired 120 degrees F. The reduction in temperature will extend the bearing and gear life, but this doesn't eliminate the cause of the extra heat in the first place, which is the mechanical overloading of the system. Like the weakest link in a chain, eventually some component—a bearing, gear, valve, pump, or motor—will succumb to the heat and fail. Eliminating the extra heat only extends the components' useful lifetimes.

But that's the nature of the tube producing industry. It's competitive, and tube mills have to run fast—and hot—to remain viable.

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