MAINTENANCE TECHNOLOGY INTERNATIONAL INC.

INDUSTRIAL EQUIPMENT MAINTENANCE CONSULTANTS, TRAINERS & CERTIFIED LUBRICATION SPECIALISTS

Troubleshooting Compressor Problems

Compressor Types and Applications

Compressors are classified as either "positive displacement," where intermittent flow is provided, or "dynamic," which provides continuous flow of the air or gas being compressed.

Positive displacement compressors include reciprocating piston types of various design and rotary types, which include helical screw, straight lobe, liquid piston and rotary vane compressors.

Positive displacement compressors confine volumes of air or gas in an enclosed space, which is reduced to accomplish compression. In contrast, dynamic compressors convert energy from the prime mover into kinetic energy in the gas being compressed, which is then converted to pressure.

Dynamic compressors include centrifugal and axial flow types. Some or all of these compressor types may be found in any industrial facility functioning in one or more of four primary applications.

1. **Air compressors** provide pressurized air to operate tool or instrument air systems.
   Compressors commonly used for this application include reciprocating piston types and rotary types, such as centrifugal, straight lobe and screw compressors.

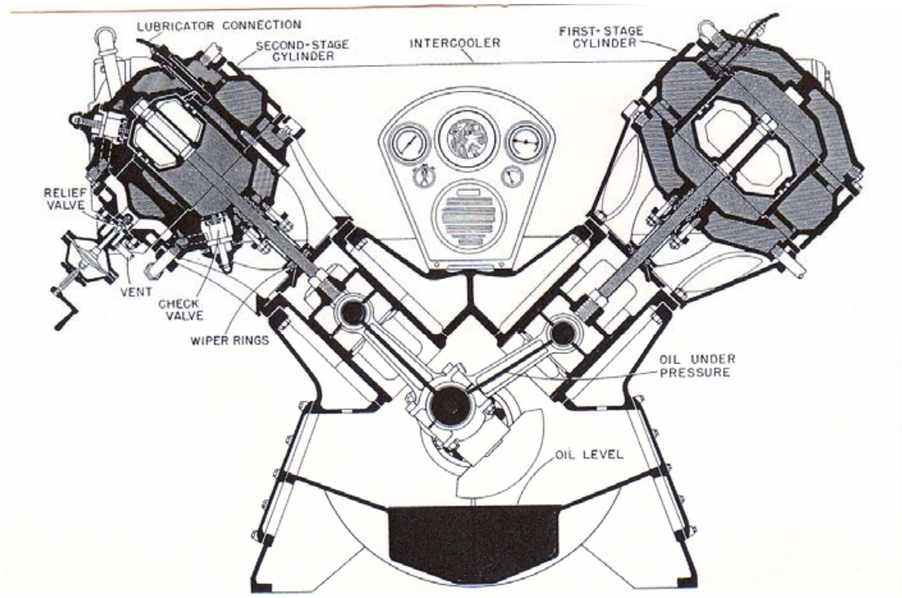


Figure 1 V-type, Two Stage, Double Acting Reciprocating Compressor

2. **Inert Gas Compressors** are used to process gases that do not react with lubricating oils and that do not condense on cylinder walls or compression chambers at high compression pressures. Examples of these inert gases are neon, helium, hydrogen, nitrogen, carbon dioxide and carbon monoxide, as well as ammonia and blast furnace gas.

   Compressors used for these applications may include all types of positive displacement compressors both reciprocating and rotary. Generally, compression of these gases introduce no unique or unusual problems and the lubricants used for air compressors are also suitable for these applications. **(SEE FIGURE 2.)**

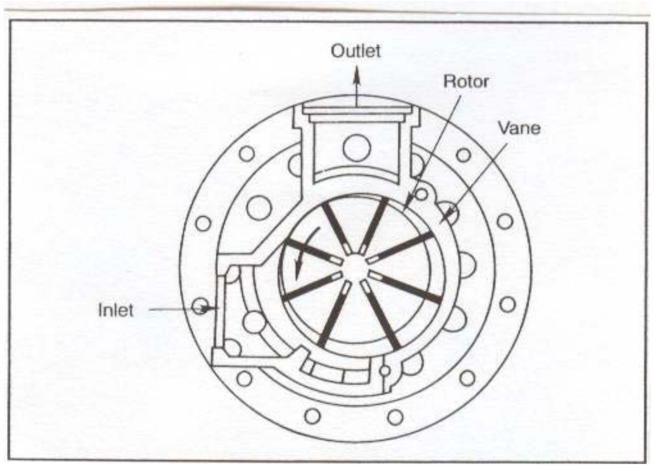


Figure 2 Sliding Vane Rotary Compressor

3. **Hydrocarbon Gas Compressors** are used primarily in natural gas processing applications, but are also used to process such gases as methane, ethane, propane, butane, acetylene and nitrogen. Where the hydrocarbons being compressed must be kept free of lubricating oil contamination, dynamic compressors are most frequently found, but where high pressures are required, reciprocating types are also used. **(SEE FIGURES 3. AND 4.)**

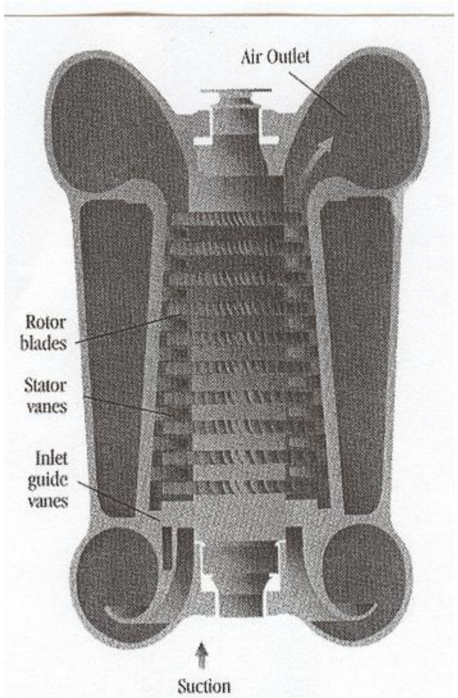


Figure 3 Dynamic Axial Flow Compressor used in Continuous Flow Applications.

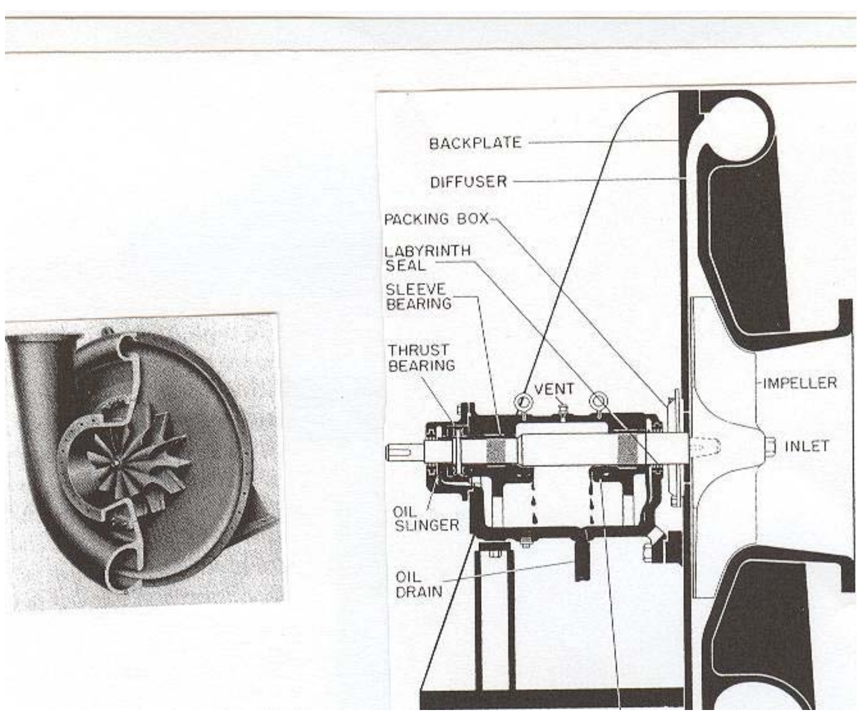


Figure 4 Centrifugal Compressor. They are used most often in refineries, chemical processes and natural gas pipelines. They are suited to very high speed operation

(20,000 rpm and higher) and if rolling element bearings are used to support the shaft, precision bearings designed for such speeds may be required.

4. **Chemically Active Gas Compressors** are used to process gases which will react negatively to petroleum lubricants. In these compressor applications, which may be of either reciprocating or rotary types, petroleum based oils should **not** be used if there is **any possibility** that the lubricant may come into contact with these chemically active gases. These may include oxygen, chlorine, sulphur dioxide, hydrogen sulphide, or hydrogen chloride.

   For example, petroleum based (hydrocarbon) oils which come into contact with chlorine or hydrogen chloride will result in the formation of gummy sludge, while sulphur dioxide dissolved in petroleum oil may form sludge and could dramatically reduce the oil's viscosity. Sulphur dioxide gas has also been found to generate carbon deposits when in contact with hydrocarbon oils, either mineral or synthetic types.

   In compressors processing hydrogen sulphide, corrosion in the presence of **any** moisture will occur, including any small amounts suspended in the oil. Mineral base oils, including synthetic hydrocarbons coming into contact with oxygen may **combine** to **cause explosions. (SEE FIGURE 5.)**

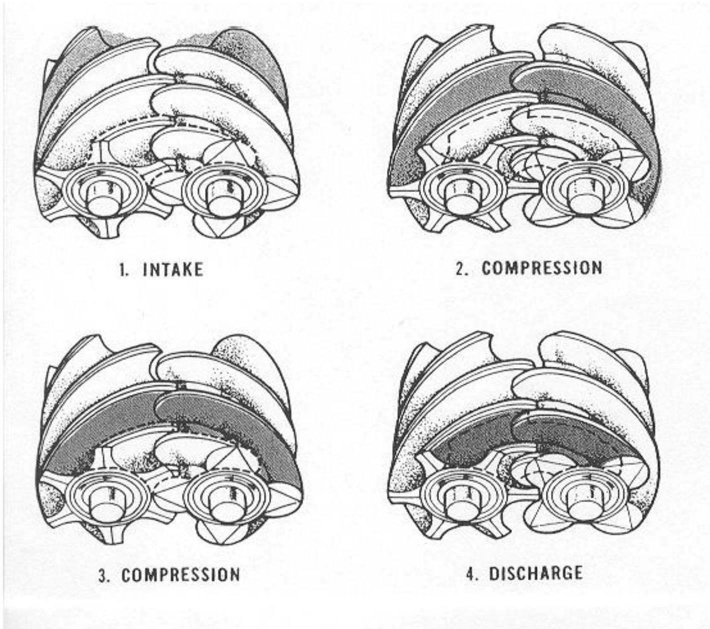


Figure 5 Helical screw compression process where the gas being compressed does not come into contact with the oil. This application is referred to as a "dry screw" compressor. The lubricant used in chemically active applications to lubricate the timing gears and support bearings should be an inert synthetic lubricant, such as chlorofluorocarbon.

5. **Refrigeration and Air Conditioning Compressors.** Compressors used in these applications may include reciprocating piston types, as well as centrifugal, sliding vane and screw compressors.

Some electric motor driven compressors are hermetically sealed with all operating parts, including the motor, inside the sealed unit. The lubricant used in these cases must have good dielectric properties, must not affect motor insulation and should not affect the fluorocarbon refrigerants used in these systems. This is because the motor is completely surrounded by a refrigerant oil mixture.

Where other types of refrigerants are used, such as carbon dioxide, methyl and methylene chloride, polyglycol synthetics are available, however where any question exists, the compressor manufacturer should be consulted.

Compressor Operation

To understand the challenges in troubleshooting compressor problems and to more effectively maintain this critical machinery, it is necessary that operators have a full understanding of their particular compressor operation.

In a typical reciprocating piston compressor, air (or gas) is drawn into the cylinder or cylinders through a filter or strainer, where the air or gas is contained, compressed and then released by valve arrangements that operate by differential pressure. The compressor cylinders may have one or more inlet and discharge valves.

Piston rings or packing contain the air (or gas) under pressure within the cylinder and also keep lubricating oil from the pressure chambers above the piston head(s). **(SEE FIGURE 1.)**

The cycle of operation consists of intake, compression, discharge and expansion, (expansion occurs as the small volume of air or gas remaining in the clearance pockets expands as the piston retreats on the intake stroke).

Due to the high compression pressures, the temperature of the discharged air (or gas) has increased substantially. In addition, compression causes water to condense in air compressor systems.

These conditions, increased temperature of discharged gas and condensate in discharged air, must be controlled and are important considerations in the maintenance of compressor systems. When very high discharge pressures are required, compression is often carried out in two or more stages to cool the gas between stages in order to limit temperatures to reasonable levels. **(SEE TABLE 1.)**

DISCHARGE PRESSURE		DISCHARGE TEMPERATURE					
		1 STAGE		2 STAGES		3 STAGES	
Psi	kPa	°F	°C	°F	°C	°F	°C
70	483	398	203	209	98		
80	552	426	219	219	104		
90	621	452	233	226	109		
100	689	476	247	238	114		
110	758	499	256	246	119		
120	827	519	271	254	122	182	83
250	1724			326	163	225	108
500	3447			404	207	269	132

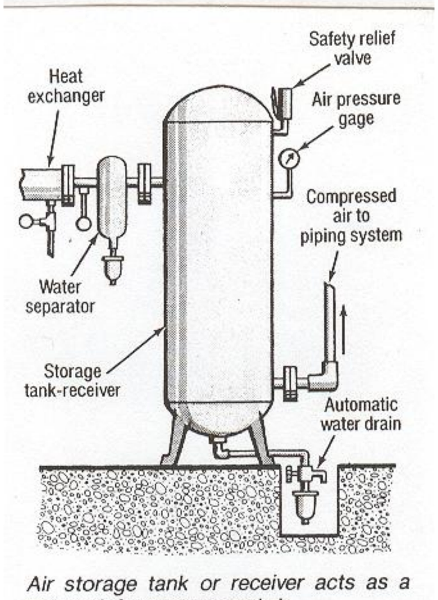
Table 1

With regard to condensate in discharged air, after coolers or heat exchangers are frequently used to lower the temperature and precipitate out much of the water in the saturated compressed air. It is very important to remove water from heated compressed air, because water becomes acidic at 180°F (82.2°C) and can result in corrosive deposits in piping, valves and compressed air reservoirs.

In a typical rotary compressor, such as a “flooded helical” screw type, the rotors draw air (or gas) through the intake filter which is then trapped between the rotors and mixed with lubricating oil. In these machines, lubricating oil is required in the rotor set in order to ensure proper lubrication of the screws, but results in an air (or gas) oil mixture during the compression cycle. **(SEE FIGURE 5.)**

Compression raises the temperature of the air (or gas) oil mixture in addition to causing moisture in the air to condense. This mixture exits the outlet or air end of the compressor where it flows into an oil separator. This tank acts as a reservoir for the separation and recovery of the oil from the air or gas being processed. This oil is filtered and returned to the point of injection.

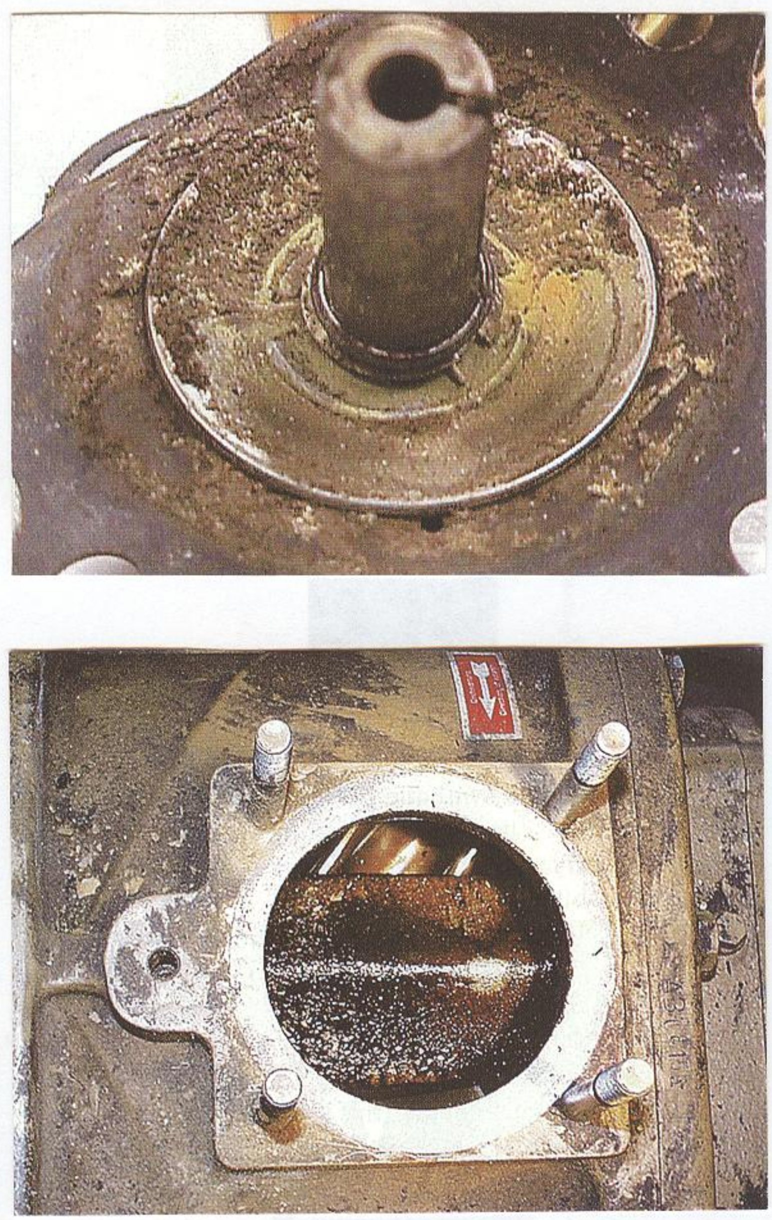
The compressed air meanwhile, passes through a heat exchanger or after cooler to reduce its temperature. The cooled air enters a water separator, which removes condensed water, the air enters the reservoir and the process is repeated. **(SEE FIGURE 6.)**



Air storage tank or receiver acts as a reservoir for compressed air.

FIGURE 6.

As can be seen, these compression cycles, depending on the type of compressor, or the gas being processed, can create unique problems, resulting in oxidized lubricants, the formation of sludge and varnish, contamination, corrosion, rust development and explosion potential, due to hot spots at discharge valves, caused by carbonaceous deposits. **(SEE FIGURES 7. & 8.)**



Figures 7 & 8

In addition, incompatibility issues may result if seals and process gases react chemically with incorrect lubricants. This is precisely why compressor operators must be familiar with the potential problems associated with inadequate compressor system design, excessive operating temperatures and careless selection of lubricants.

Lubricant and Lubrication Considerations

Lubricants selected for compressor applications generally depend upon eight conditions; the type of compressor, the type of gas being processed, discharge pressures and temperatures, lubricant oxidation, rust and foaming resistance, hydrolytic stability, carbon deposit forming tendencies (particularly at discharge valves) and compatibility (with seal materials and the gas itself).

Even though today's top quality mineral base oils are frequently used as compressor lubricants, the trend is toward synthetic fluids, most notably; polyglycols, diesters, polyolesters, phosphate esters (for compressors requiring fire resistant lubricants) and polyalphaolefin hydrocarbons. The primary reasons for their use are their extremely high viscosity indices and superb oxidation resistance.

A synthetic lubricant with a high viscosity index can reduce power consumption by up to 12%. A typical rotary air compressor will discharge air with an average temperature of 93°C (200°F). Without a proper lubricant, this air temperature could be as high as 370°C (700°F).

Even well formulated, oxidation resistant mineral base oils tend to begin oxidizing at about 70°C (160°F) with the potential of forming carbon deposits and varnish. At air discharge temperatures of 93°C, lubricant life can exceed 8,000 hours of operation. If discharged air temperature is 110°C or higher, lubricant life can be reduced by 60–70%.

Moisture is also a factor, particularly in air compressors, when they are allowed to run unloaded. This is because condensation occurs during unloaded periods when the cylinders cool below the dew point of the air remaining in them. This condensate can cause severe corrosion and rust deposits if not controlled. The lubricant must provide excellent hydrolytic stability. When using mineral based or synthetic hydrocarbon oils, water content should not exceed .5% (5,000 ppm). If polyglycol fluid is used, this lubricant can tolerate about .8% (8,000 ppm) of free water. (These are guidelines only. Operators should consult the compressor manufacturer for specific details).

Guide to Reciprocating Compressor Lubrication
(Crankcase and Cylinders)

1. **Crankcase oils** recommended are ISO viscosity grade 68, 100, 150, or 220 depending upon ambient temperatures. Generally, these lubricants will be paraffin base recirculating oils with rust and oxidation inhibitors and some may have anti-wear characteristics. If mineral base hydrocarbon oils are used where discharge temperatures are below 149°C (300°F), napthenic base oils are frequently recommended because these lubricants have low floc points and will not form wax crystals at low temperatures.

   When discharge temperatures are between 150°C–200°C (302°F–392°F), it is recommended that synthetic diester, polyglycol, polyolester or phosphate ester fluids of equivalent viscosity grades be used.

   When compressing chemically active gases, such as oxygen or hydrogen chloride, mineral base oils, including synthetic hydrocarbons such as polyalphaolefins and alkylated aromatics, must **never** be used. (Mineral base oils coming into contact with oxygen will cause explosions). Lubricants recommended for these applications include synthetic chlorofluorocarbons and polybutenes.

In self driven integral engine compressors, both engine and compressor pistons are connected to the same crankshaft. The running gear may also share a common crankcase. As a result, diesel engine oils are frequently used and may be mineral base or synthetic of similar viscosity grades as noted previously.

2. **Cylinders** used in single and two stage crosshead or trunk type compressors processing air or inert gases, are usually lubricated using the same oil found in the crankcase. When these compressors are used in processing hydrocarbon gases such as methane or butane, or where the compressors are processing "wet" gas containing condensed hydrocarbons or moisture, it is recommended that viscosity grades 320 or 460 be used where discharge pressures are 14,000 kpa (2,000 psi), 21,000 kpa (3,000 psi) and 28,000 kpa (4,000 psi) respectively.

   Many sour gas or wet hydrocarbon applications may recommend the use of viscosity grade 460 or 680 oils compounded with 3 to 6% fatty oil to ensure cylinder lubrication. Ensure that cylinders receive the correct oil drop feed rate.

   Another factor that determines cylinder oil selection is the operating temperature. Thin films of compressor cylinder oil will inevitably reach the discharge valves. The hot metal surfaces create severe oxidizing conditions and the formation of carbon deposits. These deposits restrict the discharge passages, further increasing discharge temperatures contributing to more deposits. Eventually a hot spot will develop which may result in a fire or explosion.

Lubricant selection and condition monitoring are critical considerations in reciprocating compressor operation and not enough attention is paid to these requirements for safety and insurance reasons.

Guide to Rotary Compressor Lubrication

1. **Centrifugal compressors;** require lubrication only at the support bearings, usually an anti-wear oil of a viscosity range of 32 or 46, depending upon the ambient temperature. In units with rolling element bearings, NLGI grades 1 or 2 lithium greases may be used.

2. **Sliding vane compressors;** require "flooded lubrication" and because of the high potential for vane to housing contact, oils fortified with anti-wear or mild EP additives are required in a viscosity range of 46, 68, or 100. Some manufacturers recommend polyalphaolefin, diester or polyglycol synthetics.

3. **Liquid (usually water) piston rotary compressors;** require lubrication only at the support bearings which are of the rolling element type. Lubricants range from R & O type oils in the viscosity ranges of 32, 46, or 68 to lithium grease of an NLGI grade of 1 or 2, depending upon bearing type and speed.

4. **Helical lobe screw compressors;** are primarily of the "flooded lubrication" type where there is major contact between the gas being compressed and the lubricant, thereby causing great potential for oxidation and deposits.

Where discharge temperatures are in the range of 85°C–135°C (185°F–275°F), lubricant requirements range from high quality R & O mineral oils to synthetic fluids in the viscosity range of 32, 46 or 68. Depending upon the manufacturer's recommendations, PAO's (polyalphaolefins), POE's (polyolesters), PAG's (polyglycols) and diesters are the primary synthetic lubricants frequently used in these compressor types, depending upon their application.

("Dry or oil free type" helical screw compressors require only that the timing gears and bearings are lubricated. Viscosity ranges recommended are 32, 46, 68 or 100, depending upon temperature, speed and application).

5. **Straight lobe screw compressors;** generally require viscosity grade 150 or 220 for higher ambient temperatures. When low ambient temperatures are experienced, viscosity grade 68 is acceptable. All of these oils should be of the R & O type with anti-foaming additives. Depending upon the manufacturer or the application, synthetic lubricants may be recommended.

6. **Axial flow compressors;** require lubrication for shaft support journal bearings, axial thrust bearings, usually of the tilting pad type and any seals which may require lubrication. The lubricant generally recommended is a premium rust and oxidation inhibited oil of ISO 32 viscosity grade. In cases where a gear driven speed increaser is used, an ISO 46 or ISO 68 viscosity grade may be required. The synthetics most commonly used are diesters, polyglycols, polyalphaolefins and fluorosilicones.

Conversion To Synthetics

There are two very important considerations when converting any compressor system to synthetic lubricants. The first is that some synthetics will dissolve mineral base oil deposits and a viscous tar-like substance may develop, plugging piping, valves, intercoolers and heat exchangers. Conversion to synthetics therefore may require a complete flushing and cleaning of the entire system before installing the new fluid. Diester fluids in particular have excellent solvency and are frequently used as flushing fluids.

Secondly, all synthetic fluids may not be compatible with all seals or sealing materials. It is also necessary to determine if the synthetic fluid being considered is compatible with machine coatings or paints often found on the inside surfaces of reservoirs or other components. In general, polyglycols, diesters, polyalphaolefins and alkylated aromatics are compatible with the following seal materials.

Viton	Thiokol 3060
Kalrez	Polysulphide
Butyl k53	Mylar
Buna N	Polypropylene
Neoprene	Nylon elastomers
EPDM	Teflon
Polyethylene	Acrylonitrile-Butadiene

One exception is diester fluid, which is **not** compatible with neoprene or "low nitrile content" Buna N. Another exception is polyalphaolefins, which are **not** compatible with EPDM seal materials.

Where any question or concern exists when selecting synthetic fluids, **always** confirm your decision by consulting the equipment manufacturer and lubricant supplier.

Preventive/Predictive Maintenance and Condition Monitoring Recommendations

1. Determine and record normal full load electric motor current at a specific voltage. This can be referred to as a baseline when problems are experienced.

2. If the compressor has its own receiver, allow the compressor to fill this reservoir from zero to the cutout pressure. Record the cutout pressure and the time it takes to fill the reservoir. This can be used to monitor compressor efficiency at any later date.

3. Determine the acceptable discharge temperature. Normally, the high air temperature switch on a water cooled, dual stage reciprocating compressor is set at about 150–165°C (302–328°F). This temperature should be recorded and monitored as part of the condition monitoring program. (The higher the discharge temperature, the greater the possibility of corrosion, varnish and carbon deposits, lubricant oxidation and possible discharge line explosions if hot spots develop).

   In rotary compressors, the high air temperature switch is normally set at about 110°C (230°F) and is intended to shut the compressor down if the temperature rises. (As a rule of thumb, discharge temperature should be about 38°C (100°F) higher than the temperature of the inlet air).

4. Determine the oil operating temperature. It is important to maintain oil temperatures at about 65°C (150°F). This will ensure that the oil temperature is about 15 to 20 degrees higher than the pressure dew point which will help reduce the formation of condensate, as well as the formation of carbon and varnish deposits. (Pressure dew point is the lowest temperature to which compressed air can be exposed without causing condensation of entrained water vapor).

   For example, in a two stage air compressor taking in air at atmospheric pressure and a relative humidity of 75%, with a discharge pressure of 120 psi (758 kPa), about 14L (3 ¾ gal.) of water per hour may be condensed for each 1000 CFM of free air compressed. Any unusual increase in the recorded oil temperature should be immediately investigated.

5. Determine the filter quality necessary to ensure that inlet air enters the compressor uncontaminated and oil and bearing filters are capable of removing contaminants in the 10 micrometer absolute range or smaller. In flooded rotary compressors, the oil separator is also a critical component. It is a large sub-micronic filter and its quality of operation is far more important than its initial cost. It should be replaced or cleaned when differential pressure reaches about 10 psi.

6. Determine the normal, expected discharge pressure and record it for future reference and comparison if problems arise.

7. Due to the potential for corrosion, rust and varnish deposits, intercoolers, cylinder water jackets, aftercoolers or heat exchangers should be inspected and/or cleaned at least annually, as part of the PM program.

8. Air receivers (reservoirs), drains, condensate traps and air line filters should be visually inspected and drained at least once each week to ensure clean, moisture

free instrument or tool system control air. (This is a frequently neglected PM activity and the "best practices" approach recommended is to inspect and drain these components once a day. Automatic drain valves are of absolutely **no use** if they are **not working** properly!)

9. Inspect and clean lubricators regularly. In most pneumatic systems the lubricant is carried in the air stream and the amount of oil metered, whether as a fog or mist, is usually determined by adjusting the oil feed rate. This oil drip feed rate must be monitored regularly and the most effective feed rate recorded for maintenance reference.

   Some types of chemicals, such as synthetic solvents or lubricants and ketones may cause deterioration of the plastic or polycarbonate lubricator bowls, causing cracks or breakage, so determine compatibility of these products before their use.

10. Determine the cylinder lubrication feed rates for reciprocating compressors and record this information in the maintenance files. It is recommended that new or rebuilt compressor cylinders should be run in for 5–10 hours of operation at no load conditions using at least double the oil feed rate. This process will establish normal wear patterns and eliminate the possibility of scoring a new cylinder or its associated components.

    In general, the larger the bore and the higher the pressure, the longer the run in time required. Once run in is completed, the proper lubricator oil feed rate can be determined using the following formula:

$\frac{B \times S \times N \times 62.8}{10{,}000{,}000}$		=	Q
Where	B	=	Bore in inches
	S	=	Stroke in inches
	N	=	Compressor RPM
	Q	=	Quarts of oil per 24 hour operation

Once the proper rate has been established, the oil drops may be counted and this information recorded in the maintenance files. If the oil type or specifications are changed, this process **must be repeated.**

A typical example is:
A 12 inch (30.5 cm) compressor cylinder compressing air at a discharge pressure of 10 bar (145 psi) would require a lubricating oil feed rate of 12 drops per minute after run in. If the cylinder has two (2) lubrication points, each point should receive 6 drops per minute.

11. Inspect piping to ensure that fittings and drain valves are not leaking and supports are in good condition. In North America, leaking compressed air systems cost industrial plants hundreds of thousands of dollars annually.

For example; a combination of leaks totaling a ½ inch diameter hole, escaping at 60 psi of leaking pressure, will cost approximately $30,000.00! In addition, piping systems tend to corrode and form deposits and today's "best practices" suggest that when repairing or replacing piping, smooth bore pipe such as aluminum, or plastic should be used.

Interior pipe corrosion, poor piping system configuration and contaminated air or gas can cause inefficient energy use.

For example, a 15 psi pressure drop uses about 10% additional energy and over a ten to twelve year period, the cost of energy may exceed all other maintenance costs! **(SEE FIGURE 9.)**

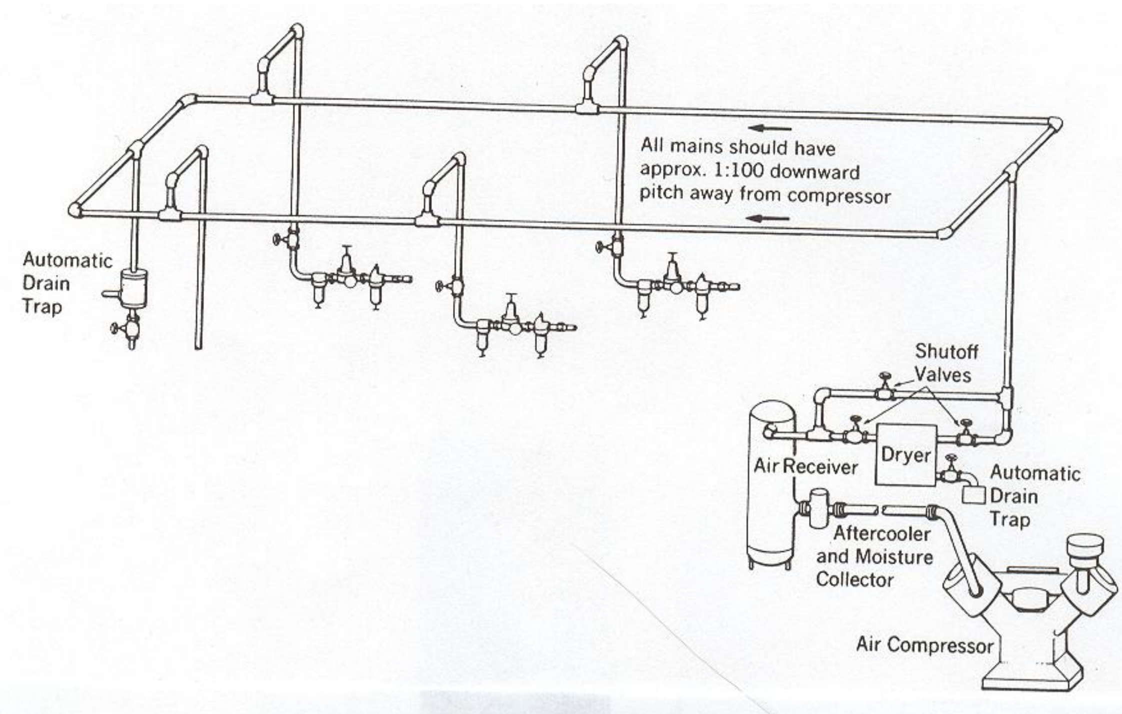


FIGURE 9.

12. Use predictive maintenance technologies to monitor compressor system condition on a regularly scheduled basis. The following pdm technologies are recommended for compressor condition monitoring.

    a) **Oil Analysis;** Using spectroscopic analysis, the levels of wear metal elements will provide information on the rates of compressor component wear. Oxidation levels of synthetic hydrocarbon and mineral base oils can be monitored effectively using infrared spectroscopy. In addition, pH, acid number and viscosity should be monitored for these lubricant types. A rapid or excessive decrease in pH indicates the ingestion of acidic gases or other contaminants. An increase in acid number suggests that the oil is reaching the end of its useful life. For systems with large lubricant reservoirs, the rotating pressure vessel oxidation test (RPVOT) will reveal the remaining useful life of these lubricants. The cost of this test will be far less than the replacement cost of the oil.

For polyglycol and polyolester synthetic lubricants, pH and acid number testing is also recommended.

In all compressor systems, water content should be measured regularly using such accurate methods as the Karl Fischer test. In addition, particulate content should be monitored regularly, using particle counting technology. Finally, whenever wear rates or particulate levels increase, analytical ferrography should be carried out. This analysis will provide information as to the type of contaminant or trace element and its possible source.

Compressor condensate analysis is also recommended to detect corrosive or acidic gases in the air which may be harmful to the system. A low pH or high acid number resulting from condensate analysis can reveal potentially serious corrosion conditions that could lead to shortened aftercooler and dryer life.

b) **Vibration Analysis;** Vibration analysis programs are now available for both reciprocating and rotary machinery. The most common vibration problems are unbalance (of pistons or rotors), misalignment (of drive belts, cylinder rods, or couplings), mechanical looseness (of mounting bolts, couplings, base plates, bearing caps, or drive motor components), resonance (of any component in the system), or bearing failures. If a vibration is suspected, a stroboscope can be used to confirm if a vibration is present, after which analyzers can be used to determine the source. Often noise is mistaken for a vibration. Ultrasonic analyzers are now available that are so sensitive that they can determine if noise levels are associated with a faulty component, such as early stages of bearing failure, or noise caused by an air leak in a control valve. These testers are **invaluable** for locating air or gas leaks that are difficult to locate. In fact, resonant conditions may be the **result** of excessive air or gas leaks, so it is recommended that leaks be corrected **before** more advanced troubleshooting or repairs are wasted.

c) **Thermographic analysis;** This predictive maintenance technology has been used primarily for locating electrical system hot spots, but it has become an extremely useful tool for locating hot spots caused by excessive discharge temperatures, partially plugged components, such as intercoolers or heat exchangers, seal rubs, misaligned couplings or drive belts, overheated bearings and faulty lubricating oil pumps. All of these conditions may cause increases in operating temperatures and **any** higher than normal temperature should be investigated immediately.

For example; a slightly misaligned coupling can cause an increase in temperature **without** any apparent vibration. The temperature increase at the coupling will be high enough to cause premature failure of the bearings nearest the coupling, because the higher than normal temperature could cause premature oxidation of the grease in the bearings. This is a common cause of premature bearing failure in both drive and driven machinery.

Troubleshooting Compressors

Symptom	Possible Cause(s)
Failure to deliver output	-Excessive clearance between vanes, lobes or screws (rotary compressors). -Worn or broken valves and/or defective unloader(s) (reciprocating compressors).
Insufficient output or low pressure	-Restricted or dirty inlet filter. -Excessive leakage (air system). -Inadequate speed. -Worn or damaged piston rings (vanes, lobes or screws on rotary systems). -System demand exceeds capacity. -Worn valves or defective unloader(s).
Compressor overheats	-Carbon deposits on discharge valves. -Excessive discharge pressure. -Worn or broken valves. -Excessive speed. -Inadequate cooling. -Dirty cylinder water jackets. -Inadequate cylinder lubrication. -Defective unloader(s).
Compressor running gear overheats	-Inadequate lubrication. -Excessive drive belt tension (where used). -Excessive speed. -Excessive discharge pressure. -Worn or damaged rotating components (rotary compressors). -Excessive discharge pressure.
Compressor knocks	-Inadequate lubrication. -Insufficient head clearance. -Excessive crosshead clearance. -Loose piston rod(s). -Excessive bearing clearance. -Loose or damaged piston(s) (reciprocating compressors). -Loose flywheel or drive pulley (where

	used). -Misalignment at coupling. -Damaged foundation or grouting. -Loose motor rotor or shaft.
Compressor vibrates	-Piping improperly supported causing resonance. -Misalignment at coupling. -Loose flywheel or pulleys (where used). -Defective unloader(s). -Unbalanced motor or defective motor bearings. -Inadequate cylinder lubrication. -Loose base plate mounting bolts or soft foot. -Incorrect speed. -Damaged foundation or grouting. -Excessive discharge pressure. -Worn or damaged rotating components (rotary compressors).
Excessive intercooler pressure	-Worn or broken valves, second stage. -Defective unloader, second stage.
Low intercooler pressure	-Worn or broken valves, first stage. -Defective unloader, first stage. -Dirty or restricted inlet filter or suction line. -Worn piston rings on low pressure (first stage) piston. -Worn rotating components (rotary compressors).
Excessive receiver pressure	-Defective unloader(s). -Excessive discharge pressure.
High discharge temperature	-Carbon deposits on discharge valves. -Worn or broken valves. -Defective unloader(s). -Excessive discharge pressure. -Inadequate cooling. -Dirty water jackets (or plugged or dirty fins on air cooled compressors). -Dirty or plugged intercooler. -Abnormal (high) intercooler pressure. -Inadequate cylinder lubrication.

Cooling water discharge temperature too high	-Low level of coolant. -Dirty water jackets. -Worn or broken valves. -Defective unloader(s). -Excessive discharge pressure. -Dirty or corroded intercooler. -Abnormal intercooler pressure.
Valves overheat	-Excessive discharge pressure. -Long unloaded cycles (inlet valves). -Damaged or carbonized valves. -Defective unloader(s).
Drive motor overheats	-Inadequately sized motor. -Excessive discharge pressure. -Worn or broken valves. -Abnormal intercooler pressure. -Inadequate lubrication (compressor running gear or motor bearings). -Misalignment at coupling. -Excessive belt tension (where used). -Low voltage.
High levels of condensate	-Excessive discharge pressure. -Excessive discharge temperature. -Inoperative intercooler. -Plugged or inoperative heat exchanger or water separator.
Premature oil thickening or discoloration	-Excessive lubricant operating temperature. -Compressor operating temperature too high. -Inadequate lubricant type (wrong oil for the application). -Worn or faulty piston rings. -Excessive discharge temperature. -Lubricant oxidation.
Compressor seals fail prematurely	-Excessive operating temperatures. -Lubricant incompatible with seal materials. -Misalignment at coupling. -Excessive crank case pressure. -Seal material incompatible with the gas being processed.

High oil consumption	-Oil level too high. -Faulty gas/oil separator. -Scavenger tubes plugged. -Oil leaks at gaskets, seals or fittings. -Excessive oil pumping (reciprocating compressors).

Note: This troubleshooting guide is general in nature. Depending upon the compressor type, its operating conditions or its application, some of these symptoms and their possible causes may not apply. It is therefore essential that operating personnel be completely familiar with their machine, its processes and operating conditions.

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