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What's Inside?

Front cover photo:

Photo: Yolanda Lie/ Wiki Commons

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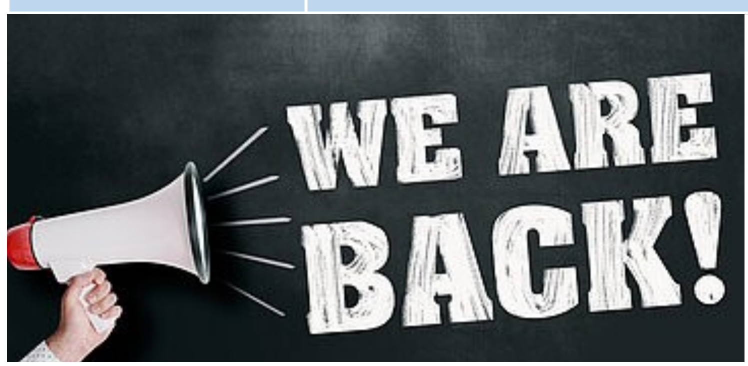

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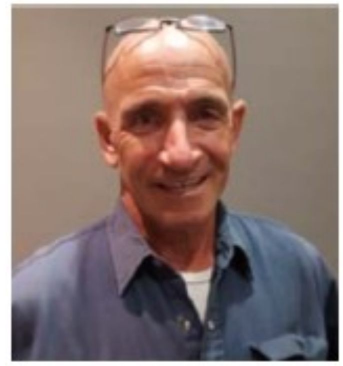
President's Message



I hope this message finds you and yours well and in good health

The winter has passed, and it is time to look at preparing the envelope of the buildings for the spring and summer. After the winter's thaw, a flat roof can retain excessive ponding water due to snow loads. Ponding water for short durations is unavoidable and considered acceptable but ponding water more than 48 hours can be detrimental to the roof assembly; anything impeding the flow of water to your roof's drain system could lead to irreversible damage. Water infiltration from poor old damaged flashing needs immediate attention or sub roof damages can be costly. Call up your local roofing company and have them come to do an inspection of areas that are questionable. The company can also assist in preparing a budget.

While the evenings are still cool it is also a good idea to perform a thermoscan of the roof as well the outside of the envelope of the building. The scan will highlight anomalies that are not easily seen with our eyes. The losses of energy from these areas can be costly to the operating budget. Thermoscans don't need to be done annually but regular inspections should be scheduled. Catching problems early and repairs or remediation of issues is effective property management. I have seen great inspection lists put out by insurance companies. Please contact your rep and I am sure they can provide one. Another good source is your favored envelope engineers. Contractors and service providers are experts in their field of endeavour; they are also a great source of information as they regularly see problems and can comment on your building.

Energy is costly and we need to be effective in its use. Losses from a faulty envelope is sometimes blatant but sometimes it is sneaky; slowly draining from the operating budget.

The Building Operators Association is now holding in-person meetings again at the Danish Canadian Club. We hold them every second Tuesday of the month from September to June, (summer break during July August). I believe we bring value to our industry. But we are struggling and need your assistance. We are for the most part a volunteer association. Please support us by paying your membership as well advertising in the Magazine. Thank you and blessings for the rest of your day.

Kind regards,

Smiles))

With kind regards,

Les Anderson PE, RPA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TEST YOUR OPERATOR IQ!

Are you equally adept at troubleshooting problems in the boardroom and the boiler room? As the resident facility guru, there's a lot riding on whether or not you know the difference between sounds control and a sound investment.

Try our monthly Operator IQ challenge...*answers on page 24*

1. Air venting is required:

a. to assure adequate water distribution in supply and return lines
b. to assure adequate air distribution in supply lines
c. to assure adequate air distribution in return lines
d. to maintain face velocity
e. all of the above

2. Double serpentine water coil circuiting is used:

a. where the water velocity in the tubes is less than 0.3 m/s
b. where the water velocity in the tubes is more than 2.4 m/s
c. for any water velocity in the tubes
d. where the water velocity in the tubes is between 0.3 and 2.4 m/s
e. in applications requiring low water velocities and low water pressure drops

3. Fin spacing of 6.35 to 1.814 mm is most normally used in which of the following cases?

a. direct expansion coils for low temperature applications
b. steam and hot water heating coils
c. chilled water cooling coils
d. cooling refrigerant coils
e. refrigerant condenser coils

4. Fin surface area is called:

a. primary surface area
b. secondary surface area
c. tube surface area
d. heater surface area
e. none of the above

5. Finned tube coils in air handling systems are often called:

a. fish coils
b. bare tube coils
c. extended surface coils
d. cooling coils
e. heating coils

How Grease Kills

by Jim Fitch

What's life like inside a rolling element bearing? Let's say you are a dollop of grease and you've just been pushed by a grease gun into the dark recesses of a bearing cavity. You are now in a combat zone. What are your orders? Maybe you are on a suicide mission. Your bearing has been screaming for reinforcements and you are it - the new recruit - all gooey and slimy.

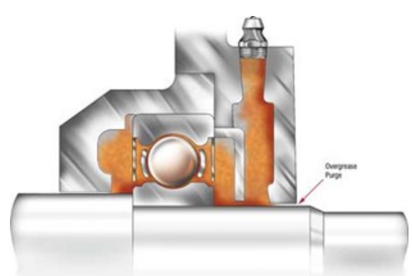
Inside you see grease casualties all around. There's the stench of oil oxidation on one side and the stiff lifeless remains of a soap-based thickener on the other. In an instant, the floor and walls begin to vibrate, then you hear a low rumbling sound. You are pushed deeper into the bearing cavity and suddenly you can't move - the heat and the pressure are excruciating. Then more pressure … crack … silence.

What just happened? How could regreasing a bearing have contributed to sudden-death failure? Doesn't fresh grease prolong bearing life and restore reliability? Not so fast. The problem here is new grease entering an old, infrequently lubricated (and overly lubricated) bearing. As the new grease enters, it must make room, and in doing so, it pushes around the crusty remnants of grease past.

Before the new grease arrived, the soap-based thickener from several earlier relubes is often packed against the inlet port and along the grease cavity walls - adjacent to the bearing's moving elements. The oil from the thickener bled out slowly over time. Some of this oil entered the bearing race providing needed time-released lubrication.

The principal contributors to a hard, crusty build-up in the bearing cavity are heat, long re-lube intervals, over lubrication (too much grease) and old bearings. There are other factors too, including grease quality, vibration, centrifugal forces, contamination, pressure and the re-lube procedure. In addition to the thickener, hard particles are sometimes deposited along with the thickener forming a wall next to the bearing. These include wear particles, dirt, rust and manufacturing debris.

For the new grease to reach the bearing core, it must break through this rock-like formation, creating a channel. Hydrostatic forces from a grease gun can reach levels exceeding 15,000 psi (103,421 kPa) - more than enough pressure to send chunks of solids careening into the bearing track. Imagine the new grease acting like an ice-breaker on a frozen river, mobilizing large blocks of ice as it moves. Sometimes fresh grease never reaches the bearing because of the wall-like barricade. Instead, it detours out the shaft seal or the vent port. The bearing is eventually starved to death.



Large bearings (especially large electric motor bearings) are often lubricated through supply pipes (line extensions) from a grease fitting. Hardened thickener, rust and other solids can build up in these pipes over time. On relubrication, the new grease functions like a plunger, driving the solids into the bearing cavity below.

So what lessons can be learned from this? Remember the maintenance paradox: “It’s broken because we didn’t work on it. It’s broken because we did work on it.” The key here is knowing when to work on it, how to work on it, what tools/hardware to use, and what lubricant to use. In the case of the bearing, there are a number of questions to be answered before regreasing begins, including:

- Whether to use grease at all, vs. oil (mist, bath lubricated, circulating, etc.).
- If grease is to be used, what type or formulation (complex soap, non-soap, high- temperature, solid additives, synthetic, high viscosity, NLGI number, etc.).
- How to gauge the quantity of grease needed. Whether to use feedback tools such as vibration, heat guns, acoustics, etc.
- How frequently to regrease the bearing based on factors such as operating conditions, environment, bearing type and orientation, temperature, grease type, vibration, etc.
- Whether to use a grease gun, single-point automatic lubricator, centralized lubrication, etc.
- What procedure to use when regreasing the bearing if lubricated manually.
- Whether to switch to sealed or shielded bearings.
- Whether to periodically analyze used grease samples.

World-class lubrication requires precision and skill. While there may be more than one right way to do something, there are many more wrong ways. The answers to these questions are rarely intuitive. Training and education develops top-drawer lubrication skills and can give the dollop of grease and the rolling element bearing a long, happy life.

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Price or Cost? - A Question of Value

by Mike Johnson, Noria Corporation

The differences between standard-performance, high-performance and specialty-performance lubricant products are not always clear. The fact that these three categories of products are all marketed to an array of mechanical and operating conditions complicates the selection process.

What are the differences between each of these three quality grades or types of products? Is there a place for high-performance and specialty products in the typical industrial environment? Is there any reason not to select a product that arguably performs at a level higher than the given application? Let's consider the arguments.

What's in a Name?

First, the product categories should be defined more thoroughly.

- **Standard-performance** products are sold in bulk and perform the minimum function required for effective operation. These are largely purchased for broad-based use through price-driven agreements. Product selections, regardless of the brand name, might be characterized as minimum-performance products because their construction is intended to meet minimum operating requirements. Roughly 80 percent of mechanical components can be effectively lubricated with these common fighting-grade products.

- **High-performance products** are manufactured with specialized raw materials. The materials offer greater performance capability (load-supporting characteristics, higher wear resistance, extended lifecycles) to the finished lubricant. Common examples could be greases fortified with solid film agents (molybdenum and graphite), high VI hydraulic oils manufactured with severely hydro-treated base stocks and ashless antiwear agents, or gear oils fortified with solid film agents to improve sliding frictional resistance. Roughly 20 percent of plant applications would be well served with high-performance lubricants.

Specialty-performance products are intended for use in extraordinary service. Lubricated components used in a radioactive environment, the vacuum of space, or for compressing oxygen and/or pumping corrosive fluids are appropriate candidates for a specialty lubricant. This type of lubricant is considered chemically and physically stable (nonreactive) for the select environment.

These materials operate at temperatures to 600°C, under vacuums, under exposure to contaminants that would quickly destroy other lubricants. The disadvantages of extra stability include that in many cases these products don't protect surfaces well due to their compressibility, their inability to support useful additives, or their inability to react with a metallic surface under boundary conditions. One to two percent of plant applications would be well served with a specialty lubricant.

The price interval between the specialty and commodity product is approximately 200 to 400:1. The price alone may limit interest in the use of these, literally, space-age technologies, so it is less likely that these will become entangled in lubricant selection debates.

Selection Decisions

Lubricants from each of these product categories can be chosen for a variety of component types, including open and enclosed gears, element bearings, plain bearings, linear bearings, chains, screws, compressors, hydraulic systems, static sumps and dynamic (circulating) sumps. Regardless of the mechanical component interaction, most brands manufacturer a fighting-grade product and a performance or high-end product. Few of the major brands design, manufacture and market "specialty" lubricants.

Is there any real performance difference between the commodity lubricants purchased through price-conscious decisions, and the premium-price lubricants that fluctuate above and below $1,500 per drum mark? Yes, and the performance differences may be clearly measurable. Common differences include:

- Thicker oil at high operating temperatures (+- 200°F)
- Thinner oil at low operating temperatures (+- -20°F)
- Improved separation from moisture, which enhances surface protection and extends lifecycles
- Reduced formation of hard carbon deposits on noncontact surfaces
- Better resistance to aging (oxidation), which promotes longer oil lifecycles
- Improved load-bearing capacity, which promotes reduced component wear

Secondly, is there a justification to select the higher price materials at three to five times the price of other generic products? Yes, but only following a successful outcome from a reasonable business value analysis that includes efficiency and reliability improvements for both production and maintenance interests. A few maintenance criteria to consider include the following:

- Total lubricant material cost differential per year
- Differential in annual relubrication labor cost
- Differential in annual replacements of lubricated machine components, preferably measured over a multiyear baseline
- Differential in annual component replacements through collateral damage from failure events, preferably measured over a multiyear baseline
- Differential in annual labor to replace components during the given time periods
- Differential in apparent wear rates as demonstrated in properly executed oil analysis
- Production costs could include the following:
- Differential in annual lost production opportunity
- Differential in scheduled and unscheduled downtime for mechanical repair
- Differential in annual energy consumption
- Differential in annual scrap production hours or units

Any one of these factors could represent a major cost reduction opportunity in itself, delivering a discounted cash value estimate (return on investment) many times the actual cost differential for the higher cost material.

Once the current-condition cost factors are determined, a reliability engineer can project an improvement plan based on experience, agreeable measurements or comparison to identical operating system (if any exist). In reality, a small amount of demonstrated improvement in mechanical operating conditions leads to the creation of significant new value to the organization, particularly if the plant is in a sold-out position.

Loss of Value

Poorly engineered application of alternative high-performance products can also decrease value. Regrettably, people with good intentions tend to over-apply high-performance materials to machines where the expected tribo-mechanical benefit cannot be realized.

When this condition exists, there should be a concerted effort to modify replenishment volume and/or frequency, in order to minimize the material purchase cost differential. Doubling the traditional sump change interval may be sufficient to offset the increased material cost. Fortunately, sump change intervals can be extended four to five times the traditional interval with careful condition analysis of the lubricant.

Although real impact to plant profitability (from the pointless use of a high-performance material) is low, there is no reason to waste resources.

Lubricant Purchases:
Less than a Rounding Error

The relative impact of lubricant purchases to the net profitability of an enterprise over the course of a year - regardless of the lubricant's cost per gallon - is irrelevant. Cumulative lubricant purchase dollars represent approximately one to three percent of annual maintenance purchases in most plants. While there is no norm for maintenance expenditures as a portion of total operating costs, eight to ten percent is not uncommon. Assuming that the maintenance portion is ten percent means that for every dollar of goods produced, the company will spend 1/10th of one cent on lubricant purchases.

Properly selected high-performance lubricants may create cost reductions many times greater than the price differential between the product types. Selecting a performance option should be based on the effect derived from a carefully engineered change, with the expected results calculated into commonly accepted financial terms.

Mike Johnson, Noria Corporation, "Price or Cost? - A Question of Value". Machinery Lubrication Magazine.

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Emergency Eye/Face Wash/ Shower Requirements FAQs

Q. How often do I need to test my emergency eye wash and shower equipment?

A. Plumbed eye wash and shower units shall be activated weekly to verify proper operation. If you have a gravity-feed unit, you need to check the manufacturer's recommendation for your unit. All emergency eye wash and shower equipment should be inspected annually to ensure compliance with the ANSI Z358.1 installation requirements. This includes flow pattern and flushing fluid flow rates.

Q. Is there a recommended temperature range for the flushing solution from emergency eye wash or shower equipment?

A. The ANSI standard states that emergency eye wash and shower equipment should deliver tepid flushing fluid. Tepid water is referenced in Appendix B6 of the ANSI Z358.1 standard as having a temperature range of 60 to 100 degrees F.

Q. How long do I have to test my emergency eye wash or shower during the weekly test?

A. Plumbed equipment should be tested long enough to ensure proper operation. It does not have to be tested for a full 15 minutes.

Q. What is meant by "personal eye wash?"

A. It is a supplementary eye wash that supports plumbed units, gravity-feed units or both by delivering immediate flushing fluid. However, a personal eye wash unit cannot be a substitute for an emergency eye wash unit because it is not capable of delivering flushing fluid to both eyes simultaneously at the ANSI Z358.1 required rate of 0.4 gallons per minute for 15 consecutive minutes.

Q. Why do eyewash solutions have an expiration date?

A. Eyewash solutions have an expiration date due to the effectiveness of the preservative present in the solution. Preservatives are used to inhibit bacteria growth. Over time, these preservatives lose their effectiveness. The expiration date serves as a warning that the solution may not be able to prevent bacteria growth past that date. Any solution past its expiration date should not be used.

Q. Are there guidelines on where I should locate an emergency eye wash or shower?

A. Yes. Eye wash and shower equipment should be accessible and should not require more than 10 seconds or approximately 55 feet to reach. The unit should be located on the same floor as the hazard and the path should be free of obstructions (doors are considered obstructions in most cases) that may inhibit the immediate use of the equipment.

Lubrication of Enclosed Gear Drives and Their Selection

by Lawrence G. Ludwig, Jr. Schaeffer Mfg. Company

Enclosed gear drives are used in a diverse myriad of industries ranging from small to large manufacturing plants, steel mills, mines and quarries. In these industries, the number of enclosed gear drives can number from only a handful to thousands. Though some of these enclosed gear drives may not be used in critical operations, it is critical that they be properly lubricated.

Gear lubricants must work and perform in diverse conditions. These lubricants must often perform in the presence of large quantities of water, high operating and ambient temperatures or in highly contaminated environments, while still maintaining their ability to protect the enclosed gear drives from wear, especially during high load conditions. In addition to these factors, there are two major factors that affect how a gear lubricant must perform:

- The increased emphasis by the users of enclosed gear drives for longer lubricant life to reduce maintenance and disposal costs.

Design changes by original equipment manufacturers of enclosed gear drives to improve gearbox efficiency. As a result of these design changes, enclosed gear drives have been downsized and built to operate at higher speeds and loads resulting in higher operating temperatures and increased gear and bearing distress. These smaller enclosed gear drives also have smaller oil capacities, so less gear lubricant is available to cool the equipment and suspend contaminants.

Types of Lubricants for Enclosed Gear Drives

The American Gear Manufacturers Association (AGMA) publishes a standard entitled "Industrial Gear Lubrication" (AGMA 9005-D94), which provides lubricant classifications and generalized application and servicing guidelines for industrial gearing that has been designed in accordance with applicable AGMA guidelines.[1] The four types of gear lubricants described in this standard include: rust and oxidation-inhibited oils, compounded gear oils, extreme pressure (EP) gear oils and synthetic gear oils.

Rust and Oxidation-Inhibited Gear Lubricants

These lubricants are commonly referred to as R&O gear oils. They are generally petroleum base oils or synthetic blend base oils that are formulated with additive systems that protect against rust and oxidation. In addition to rust and oxidation-inhibiting additive systems, some R&O gear oils contain minute amounts of antiwear additives. The viscosity grades for R&O are identified by a single-digit AGMA number 0 through 6, which corresponds to the ISO viscosity grades 32 to 320.

R&O gear oils perform well over a wide range of gear drive sizes and speeds in a temperature range of -5ºF to 250ºF (-15ºC to 121ºC).

Compounded Gear Lubricants

Compounded gear oils are a blend of petroleum base oils with rust and oxidation inhibitors, demulsibility additives and 3 percent to 10 percent fatty or synthetic fatty oils. These gear oils are frequently used in worm gear drives to provide excellent lubricity and prevent sliding wear. Compounded gear oils are limited to an upper operating temperature limit of 180ºF (82ºC).They are identified by single-digit AGMA numbers with the suffix “Comp” from 7 to 8A, which corresponds to ISO viscosity grades 460 to 1,000.

Extreme Pressure Gear Lubricants

These lubricants are commonly referred to as EP gear oils. EP gear oils are petroleum base or synthetic blend base oils that contain multifunctional additive systems. The additive systems contain rust and oxidation inhibitors, EP additives, demulsifiers, antifoam agents, and in some cases solid lubricants that are colloidally suspended, such as molybdenum disulfide, borates or graphite. The EP additive system, which includes sulfur-phosphorous, borates and sulfur-phosphorous-boron chemistries, provides a chemically protective film that protects against welding, scuffing and scoring of the gears during boundary lubrication conditions, which can occur at start-up, stopping and high shock loads. A single -digit AGMA number combined with the suffix “EP” from 2EP to 9EP corresponds to ISO viscosity grades 68 to 1,500. EP gear oils perform well over a wide range of gear drive sizes and speeds in a temperature range of -5ºF to 250ºF (-15ºC to 121ºC).

Synthetic Gear Lubricants

Synthetic gear lubricants differ from petroleum base gear lubricants in that they are formulated using synthetic base fluids. The most common types of synthetic base fluids used in the formulation of synthetic base gear oils include: polyalphaolefins (PAO), diesters, polyol esters and polyglycols.

Synthetic gear lubricants are used whenever petroleum base gear lubricants have reached their performance limit. In general, synthetic gear lubricants have the advantage of being stable over a wide range of operating temperatures, have a higher viscosity index (smaller viscosity changes with temperature variations), improved thermal and oxidation resistance and in some cases greater load-carrying capacities and better lubricity. Each type of synthetic base fluid has different characteristics and some of them may have limitations or disadvantages such as compatibility with elastomers, paints, backstops, clutches, reactions in the presence of moisture and higher price.

Synthetic gear lubricants can also contain rust and corrosion inhibitors, EP additives, demulsifiers, antifoam agents and in some cases solid lubricants. They are identified by single-digit AGMA numbers with the suffix “S” from 0S to 9S, which corresponds to ISO viscosity grades 32 to 1,500.

A Gear Lubricant’s Key Performance Properties

To meet the lubrication needs of modern enclosed industrial gear drives, a gear lubricant must possess the following key performance properties:

1. thermal and oxidative stability
2. thermal durability
3. compatibility with seal materials
4. protection against excessive gear and bearing wear
5. high-temperature extreme pressure protection (EP gear oils)
6. gear and bearing cleanliness
7. de miscibility characteristics
8. rust and corrosion protection, especially to yellow metal components
9. antifoaming characteristics

Many of these key properties can be identified by examining the lubricant supplier's technical data or specification sheets and comparing them against the minimum performance requirements for industrial gear lubricants as set by the following widely recognized specifications:

- U.S. Steel 224 Specification for non-leaded EP industrial gear lubricants - This specification identifies high load capacity and thermal stability.
- AGMA 9005-D4 - This specification closely mirrors U.S. Steel 224 and also includes minimum physical and performance specifications for R&O, compounded oils and synthetics.
- Cincinnati Milicron P-34/P-35/P-59/P-63/P-74/P-76/ P-77/ P-78 - These lubricant specifications also include minimum performance for thermal stability and antirust protection.
- DIN 51 517 Part 3 CLP - Developed by the Deutsche Institute fur Normung of Germany, this specification addresses petroleum-based gear lubricants containing additives to improve rust protection, aging characteristics and EP protection.

In addition to these platform specifications, a number of supplemental tests can be conducted to assess the performance of a gear lubricant in applications where optimum performance is required. Some of these tests will be further discussed.

Thermal and Oxidative Stability

Design changes to improve gearbox efficiency have produced smaller gear drives that operate at higher speeds, loads and temperatures, producing increased

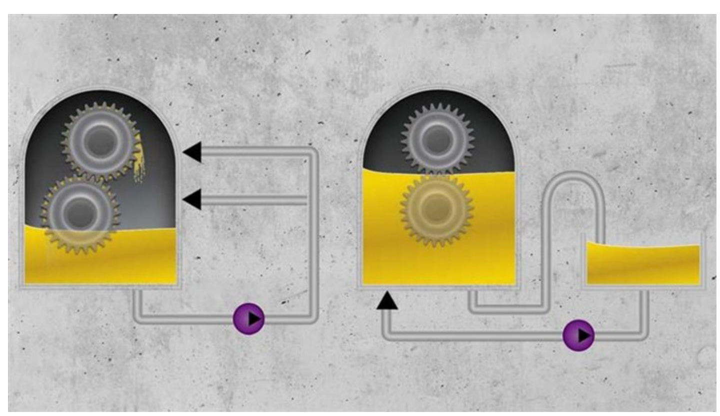
KenKen Puzzle

How to solve the Kenken puzzle:

(Answers on page 24)

- Fill in the numbers from 1 –6
- Do not repeat the number in any row or column
- The numbers in each heavily outlined set of squares, called cages, must combine (in any order) to produce the target number in the top corner using the mathematical operation indicated
- Cages with just one square should be filled in with the target number in the top corner
- A number can be repeated within a cage as long as it in the same or column

1	6			7		3	2	
5	4				8		9	1
			2		4		6	
2	3		7		6	8		9
	9	7						
		5	4		9	1		3
8							3	7
		3		6	7			
	1	6		4	3		8	2



gear and bearing stress. These enclosed gear drives also have smaller capacities resulting in less lubricant being available to cool the gears and bearings and suspend contaminants. In addition to design changes, enclosed industrial gear drives can be subjected to overheating due to inadequate load-carrying capacity, misalignment and inadequate clearances.

As a consequence, industrial enclosed gear lubricants can be subjected to extreme thermal stress. This thermal stress can cause oxidation and thermal breakdown of the gear lubricant. Oxidation and thermal breakdown of the gear lubricant can result in an increase in the gear lubricant's viscosity, the buildup of acidic components and the formation of sludge, varnish, lacquer and carbon deposits on the gears, bearings and seals. The buildup of these deposits can increase frictional drag, operating temperature and energy consumption; reduce gearbox efficiency; and cause premature and catastrophic wear to the gears and bearings. The accumulation can also cause abrasion to the seals, premature seal hardening and brittleness, thus resulting in decreased seal life and increased lubricant leakage.

Because of these factors, it is important that an enclosed gear lubricant exhibit thermal and oxidative stability.

A thermally stable gear lubricant is defined as a gear lubricant that keeps critical parts clean, with respect to deposits and sludge, when subjected to sustained high-temperature service.

Several tests measure an industrial gear lubricant's thermal and oxidative stability properties that enable it to prevent and reduce oxidative thickening and deposit formation. The accepted test methods used to evaluate thermal and oxidative stability include:

1. ASTM D943 Thermal and Oxidation Stability Test (R&O Gear Oils only)
2. ASTM D2893 and U.S. Steel S-200 Oxidation Stability Characteristics of Extreme Pressure Gear Lubricants test methods
3. ASTM D5704 (L-60-1) Thermal Oxidation Stability Test
4. FTM 3462 Panel Coker Test

ASTM D943 Thermal and Oxidation Stability Test

The ASTM D943 Thermal and Oxidation Stability Test is used to evaluate the oxidation stability of rust and oxidation-inhibited gear lubricants in the presence of oxygen, water, copper and iron metals. The test method is used for specification purposes and is valuable in estimating the oxidation stability of rust and oxidation-inhibited industrial gear lube, especially those that are prone to water contamination. The lubricant is subjected to test conditions that include water, catalytic metal (copper) and oxygen for as long as is necessary to force the oil to oxidize. The acid level is routinely checked, with a growth in acid content indicating that the test is rapidly deteriorating.

Characteristics of EP Gear Lubricants Test Methods

Both of these tests are intended to simulate service conditions on an accelerated basis. The test method is used to measure the ability of EP gear lubricants to resist oxidation and the formation of deposits when subjected to high operating temperatures. At the end of the test period, the viscosity is checked for change (maximum of five percent increase), the test utensils are inspected for sludge or residue and the lubricant color is checked for evidence of change (darkening).

ASTM D5704 (L-60-1) Thermal Oxidation Stability Test

The L-60-1 test is used to measure a gear lubricant's ability to resist thickening and deposit formation characteristics under sustained high-temperature conditions. This test method provides an accurate indication of how a gear lubricant performs in the field when subjected to high-temperature conditions.

The test method utilizes a specially built gear case in which two spur gears immersed in the gear lubricant being evaluated are run for 50 hours at 325ºF (163ºC) in the presence of a copper catalyst and 1.1 liters/hour of air flow to promote oxidation at an input shaft speed of 1,750 rpm. At the end of 50 test hours, the gear lubricant is evaluated for viscosity increase and the test gears are visually inspected and rated for carbon, sludge and varnish deposits. A thermally and oxidatively stable gear lubricant exhibits no more than a 50 percent increase in viscosity, and the gears and bearings exhibit little or no signs of deposit formation.

FTM 3462 Testing for Carbon Coking Tendency

The Panel Coker Federal Test Method (FTM) 3462 is used to determine the deposit formation tendencies of a gear lubricant and its effectiveness in keeping the system clean and free from deposits in extreme high-temperature environments. The Panel Coker apparatus is designed to continually splash the lubricant onto a hot plate (panel) that is sitting 25 degrees off of horizontal. The lubricant evaporates as it drips from the plate. At

the end of the test, the heater is turned off and the panel is allowed to cool. Once cooled, the test panel is removed, washed with solvent to remove any excess lubricant, and weighed to determine the amount of deposits adhering to the surface of the panel. The darker the color of the panel, the more deposits that have been left. A cleaner panel indicates fewer deposits.

Thermal Durability and EP High-Temperature Protection

In addition to being thermally and oxidatively stable, a gear lubricant must exhibit thermal durability. A thermally durable industrial gear lubricant is defined as a gear lubricant that has the ability to resist radical changes in its EP additive chemistry. When an industrial gear lubricant is subjected to high operating temperatures, it can become thermally stressed to a point where its EP additive chemistry undergoes radical changes in its chemical structure. These changes can result in a loss of the lubricant's EP ability to provide protection against excessive gear tooth and bearing wear, spalling and overall distress.

Compatibility with Seal Materials

Most seals commonly fail due to hardening and deposit formation, especially when high operating temperatures are encountered. Thermal stress of the industrial gear lubricant during use can cause the industrial gear lubricant to breakdown and form carbon and varnish deposits in and around the seal lip. Once formed, these deposits can abrade the seal material, causing cracking and tearing of the seal.

Seal leakage can be further aggravated by loss of seal material elasticity caused by chemical

interactions of the seal material with the industrial gear lubricant's basestocks and additive chemistry. These chemical interactions can cause the seals to either excessively swell or shrink.

Therefore, it is important that the industrial gear lubricant incorporate a careful balance of additive chemistry and base oils in order to prevent seal failures. Generally, PTFE (Teflon®) and Viton® seal materials provide the most universal compatibility.

Reference

1. ANSI/AGMA 9005-D94. Industrial Gear Lubrication. p. 1.

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Workers killed on the job is 10 times higher than official reports: WHSC

By OHS Canada

Health & Safety

The number of workers killed because of their jobs last year was 10 times higher than the official number, according to the Workers Health and Safety Centre (WHSC).

Well in excess of 2,000 Ontarians died last year as a result of traumatic incidents and hazardous exposures at work, according to estimates supported by research evidence, it said in a press release.

“And even this alarming toll is a conservative estimate according to this same research evidence,” it said.

Yet, the province’s Workplace Safety and Insurance Board (WSIB) recognized just 220 worker death claims in 2022 — and it noted that lower figure is often the “default statistic” shared when discussing the number of workers killed each year.

“This routine of under recognition in many ways is an affront to the suffering of workers, their families and communities,” said Andrew Mudge, executive director, Workers Health and Safety Centre (WHSC). “Failure to shed light on the true toll of suffering serves only to downplay the collective need to more aggressively pursue safer, healthier work through enhanced regulations, stronger regulatory nforcement and ultimately workplace prevention efforts.”

While most, if not all, traumatic deaths at work get reported to the WSIB, very few deaths caused by occupational disease are reported to or recognized by the WSIB, according to WHSC.

This is particularly the case for cancer, lung diseases and other chronic illnesses with long latency periods between workplace exposure(s) and disease onset. Consider, for instance, estimates suggesting between 600 and 5,000 Ontarians died in 2022 from work-related cancer alone, it said.

There is also under reporting and recognition of injuries and illness caused by mental health, violence, COVID-19 and other respiratory infections caused by workplace transmission.

“We recognize it is not the mandate of the WSIB to capture the true toll of suffering,” said Mudge. “We also recognize though a more accurate picture of worker deaths, injuries and illnesses must be prioritized and widely communicated.”

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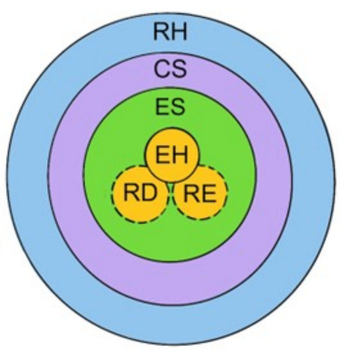
How to Audit a Building to Achieve Net Zero

Chun Liang, P.Eng., CEM, LEED AP, Tree House Energy Services,

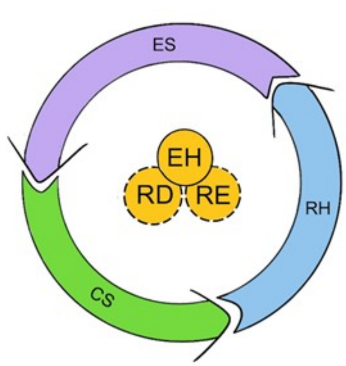
Greater Toronto Area, Ontario

Learning Objectives

- Understand ASHRAE Procedures for Commercial Building Energy Audits and ASHRAE Standard 211-2018, Standard for Commercial Building Energy Audits.
- Compare what is required in a net zero audit versus an ASHRAE audit.
- Introduce a new kind of audit with guiding principles that lead to zero-carbon retrofit pathways.



This shows principles within principles in the concentric circles, similar to growth rings in a tree. Note the following: electrification of heating (EH); coordination of energy sources (CS); reduce heat demand (RD); reduce electricity use (RE); and selection of renewable, low- or zero-carbon sources (ES). Courtesy: redesign of heating systems (RH).



This shows an iterative approach to the guiding principles This requires electrification of heat at the center with two possible options to reduce heat demand (RD) and electricity use (RE). Note the following: electrification of heating (EH); coordination of sources (CS); and selection of renewable, low- or zero-carbon sources (ES). Courtesy: redesign of heating systems.

More than 6~~5~~40 climate emergencies have been declared (to date) by municipalities in Canada, and similar declarations for many other cities around the globe have also been made. A municipality with one of the largest city populations in North America has declared it will be net zero by 2040. What is the plan to achieve these necessary — as detailed by climate scientists and the Intergovernmental Panel on Climate Change IPCC — but aggressive emission reductions?

A significant sector for emissions reductions is the building sector. Municipalities have been releasing request for proposals (RFPs) for net zero retrofits for their corporate buildings that call for what are essentially cost studies to get to net zero by 2050 or earlier and these requests include ASHRAE audits. A summary of ASHRAE audit steps: Assemble audit and implementation team.

- Collect historical energy data and preliminary analysis.
- Site visit.
- Measurement.
- Energy efficiency measure types.
- Economic analysis.
- Developing an audit report.
- Presentation.
- Implementing measures.

While the ASHRAE Procedures for Commercial Building Energy Audits was first published in 2004 and second edition in 2011 as a "go to" reference, followed by similar guidance from ASHRAE Standard 211, it was not meant for a net zero emissions target. This is apparent from the growing and additional RFP requirements. ASHRAE audits are still relevant and based on experience with net zero studies, and they have a role to play in a net zero pursuit.

While the scope of an ASHRAE audit for a deep energy retrofit compared to an audit where the goal is net zero are similar, there are significant differences in what should be seen and investigated by auditors.

The goal of emissions reduction may be implicit in the procedures or ASHRAE Standard 211 or could be an indirect result of energy reduction, but there isn't explicit guidance to an auditor when the mandate is net zero emissions. Auditors are being asked to improvise from the existing guidance or make attempts to integrate a plethora of additional requirements alongside an ASHRAE audit.

Shouldn't a more methodical approach be proposed? What are some guiding principles in this new audit, which has leapfrogged auditors into the next normal of net zero?

Before continuing the conversation on these guiding principles, a definition of a zero-carbon building as well as local energy markets can provide context.

Zero carbon buildings and local energy markets

Architecture 2030 has a definition for a Zero Net Carbon Building and the Canada Green Building Council's Zero Carbon Building - Design Standard also has the same definition:

"A highly energy-efficient building that produces onsite or procures carbon-free renewable energy or high-quality carbon offsets in an amount sufficient to offset the annual carbon emissions associated with building materials and operations."

Regarding materials for new buildings and for this discussion on existing building audits, the focus will be on operational emissions.

Building emissions in the Canadian — and specifically Ontario — context come from burning natural gas for space and water heating and peak electricity generation. Emissions from power generation are not significant when compared to emissions from heating. In Ontario, buildings are fortunate that generation is mostly from low carbon emitting sources such as nuclear and hydro power.

Thus, the challenge essentially reduces to eliminating natural gas use; the pathway to building decarbonization in Ontario (as with many jurisdictions with cleaner electricity grids) is electrification. The caveat is cost, as the current cost of electricity is significantly more than natural gas per equivalent energy unit. The spark gap, as some have termed it in a power generation context, becomes less relevant as the focus is net zero emissions.

Thus, the question of guiding principles in this context starts with the electrification of heating — the north star in the constellation of net zero audit principles.

Heating electrification and a renewable energy principle

With the north star established, its useful to return to the basic steps of energy management:

- Minimize energy (heat) demand
- Increase efficiency
- Recover waste heat
- Investigate and deploy renewables

These can be used as a framework for the development of net zero audit principles. What becomes immediately apparent is the deployment of renewables as the last step. In an ASHRAE audit, renewables may not be a consideration and historically valued engineered out of the project at final budget. Thus, a major revision to the ASHRAE audit is starting with and prioritizing the investigation of renewable, low- or zero-carbon energy sources that becomes the second guiding principle.

Renewable, low- and zero-carbon energy sources

Because net zero audits must provide a pathway to the decarbonization of building heating, the energy source must be renewable, low- or zero-carbon.

Questions to ask include:

- Is the building siting, typology and heat demand more suited for ground source, air source or sun source?
- What is the heat demand, and are there process heat demands (e.g., swimming pool) that are additive and/or seasonal?
- Is there an opportunity to split and supply the heat demand across different sources? Perhaps combination of all of the above?
- Is there a solar-ready rooftop that can support and contribute to a net zero-carbon solution to a process heat load?

In the case of ground source energy for a geo-exchange system, cost and site limitations may have already predetermined the size and capacity of the borehole field.

In the long term, is there a planned district energy system that can serve building heat demand using biomass boilers and the "Zero Over Time" guide created by the Rocky Mountain Institute?

The choice of optimal renewable energy sources — whether at a district or local scale — to decarbonize building operations can become complex especially if done in phases due to capital upgrade cycles. These energy source(s) need to be coordinated with the redesign of the heating system. The coordination of sources becomes the third guiding principle, and heating system redesign the fourth principle.

Heating system redesign to achieve net zero

According to the International Energy Agency, Energy Efficiency Report 2021 (for buildings, transport and industry), "Energy efficiency offers some of the fastest and most cost-effective actions to reduce CO_2 emissions." Some questions regarding efficiency and heating system redesign include:

- Is there is a way to reduce heating demand through building envelope modifications?
- Can the existing heat distribution system be modified to be more efficient?
- Is heat being generated (in a process) that is wasted and can this waste be recovered for heating demand?

For the first and third, the benefits are clear. For the question about heat distribution systems, there is underlying notion of minimizing the delta between room temperature setpoint and heating loop temperature. Historically, design practices, perimeter radiators and air handling coils were sized for a high-temperature heating loop and a boiler plant — the energy source — would be sized to deliver on these conditions. Starting with this high-temperature loop essentially predetermined the heating system design.

To lower the heating loop temperature, terminal units will need to be resized to maintain net heat transfer. While this adds cost to the net zero pursuit due to the increase in radiant surface area, it reduces distribution losses because the temperature difference between the insulated piping and surrounding air temperature is lower, thus reducing the rate of heat loss. Another benefit is the increase in radiant heat that heats objects — instead of air — thereby increasing thermal comfort.

Another strategy might be rezoning heating systems to reduce thermal demand for zones that are not required to operate on the same schedule as other zones. A common example is a mixed-use building where office floors do not have the same heating and cooling schedule as perhaps ground floor retail and/or restaurants. The net effect of this zone separation is the ground floor can be served by a dedicated heating and cooling system while the office floor system is no longer tied to ground floor operations and can operate less, thus reducing energy and emissions.

In an energy audit, this kind of decoupling of dissimilar zones and introduction of new systems would likely not be considered because it would be cost prohibitive. However, in a net zero audit, the minimum recommendation is to investigate rezoning.

To further assist the energy source and also eliminate natural gas use, the question of energy waste and recovery is another potential measure for the auditor. Recovery in an energy audit versus recovery in a net zero pursuit is akin to comparing apples to oranges, at its core heat recovery might be similar but the nature of recovery needs to be integrated at a system level.

In the example of using cooling loads in the heating season, there is an opportunity to recover condenser water heat instead of rejecting it into the low-temperature return loop. There also is a way to recover washroom exhaust into this loop using a coil.

While the heat recovery distribution system may be costly, there may be limitations on the renewable energy source especially in the case of ground or air source so this source needs support as much as possible so that the overall system can satisfy heat demand for code compliance and perhaps improve thermal comfort.

How can net zero be achieved?

Using the guiding principles below, the auditor should evaluate the feasibility of lowering the heating loop(s) temperatures, rezoning systems and system level integration of heat recovery:

- Electrification of heating.
- Selection of renewable, low- or zero-carbon sources.
- Coordination of sources with heating systems.
- Redesign of heating systems.

Using this “retemp, rezone and recover” approach would lead to a schematic redesign of the heating system to provide the necessary conditions through which the energy source with its potential limitations is able to meet code and comfort conditions.

Further, it should be noted that an iterative approach (versus stepwise) may be needed for everything except electrification to arrive at schematic design cost options that are able to meet budget constraints.

In general, cooling systems are already electrified and thus low-emitting in our market context. However, there are opportunities for cooling integration with heat pumps. This integration is especially compelling if the cooling adds enough electrical demand to the building to put it into a different rate class that reduces costs as in the case of the Ontario market.

This scenario may be an opportunity for energy storage to further take advantage of these rates. If the facility is planning to add more electric demand (e.g., electric vehicle charging stations), this can also be accounted for in the audit and may further the case for electrification from a billing perspective; especially if billing from the local utility is similar to the Ontario market.

A useful criterion for comparing low and zero carbon options is the ratio of the option’s capital cost divided by greenhouse gases reduced. To be clear, life cycle cost and emissions should also be integrated into this ratio. While not the only criteria, the ratio can inform a “red, yellow or green light” decision.

There is an option to reduce electricity demand from receptacle or plug loads of a building, especially in the case of an office tower with a data center that can be the largest part of the energy end-use pie. There are a number of strategies that can be investigated, including virtual servers. Whether there is a data center or not in the net zero pursuit, this reduction is meant to avoid or minimize an electrical service increase that isn’t attributed to an increase caused by the electrification of heat. An electrical service increase is likely and may add significant costs, thus, its recommended a cost investigation be undertaken as this cost may drive the decision making process of the audit.

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Please click on the link for further information:

https://ncbfo.ca/western/events/ncbfo-2023/

Kenken Puzzle Answer

1	6	8	9	7	5	3	2	4
5	4	2	6	3	8	7	9	1
3	7	9	2	1	4	5	6	8
2	3	1	7	5	6	8	4	9
4	9	7	3	8	1	2	5	6
6	8	5	4	2	9	1	7	3
8	5	4	1	9	2	6	3	7
9	2	3	8	6	7	4	1	5
7	1	6	5	4	3	9	8	2

TEST YOUR OPERATOR IQ ANSWERS

Answers: 1) a 2) b 3) b 4) b 5) c

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Please visit the Building Operators Association of Canada YouTube Channel to watch the Speakers and Presentations from the Tradeshow 2022 & Previous Guest Speakers.