ANGI ENERGY SYSTEMS

JUNE 2006

OPERATION AND MAINTENANCE MANUAL

ELECTRIC MOTOR DRIVE ARIEL CNG COMPRESSOR STATION

NOTICE

IMPORTANT SAFETY INFORMATION

Only operate this equipment in accordance with the instructions provided in this manual. Improper operation of this equipment could cause serious bodily harm or death and will void the equipment warranty.

Repair or maintenance of this equipment should only be completed by ANGI Customer Service personnel or the Customer's qualified service representative.

Should you detect a gas leak…

1. Immediately shut down the compressor and leave the compressor station.
2. Extinguish any open flame or source of ignition.
3. Shut off the supply valve and contact your authorized ANGI service representative and/or gas supplier.

ANGI NATURAL GAS COMPRESSOR STATION
ELECTRIC MOTOR DRIVE, ARIEL PACKAGE

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USER MODIFICATION

ANGI must authorize all modifications to this equipment. Any unauthorized modifications will void the warranty, may cause damage to the equipment and could cause bodily harm.

DISCLAIMER

ANGI disclaims any responsibilities whatsoever to the customer or to any person for injury or damage to or loss of property or value resulting from the use of its products which have been subjected to misuse, accidents, misapplied, repaired by unauthorized person, or improperly installed.

NOTICE: This manual is as current as possible at the time of printing and is subject to change without notice. For information not covered in this manual, consult ANGI.

CONTRACTOR OR INSTALLER: Leave this manual with the compressor station after installation is complete.

CUSTOMER: Retain this manual for future reference.

1. INTRODUCTION

This manual is intended to assist in the operation and maintenance of ANGI compressed natural gas (CNG) compressors used in CNG vehicle re-fueling applications.

ANGI Compressor Stations are designed for continuous duty and unattended operation when properly applied and serviced. This compressor station is designed to compress natural gas to desired discharge pressure. The compressor, manufactured by Ariel Corporation, is a lubricated, multi-stage, horizontally opposed, balanced, reciprocating compressor.

An electric motor drives the compressor by means of a direct coupling. The compressor package includes forced-air inter-coolers and after-cooler to cool the process gas between each stage of compression and prior to discharge, relief valves, and particulate and coalescing filters and priority storage valves.

The compressor station is delivered with a control system to provide automated compressor operation, shut down limit monitoring and fault annunciation.

The machine is designed and manufactured to conform to NFPA 52 for Compressed Natural Gas (CNG) Vehicular Fuel Systems and the National Electrical Code ANSI/NFPA 70.

2. DESCRIPTION

2.1 COMPRESSOR

The compressor station utilizes an Ariel compressor frame configured with specific cylinders, pistons, and valve components sized to provide the gas delivery performance required for this application. Full details on the Ariel compressor used in this application may be found in the Ariel manuals provided with this machine.

Integral to the compressor is a chain driven frame lube pump and filter system, a separate force feed lube and manifold system to distribute lubricant to the lube points for the packing seals and rings and a venting system. The oil is cooled by means of a remote oil cooler. An optional oil immersion heater is used to maintain a minimum oil temperature in cold service environments.

2.2 GAS SYSTEM

The gas system can be divided into the induction system, compressing system, re-circulation system.

2.2.1 Induction System

Gas is delivered to the station by a user-supplied connection. If it is possible for the inlet gas pressure to rise above the specified inlet pressure, then the user must provide an inlet regulator to restrict the inlet pressure to a value within the limits of the machine. The control system monitors the inlet gas pressure and will shut down the compressor if the inlet gas is not provided within the allowable pressure range. The shut down levels for the inlet gas pressure have been set for the proper operating pressure range and should not be adjusted in the field.

Gas is also re-introduced into the inlet of the compressor from the captive recovery tank located on the skid. An on-skid regulator is provided to regulate the pressure of the re-circulated gas to match the specified inlet gas pressure. By re-circulating the gas in this fashion, the gas from the compressor blow-down process is recovered.

An actuated inlet valve is provided on-skid to interrupt gas flow to the compressor. This valve is only open when the compressor running in loaded operation and during the warm-up and cool down cycle. This valve remains closed when the compressor is off or in stand-by.

An inlet filter is provided to trap any incoming particulate and minor slugs of water or oil from the captive recovery tank. The bowl on this filter is provided with a sight gauge to determine if the filter should be drained.

The inlet piping is provided with a safety relief valve to prevent over-pressurization due to failure of one of the pressure regulators or 1st stage compressor valves.

2.2.2 Compressing System

This portion of the system contains the reciprocating compressor, safety relief valves, inter-stage filtration, inter-stage cooling and after cooling. The gas is compressed to the specified discharge pressure in multiple stages of compression.

Between each stage of compression, the gas is passed through air-cooled fin and tube heat exchangers to be cooled. The heat exchangers and fan system have been sized to meet the application.

After cooling, the gas is past through a filter to remove any condensed liquids and to reduce the amount of oil introduced into the gas stream by the compressor.

At the discharge of each stage of compression, the gas temperature and pressure is monitored against shutdown limits and the compressor will shutdown should any inter-stage pressure or temperature trend outside of the operational limits.

Exiting the final stage of compression, the gas is passed through an air-cooled, fin and tube heat exchanger for after-cooling. The after-cooler and cooling fan have been sized to meet the application.

The gas is then passed through a pre-coalescing filter and a coalescing filter to remove oil from the gas stream prior to delivery to the storage system or dispenser.

After the final stage filtration, the discharge pressure is monitored by the control system against START and STOP limits to determine if the compressor should resume, continue or stop compressing gas.

Safety relief valves are provided on each stage of the compressor discharge piping to prevent dangerous over-pressurization due to compressor valve failure, flow blockage or control system failure.

2.2.3 Re-circulation System
Tubing lines and valves are installed between the inter-stage and discharge filter bowls and the captive receiver tank. At pre-determined intervals of operation and during warm-up and cool-down sequences, the gas is allowed to flow from the discharge of the compressor stages, through the filter bowls and into the receiver tank. During this time, the compressor is effectively operating unloaded and, consequently, allows for smooth compressor starts and stops. This system also allows for automatic purging of the filter bowls of accumulated liquids.

2.3. COMPRESSOR AND FAN DRIVER

An electric motor rated for the application is used to drive the compressor. The motor has been sized for this application and has adequate power to drive the compressor with ample reserve power to maintain a continuous duty rating. A smaller secondary motor is provided to drive the cooler fan.

A motor starter starts the compressor motor. Inside the motor starter enclosure is a motor contractor for starting the fan motor. The motors are started and stopped automatically based on control signals sent to the motor starters from the control system.

2.4 CONTROLS AND INSTRUMENTATION

2.4.1 Control System
This compressor station is delivered with a PLC based control system. The control system provides all the compressor controls and monitoring function required to allow fully automatic, unattended operation and to provide fault code annunciation for quick fault recovery.

For additional technical information on the control system refer to the control system operations manual and the electrical drawing package included in this manual.

2.4.1.1 Modes of Operation
With power supplied to the station and the ON/OFF keyswitch placed in the ON position, the control system is capable of supporting five modes of operation. These modes of operation are;

1) STAND-BY
In this mode the storage is considered to be full and the compressor is stopped. The control system monitors the discharge pressure against a START pressure limit. The compressor will remain in this mode until the storage is depleted below this START pressure limit.

2) WARM-UP
Once the control system detects that the gas storage has been emptied below the START pressure limit, the pre-lube pump runs for a period of time, the inlet valve opens, the fan motor is started and runs and then the compressor drive motor is started and runs. During this warm-up period the load/recirculation valve is open so that gas is simply re-circulated through the captive receiver tank.

3) COMPRESSION
After the completion of the warm-up cycle, the control system switches to loaded compressor operation. During the transition from warm-up mode, the fan and compressor motors remain on and the load/recirculation valve is closed so that gas flows into to the discharge piping. During longer, uninterrupted operation in this mode, the load/recirculation valve will open during pre-determined intervals to drain the filter bowls of accumulated fluids. The control system

will continue to run in this mode until the discharge pressure reaches the STOP pressure set point defined in the controller (or the compressor faults)

4) COOL-DOWN
Once the controller determines that the storage pressure is above the STOP pressure set-point, the load/recirculation valve opens and the compressor motor and fan motor continue to run for a period of time to allow the compressor to unload and cool. After a cool down timer expires, the fan and compressor motors are stopped and the control system returns to STAND-BY mode.

5) FAULTED
During any of the modes mentioned above, the control system may detect a shutdown condition and the machine will be placed in FAULTED mode. In this mode the suction valve is closed and the fan and compressor motor is stopped. The nature of the fault is announced on the front panel of the control enclosure.

2.4.1.2 Fault Conditions
A number of digital inputs and analog transducers are monitored by the control system to initiate a machine shutdown due to faulted operation.

Only a subset of all the inputs and transducers are monitored for fault conditions in any one of the possible modes of operation. For example, the compressor oil pressure reading is ignored during STAND-BY operation.

The fault tables below identify possible fault conditions.

DIGITAL FAULTS	
	DESCRIPTION
	Keyswitch
	Reset
	Oil Level Low
	High Vibration
	Low Oil Flow – Compressor
	High Final Pressure
	Emergency Stop Activated
	High Liquid Level – Receiver
	High Lube Temp – Compressor
	Too Many Starts Per Hour

Note: An Emergency Stop Fault is an indication that either a remote or local E-Stop pushbutton has been depressed (or a rate of rise heat detector has detected a fire or the gas detector has detected a gas leak).

HIGH ANALOG FAULTS	
	DESCRIPTION
	High Suction Pressure
	High Receiver Pressure
	High Final Pressure
	High 1st Stage Pressure
	High 2nd Stage Pressure
	High 3rd Stage Pressure
	High 4th Stage Pressure
	High Oil Pressure – Compressor
	High 1st Stage Temperature
	High 2nd Stage Temperature
	High 3rd Stage Temperature
	High 4th Stage Temperature

LOW ANALOG FAULTS	
	DESCRIPTION
	Low Suction Pressure
	Low Receiver Pressure
	Low Final Pressure
	Low 1st Stage Pressure
	Low 2nd Stage Pressure
	Low 3rd Stage Pressure
	Low 4th Stage Pressure
	Low Oil Pressure – Compressor
	Low 1st Stage Temperature
	Low 2nd Stage Temperature
	Low 3rd Stage Temperature
	Low 4th Stage Temperature

3. COMPRESSOR SAFETY

3.1 GENERAL SYNOPSIS

ANGI designs and manufactures all its products for safe operation. However, the responsibility for safe operation rests with those who use and maintain these products. The following safety precautions are offered as a guide, which, if followed, will minimize the possibility of accidents throughout the useful life of this equipment.

Only those delegated individuals who have read and understand the operator's manual and have satisfactorily completed the ANGI training should operate this CNG compressor station. Failure to follow the instructions, procedures and safety precautions in this manual may increase the possibility of accidents and injuries.

Never start this CNG compressor station unless it is safe to do so. Do not attempt to operate the CNG compressor station with a known unsafe condition. Lock Out / Tag Out the compressor station to render it inoperative so others who do not know of the unsafe condition will not attempt to operate the unit until the unsafe condition has been corrected.

Never clean, adjust or repair this machinery while it is in an operating state. To reduce the risk of injury while performing service follow the instructions in the manual for placing the CNG compressor station in a zero energy state.

Use and operate this CNG compressor only in full compliance with all pertinent OSHA requirements and pertinent federal, state and local code requirements.

Do not modify this CNG compressor station except with written factory approval.

3.2 OPERATING

3.2.1 Before You Start the Compressor

* Assure that there are no obstructions near the enclosure that may restrict ventilation flow.
* Check fluid levels
* Check for any signs of fluid leaks on the floor/ground.
* Remove all tools and/or loose items from the equipment.
* Verify that the inlet gas pressure does not exceed allowable limits of this machinery.
* Verify that all guards are in place
* Verify that all sources of ignition are extinguished.
* Verify that authorized personnel have satisfactorily completed all scheduled maintenance tasks.
* Verify that all valves between compressor discharge and storage are open.

3.2.2 Use of Compressor Station

* Do not wear loose clothing around the machinery.
* Do not operate the equipment with loose, broken or out of balance fan blades.
* Do not operate the equipment with a known gas leak.
* Routinely (daily) monitor and record all gauge pressures as part of your predictive maintenance program.

3.2.3 Other Safety Precautions

* Do not touch hot surfaces or moving parts, such as exhaust or fans.
* Do not adjust or restrict relief valves.
* Do not disconnect or alter shutdown sensors or switches.
* Be aware of hot surfaces, sharp corners and edges.

3.3 SERVICING

* Before servicing this compressor station, place the station in a zero energy condition in accordance with the instructions below.
* Make repairs only in clean, dry, well-lighted and well-ventilated areas. Keep all parts of the body and any hand held tools or other metal objects away from exposed live parts of the electrical system.

3.3.1 Zero Energy Condition

To minimize the risk of injury or accident during servicing, these procedures should be followed to place the station in a zero energy state.

CAUTION! ELEVATED PRESSURES WILL STILL EXIST IN PORTIONS OF THE COMPRESSOR STATION PIPING AFTER PERFORMING THESE PROCEDURES.

1) Using your companies approved Lock Out / Tag Out procedures, disconnect the three phase electrical voltage and the control voltage. Consult site drawings for the location.
2) Using approved Lock Out / Tag Out procedures, turn off the main inlet gas valve.
3) Using approved Lock Out / Tag Out procedures, turn off the isolation valves on the storage cascade. Consult site drawings for the location.

4) Insure there is no source of ignition near or down wind of the compressor station.
5) Open the manual ball valve, located near the final compressor stage relief valve, in the final stage discharge line to vent discharge line gas.
6) Open the manual ball valve on the captive receiver tank to vent the gas in the tank.

Failure to heed any of the above warnings or misuse of the compressor, even though not expressly mentioned herein, may result in severe injury or death, property damage and/or mechanical failure for which ANGI will not be held responsible.

3.4 LIFTING/TIE DOWN

The compressor station will be provided with four lifting eyes on the outside corners of the station or it will be supplied with four overhead lifting eyes. If overhead lifting eyes are provided, use them instead of the 4 corner lift points to eliminate the requirement for the long spreader bar and to reduce the occurrence of damage to the compressor enclosure.

If there are any question regarding lifting, tie down or securing this equipment, contact ANGI prior moving this equipment.

Only designated personnel shall do the lifting. The load capacity rating shall be clearly marked on hoist. Do not exceed load rating. Inspection and testing for cracks or defects in hoist system shall be performed on a regular basis. Before lifting, alert personnel in immediate areas. Do not stand under unit while it is being moved from one area to another on a hoist. Do not stand under unit to do maintenance work.
Lifting eyes are positioned to provide safe lifting and/or tie down and must be used properly. Secure or lift using all rings at all times. Secure at approved tie down points only. Failure to follow proper procedures can result in damage to equipment and injury to personnel.

4. INSTALLATION

4.1 UNPACKING AND HANDLING

Occasionally, damage may occur during shipping. Be sure to carefully inspect the unit before and after unpacking. If damage has occurred, contact the freight carrier and file the appropriate claim forms. Then inform your ANGI representative immediately.

Your compressor station has been prepared for shipping at ANGI's factory. This preparation requires disassembly of some of the station components. Re-assembly at the site is to be completed with proper instruction or supervision of the ANGI service representative.

4.2 SITE REQUIREMENTS

Installation is only to be completed with the direct involvement of an authorized ANGI customer service representative or with full installation drawings present at the installation site. Do not attempt to install this equipment without these resources.

During installation, should any discrepancy be found between the actual machinery and the machine prints or site drawing, immediately notify the installation coordinator and the ANGI customer service representative.

4.2.1 Foundation

Your ANGI compressor station should be installed on a level pad of 8 inch (minimum thickness) reinforced concrete. The compressor station should not be operated prior to being secured to the concrete pad.

4.2.2 Gas Supply

CAUTION! THE INDUCTION MUST NEVER BE ALLOWED TO FLOAT HIGHER THAN THE SPECIFED MAXIMUM INDUCTION PRESSURE. MACHINE DAMAGE MAY RESULT.

The volume of gas required is dependent on induction pressure and discharge pressure conditions.

4.2.3 High Pressure Gas Connections

High-pressure discharge lines between the compressor station and the storage and/or dispenser(s) are typically connected by qualified contractors or by an ANGI authorized customer service representative. Consult the site diagrams and the on-site ANGI representative prior to making these connections.

4.2.4 Electrical Connections

High voltage connections are to be made only by a qualified electrician, in accordance with the ANGI interconnection diagrams.

Each of the following connections is required between the compressor station and the site's control and power distribution center:

1) Grounding connections
2) Control power lines
3) Control signal wires
4) Infallible ground connection
5) ESD wiring
6) Telephone wiring (If required)

Verify that each of these connections have been made as specified on ANGI's interconnection diagrams.

4.3 STORAGE

In some cases it may be necessary to store the compressor for extended periods of time before placing the unit in operation:

1) Place the station in a zero energy condition in accordance with the instructions provided in this manual.
2) Cover and seal all machine openings to prevent the entrance of water and dirt.
3) If the storage conditions are below freezing, make sure any moisture is drained off aftercoolers, traps, water-cooled heat exchangers and attendant piping.
4) Cover with a waterproof tarpaulin that can be easily removed for in-storage maintenance.
5) Place a fresh desiccant package in the control enclosure and in the on skid motor starter enclosure (if supplied)
6) Compressor cylinders, valves, valve pockets, cross-head guides and the inside of the cylinder lube pump box should be coated with a polar anti-seize/anti-rust agent such as Mobil Oil Corporation, Mobilarma No. 246.
7) Pour 3 ounces of liquid vapor corrosion inhibitor such as Corroless 300 into the crankcase.
8) Every two or three months, manually crank the compressor motor over one turn plus 90 degrees to prevent flat spots on the bearings that could lead to premature failure.

At the end of the storage period, follow the uncrating and start up procedures. If the unit has been stored for an extended period, contact ANGI before restarting the compressor.

5. OPERATION

5.1 INITIAL START UP

IMPORTANT! READ ARIEL CORPORATION'S SERVICE MANUAL AND COMPLETE THE ARIEL START-UP CHECK LIST.

1) Verify that all scheduled installation tasks have been completed and inspected and all auxiliary equipment is prepared.
2) Complete the Ariel Compressor Start Up Check List in entirety
3) Inspect fan blades to insure they are not missing, cracked or otherwise damaged.
4) Verify all belts are in place and properly tensioned and guards are in place and that they do not interfere with rotating equipment.
5) Verify that all safety devices and Emergency Stop circuits are functional.
6) Verify inlet pressure is correct.
7) Verify all electrical connections to the motor starter are properly made.
8) Verify that all personnel are at a clear and safe distance from the machine and have been instructed that the machine is to be started.
9) When ready to start, apply power to the station and place the ON/OFF keyswitch in the ON position.
10) Observe that the fan motor starts smoothly without lugging and without belt slippage.
11) Observe that the compressor motor starts smoothly without lugging and absent of harsh vibrations and noises.
12) Verify that the compressor crankcase develops oil pressure and that the indicator pin is moving on the compressor lubrication distribution block.
13) Observe that there are no excessive vibrations or unusual noises.
14) Check for any gas leaks.
15) Check for any oil leaks.
16) Monitor and record inter-stage and discharge pressures.

6. MAINTENANCE

6.1 RECOMMENDED PREVENTATIVE MAINTENANCE SCHEDULE

ANGI has developed a preventative maintenance schedule for this equipment based on number of hours of operation. Adhering to this schedule will minimize unscheduled downtime and assure long machine life.

This maintenance schedule is summarized in the **Preventative Maintenance Table** included in the Appendix in this section. The maintenance intervals in this table are based on the hours of operation displayed on the control panel hour meter. When using this table, refer to the Service Specifications in this manual for detailed servicing procedures and considerations.

This table has been set-up based on nominal operating conditions and will need to be altered for harsh operating environments.

When performing any maintenance, lock out the controls to prevent inadvertent starting.

6.2 SERVICE SPECIFICATIONS

6.2.1 COMPRESSOR CRANKCASE LUBE SYSTEM

6.2.1.1. Compressor Lubrication Spec.
See Compressor Operation & Maintenance Manual for the correct lubrication specifications.

The compressor is shipped with Polyglycol lubricant in the crankcase on all North American orders. DO NOT MIX with Petroleum based oils.
International shipments have diester synthetic oil in the crankcase. Diester synthetic will mix with petroleum oils.

6.2.1.2. Compressor Crankcase Lube Level
A sight glass is provided on the auxiliary end of the crankcase that identifies the lubrication level. The oil should always be replenished by removing the breather cap and adding oil through the top cover.

DO NOT ADD OIL WHILE THE COMPRESSOR IS RUNNING

The oil level should be filled 2/3-3/4 of the sight glass. DO NOT OVERFILL THE CRANKCASE SUMP. After running the compressor, it may be necessary to add oil to the crankcase sump to one-half level on the sight gauge, but never must exceed two-thirds height when the compressor is primed and running.

Assure that the system has been fully primed prior to checking oil levels.

6.2.1.3. Compressor Crankcase Oil Pressure
A spring loaded oil pressure regulator is provided on the compressor. The oil pressure may be adjusted by removing the cover on the regulator and turning the adjusting bolt. The oil pressure has been set by ANGI to the proper operating pressure of 55-60 psig as measured on the downstream side of the oil filter.

6.2.1.4. Compressor Crankcase Oil Filtration
A strainer basket and oil filter is provided to provide filtration. Always replace the oil filter element and clean the strainer basket when replacing the crankcase oil.

The strainer basket is located on the auxiliary end of the compressor frame below the oil level.

Only the replace filter element with a same grade element. Element replacement interval should be completed per the Periodic Maintenance Schedule or any time a 10 psig pressure drop is detected across the filter.

6.2.2. COMPRESSOR FORCED FEED LUBRICATION SYSTEM

6.2.2.1. Lubrication Reservoir Level
A separate lubrication reservoir and sight glass is provided to lubricate the worm gear and cam on the lubricator.

6.2.2.2. Lubrication Rate
The lubrication feed rate may be adjusted by turning an adjuster knob on top of the lubricator. Proper lubrication rate may be confirmed by observing the indication on the digital no-flow switch. This switch is mounted to the lubrication distribution block. Verify that the lubrication rate by observing the indication and comparing the rate to that specified on data plate attached to the lubricator.

6.2.3. COOLING SYSTEM

6.2.3.1 Cooling Fan
The fan blade should be inspected for cracked or broken blades. Additionally, the blade pitch should be uniform between blades. Verify that the fan is not rubbing on the bell or on any fan guarding.

Never operate the station with missing or damaged fan blades or without the fan blades properly installed.

6.2.3.2 Gas Cooler Cores

Inspect coolers for loose inlet and discharge clamps, leaks and debris caught in the cooler fins.

Clear all debris from cooler fins and/or cooler levers to assure full, unrestricted air flow is permitted across the entire cooler face.

6.2.5. MONITORING & REPORTING GAUGE PRESSURES AND TEMPERATURES

Recording and charting of gauge pressures and gauge temperatures can help identify a developing compressor problem before downtime or damage results.

ANGI recommends that all gauge temperatures and pressures be recorded on a daily basis and charted for trends. Be sure to also record time of day, ambient temperature and any other environmental condition that may influence gauge readings.

6.2.4. RECEIVER TANK

Fluids filtered from the filter bowls are automatically drained and will collect in the receiver tank. Therefore, the receiver tank should be drained periodically. To drain the receiver tank, slowly open the manual valve located on the drain piping exiting the bottom of the receiver tank.

A high liquid level switch is provided in the receiver tank to fault the station should the liquid level become to high.

6.2.5. COMPRESSOR VALVES

This compressor is equipped with premium compressor valves manufactured by the Hoerbiger Corporation.

Compressor valves require periodic inspection, cleaning and rebuild. These operations should be performed per instructions provided in the Hoerbiger service manual and the Ariel compressor service manual included with this manual.

Careful attention must be paid to component orientation and assembly sequence. When replacing springs, use replacement springs with identical springing valves.

6.2.6. FILTERS AND OIL SEPARATORS

6.2.6.1 Inlet Filter

An inlet filter is provided to keep particulate material and minor slugs of water and oil out of the compression system. This filter is equipped with sight gage to indicate if any amount of liquid is accumulating in the filter bowl.

If liquid has collected in the bowl, drain the filter bowl using the manual service valve at the bottom of the filter bowl.

Since this filter has only limited capacity to protect the compressor from damage due to liquid in the gas stream, any observance of liquid in the filter bowl should be investigated. If an inlet gas dryer is used in the process it may need to be serviced. If no dryer is present, one may need to be added.

The inlet filter has a replaceable or washable filter element installed. This element needs to be changed or cleaned at the prescribed service interval.

6.2.6.2 Coalescing Filters

Inter-stage and final discharge coalescing filters are provided to control oil introduced into the gas by the compression process and to eliminate in liquids which may have condensed out of the gas stream during compression.

The inter-stage filters utilize removable fine mesh strainer elements that may be cleaned and re-used. These elements should be pulled out of the filter housing for inspection and cleaning at the prescribed service interval. If any portion of the element appears damaged or stressed, then replace the element with a new one. Inspect the sealing o-ring on the element holder and the housing cover to assure it has not been damaged. Use care not the damage the seals when re-installing the element and element holder.

The final filters utilize replaceable filter elements that should be replaced at intervals prescribed on the periodic maintenance schedule. When replacing these elements, assure they are properly mounted in the filter assembly and use caution not to cut or damage pressure-sealing o-rings on the filter.

7. TROUBLESHOOTING

1. Low Compressor Oil Pressures
   A. Check the oil level
   B. Check/Replace oil filter element
   C. Clean oil strainer bowl
   D. Check for oil leak
   E. Check for defective pressure switch
   F. Check/Adjust oil pressure reg. setting
   G. Check oil pressure pump
   H. Check 3 phase circuit breaker/fuses

2. High Discharge Temperature
   A. Check for failed compressor valve
   B. Check cooler fins for debris
   C. Check cooler fan.
   D. Check for high discharge temperature
   E. Compare RTD reading to thermometer reading to verify RTD function

3. High Inlet Pressure
   A. Check induction regulator setting (off skid)
   B. Check receiver tank discharge regulator setting

4. High Discharge Pressure
   A. Check compressor valves
   B. Check for blockage in discharge piping

5. Low Discharge Pressure
   A. Check for low induction pressure
   B. Check for leaks
   C. Check valves
   D. Check for restrictions in inlet
   E. Check/Replace Filter Elements

6. Low Flow Capacity
   A. Check for leaks
   B. Check for low induction pressure
   C. Check for proper driver rpm
   D. Check compressor valves
   E. Inspect compressor piston rings

8. Unit Shuts Down After Start Sequence
   A. Read fault indications
   B. Verify that the motor starter did not overload

9. High Oil Carry-over In Discharge Gas
   A. Check/Replace inter-stage & final filters
   B. Verify operation of automatic drain sequence
   C. Check for proper crankcase lube level
   D. Verify force-feed lube rate
   E. Check compressor inlet valves

10. High Lube Temp – Compressor
   A. Clear any debris from oil cooler
   B. Check/Replace oil filter element
   C. Change oil if required.

11. High Receiver Tank Pressure
   A. Verify receiver discharge reg. setting
   B. Make sure liquid level float switch is functioning and the receiver tank is drained
   C. Check discharge check valve for leakage

12. Hi/Low Analog Temperature Readings On Several Channels
   A. Verify that DC power supply in the control panel is delivering 24.0 VDC
   B. Replace or swap analog input card

13. Hi/Low Analog Temperature Readings on a Single Channel
   A. Check wiring between A/D card and barrier and between barrier and traducer.
   B. Replace transmitter or RTD
   C. Replace input barrier

APPENDIX 1. Preventive Maintenance Schedule

Maintenance Levels		Level 1	Level 2	Level 3	Level 4	Level 5
Operation Interval		Daily	Monthly	Every 2000 Hours Of Operation	Every 4000 Hours Of Operation	Every 8000 Hours Of Operation
Shutdown Required		Yes	Yes	Yes	Yes	Yes
Item	Service Item					
1	Monitor & Record Working Pressures and Temperatures	✓				
2	Check Compressor, Piping and Tubing For Obvious Leaks, Loose Connections or Loose Clamps	✓				
3	Check For Rough/Unusual Noises	✓				
4	Check Compressor Oil Level	✓				
5	Drain Receiver Tank If Required		✓			
6	Drain Condensate Pot		✓			
7	Change Compressor Oil & Filter And Clean Strainer			✓		
8	Clean Inter-stage Stage Filter Elements and Replace Final Filter Elements and Inlet Filter Elements			✓		
9	Inspect Safety Relief Valves			✓		
10	Inspect Compressor Valves			✓		
11	Inspect Compressor Rings and Seals				✓	
12	Verify Driver / Compressor Alignment				✓	
13	Inspect Compressor Crank Shaft Main & Rod Bearings				✓	
14	Inspect Compressor Lub. Drive Chain				✓	
15	Drain and Clean Heat Exchanger Cores				✓	