

WELCH-ILMVAC

OWNER'S MANUAL FOR VACUUM PUMP MODELS: 1376N, 1376N-01, 1376N-10, 1376N-63, 1376N-49, 1376N-53, 1376M-10, 1376N-57 & 1376N-60



WARNING

Never block the Exhaust Port.

If the exhaust port is blocked, pressure will build-up in the pump with the potential of the pump body bursting and causing possible injury to personnel in the area.

Welch-Ilmvac
5621 W. Howard Street
Niles, IL 60714
Phone: (847) 676-8800 (Technical Support)
Fax: (847) 677-8606
E-Mail: gdwelchvacuum@gardnerdenver.com
Web-Page: www.welchvacuum.com

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INSTRUCTION
WARNING AND CAUTION
PLEASE READ BEFORE OPERATION

While reading your manual, please pay close attention to areas labeled:
WARNING AND CAUTION.

The description of each is found below.

WARNING

Warnings are given where failure to observe instruction could result in injury or death to people.

CAUTION

Cautions are found where failure to observe the instruction could result in damage to the equipment, associated equipment and process.

These units conform to the SI International system of units of measurement.

The following symbols (with recommendation of IEC1010) of warning will be found on the pump.



Caution - Refer to accompanying documents



Caution - Risk of electrical shock



Caution - Hot surface

WARNING

Motor includes a self resetting thermal cutout and the pump could restart without actuation under fault condition.

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Section 1: INSTALLATION

1.10 Introduction

This manual has been compiled not only for the care and maintenance of the pump now in your possession but as a helpful reference and guide for many problems which are usually associated with mechanical vacuum pumps. Take time to read these instructions carefully and preserve this manual for future reference; we think it will be useful to you.

1.11 Unpacking

Carefully remove the pump from the shipping case and unfasten and remove the wooden skid. Preserve all paper work and inspection tags for future reference. If damage has occurred from shipment a claim must be filed with the carrier immediately; preserve the shipping container for inspection by the carrier. If you are required to communicate with your dealer or with Welch Vacuum be sure to include your order numbers for quick identification. Do not return the pump to the factory without first completing the on-line request form for returned goods authorization at www.welchvacuum.com.

1.12 Pump Mounting

1.121 Mounted Pumps

Rubber bumpers are supplied with most of our mounted pumps, either loosely or attached. Bumpers are excellent for applications involving a semi-flexible surface such as a bench top; they help to isolate noise and eliminate creeping. For more rigid requirements, the pump base may be bolted directly to a firm foundation with or without the bumpers. All pumps should be mounted in a horizontal plane.

1.122 Unmounted Pumps

If you have purchased an unmounted pump, refer to parts list for information concerning the motor, motor pulley and belt necessary to drive your particular pump at the recommended speed.

1.13 Pump Location

The pump should be located preferably in a clean and well ventilated area and adequate space should be provided wherever possible for routine maintenance such as changes of oil and belt adjustments and replacements. Above all, the pump should be located as closely as possible to its system in order to utilize it most efficiently. Its location should include such determining factors as the length and size of connections, the number of bends and the type of exhaust connections.

1.14 Exhaust Provisions (See Accessory section in back of this manual.)

Exhaust connections will be determined by the type of system to be exhausted and the desired cleanliness of the atmosphere surrounding the pump. Under normal conditions of mild evacuation nothing more than the dust cap will be necessary to cover the port. Where relatively high gas flows are involved or where the presence of oil vapor is objectionable an exhaust filter may be fastened to the exhaust port in place of the dust cap. The exhaust filters used on our pumps are capable of absorbing and restricting any vapor particle larger than 0.1 micron.



WARNING

Never block the Exhaust Port. If the exhaust port is blocked, pressure will build-up in the pump with the potential of the pump body bursting and causing possible injury to personnel in the area.

Where extreme exhaust conditions are encountered it is best to pipe the exhaust direct out of the building. Welch recommended wire reinforced PVC, metal pipe or thick walled rubber hose be used as exhaust lines to avoid potential of line becoming crimped or collapsing resulting in the exhaust port being clogged. Be sure to call Welch technical service prior to start-up at 847-676-8800 if you have any questions.

1.15 Electrical Power

1.151 Power Source Review

Review the power source and the motor rating to be sure they agree in voltage, phase and frequency. On three-phase applications the direction of rotation of the motor must be considered. Make a momentary check rotation at the time of power installation and wiring. Momentary backward rotation of the pump is not harmful. Check the layout drawings for proper direction of rotation.



CAUTION

Make certain the power settings on the pump match your power source before attempting to operate the pump

1.152 Overload Protection

Motor thermal overload protection is made available by the motor manufacturer as an aid to minimizing motor failure. Overload protection is a standard feature on all single-phase 60Hz motors. Single-phase motors will normally have automatic overload protection. Motors of 1-1/2 horsepower or larger supplied with pumps contain no overload protection. Installations of such equipment must comply with local electrical codes which dictate appropriate starter and protection devices. It is strongly suggested that you familiarize yourself with the protection supplied with your motor so that you may react accordingly in the event of an emergency. Automatic reset protection is designed to reset itself after a predetermined cooling period. If the fault to the drive remains unaltered, the motor will cycle on and off until the fault is corrected. The motor data plate will indicate the presence of thermal protection.

1.16 Vacuum Connections (See Accessory Section in back of this manual.)

1.161 Choice of Connections

The choice of connections and fitting can have a very marked effect on the pumping speed at the vacuum chamber. Any connection placed between the pump and the chamber creates an impedance to the flow of gas. This is particularly true at low pressures in the millitorr range where the gas flow is substantially molecular in character. The gas flow is then dependent upon the kinetic activity of the molecules to bring it to the intake of the pump.

1.162 The Effects of Conductance

It has been shown that the conductance of a tube is proportional to the cube of its radius and inversely proportional to its length. Therefore it is imperative that the connecting lines be as large in diameter and as short in length as practical. For best results the diameter of the connecting tube should be at least as large as the diameter of the pump intake. To avoid a large reduction in pumping speed at the vacuum chamber, it is clear that the conductance of the line must be considerably greater than the speed of the pump.

1.163 Metal Joints

If metal piping or tubing is used, it is preferable to solder or braze all of the connections. Where threaded joints must be used, coat the threads with LocTite® Thread Sealant with PTFE, or Leak Lock and screw together tightly. Flanged connections with elastomer gaskets make excellent demountable joints. Modular vacuum piping and fittings are now extensively used.

1.164 Rubber Tubing Joints

Where metal tubing is used between the system and the pump intake, joints can be made by butting the ends of the two sections together in a short section of vacuum hose. Worm-screw band clamps are useful for securing the hose to the tubing. Whatever the joint you choose to use, cleanliness should be of utmost importance.

1.165 Valves and Stopcocks

Metal valves or stopcocks may be used in the connecting line between the system and the pump to provide a means of isolating the pump from the system. To minimize the impedance of flow, the valve openings should be as large as possible. Lubricate the rotating plug of the stopcock with a film of vacuum grease sufficiently thick enough to prevent seizure.

1.17 Traps (See Accessory section in the back of this manual.)

1.171 The need for a Trap

Where corrosive vapors or large quantities of condensable vapors are evolved from vacuum processing, a cold trap may be used in the connecting line to the pump. It will help prevent damage to the pump mechanism and reduce oil contamination. The cold trap, immersed in a suitable Dewar flask, is installed so that the vapors may come in contact with the surfaces of the trap and condense. Commonly used refrigerants are liquid nitrogen or dry ice and acetone. The refrigerant to be used depends upon the freezing point of the contaminations. A variety of cold traps are available from Welch-Ilmvac.

1.172 The care of a Trap

When using a cold trap the refrigerant should be maintained at a high level in the flask to keep the trap at a uniformly low temperature. If the trap is re-warmed it may allow re-evaporation of the condensate. The refrigerant add tube on the liquid nitrogen trap should not be obstructed as the refrigerant boil-off can produce dangerously high pressures. If the trap becomes saturated it should be disconnected from the system, drained and cleaned. An increase in pressure in the vacuum system will normally indicate that the trap has become saturated. To clean the trap, remove the trap from the system, allow the trap to warm up and rinse off the condensate with a suitable solvent in a fume hood. Thoroughly clean and dry the trap before reinstalling in the system.

Section 2: OPERATION

2.10 Starting Procedures

2.101 Starting a Pump

Before attaching the pump to a system it is well to familiarize yourself with the function and action of the pump which you have now required. Remove the intake and exhaust port plugs and temporarily provide a stopper for the intake and a dust cap for the exhaust. Review the power requirements as described in Section 1.4.



CAUTION

Do not run this pump with the intake open directly to the atmosphere. The pump will overheat, excessive oil mist will be emitted from the exhaust and the pump will eventually seize.

2.103 Cleanliness

Take every precaution to prevent foreign from entering the pump. A fine mesh screen is provided for this purpose in the intake passage of all pumps.

2.104 Oil Level Determination

The amount of oil suitable for efficient and satisfactory performance should be determined after the pump has reached its operating temperature. Initially, however, the pump should be filled with fresh oil while the pump is idle. Fill the pump until the oil level falls half way of the oil level window. If after a short period of operation the level should fall, it is likely the result of oil entering some of the interior pockets of the pump. If the oil level rises, this signifies oil has drained into the pump cavity while pump was idle. Shut off pump, then drain oil down to proper level.

If a gurgling sound occurs, additional oil must be added. Mechanical pumps will gurgle in varying degrees under four conditions of performance: [a] when operating at high pressure as in the beginning cycles of evacuation of a chamber; [b] when the oil level in the pump reservoir is lower than required; [c] when a large leak is present in the system; and [d] when the gas ballast is open. Awareness of the possibilities will save time in setting up a system. Best performance of a mechanical pump is generally obtained after sufficient time has been allowed for the pump to come to operating temperature.

2.20 Operation and System Optimization

2.21 High Pressure Operation

two-stage pumps are designed to be most efficient when operated at or near their ultimate blanked off pressure. The pump is designed to remove air from a vacuum system at atmospheric pressure to a deep vacuum. When the pump is operated at elevated pressures up to about 10 Torr for long periods of time, the pump will run hotter. At elevated ambient temperatures under these conditions, the thermal protection switch on single phase motors may cut out. Use of an exhaust filter with coalescing element is required.



CAUTION

Do not run this pump for prolonged periods of time at or above 10 Torr. The pump will overheat, excessive oil mist will be emitted from the exhaust and the pump will eventually seize.

Leaky vacuum systems, too large a vacuum chamber for pump size or high gas loads to the vacuum systems are causes for extended runs of the pump at elevated pressure. If you need additional information, please contact Welch Vacuum at 847-676-8800, extension 1, for further information and precautions.

2.22 Principle of Gas Ballast

2.221 Effects of Unwanted Vapor

Systems which contain undesirable vapors cause difficulty both from the standpoint of attaining desirable ultimate pressures as well as contamination of the lubricating medium. A vapor is defined as the gaseous form of any substance which is usually a liquid or a solid. Water, oil and a mercury vapors are three of the more common vapors encountered in typical vacuum systems. When such vapors exist in a system, the vapors or mixtures of gas and vapor are subject to condensation within the pump; the precipitated liquid may thus ultimately dissolve or become emulsified with the lubricating medium. This emulsion is recirculated to the chambers of the pump where it is again volatilized causing increased pressure within the system.

2.222 Presence and Removal of Condensate

Condensation takes place particularly in the compression stroke of the backing or second stage of a two-stage pump. The compression stroke is that portion of the cycle during which the gas drawn from the intake port is compresses to the pressure necessary to expel it past the exhaust valve. Condensation takes place when the ratio between the initial pressure and the end pressure of the compression is high, that is, when the mixture of vapor and gas drawn from the intake port is compressed from a low pressure to high pressure. By adding air though the gas ballast valve to the mixture of vapor and gas being compressed, the pressure required for delivery past the exhaust valve is reached with a considerably smaller reduction of the volume of the mixture; this, depending upon the amount of air added, condensation of the vapor is wither entirely avoided or substantial reduced.

2.223 Pump Function With Gas Ballast

In a pump functioning on a contaminated system and operating without the gas ballast, compression within the stage takes place in the normal manner until the saturation pressure of the contaminating vapor contained within the mixture of gas and vapor is reached. The saturation pressure of water vapor is that pressure and corresponding temperature at which the dew point of the vapor is reached and condensation occurs. The saturation pressure of water vapor at an ambient temperature of 20°C is 17.5 Torr, while at 60°C, the approximate operating temperature of a pump, the saturation pressure is 149 Torr. The external side of the exhaust valve is subjected to atmospheric pressure. Consequently a compressive force somewhat greater than atmospheric pressure is required to open the valve and permit expulsion of the gas. Sometime during increased compression of the mixture of gas and vapors, the saturation pressure of 149 Torr for the water vapor is reached and the vapor condenses. The condensate is then allowed to emulsify with the oil which is recirculated within the pump stages this providing continued contamination of the system.

2.224 Pump Function With Gas Ballast

On the other hand, when ballast air at atmospheric pressure is supplied to the compression stroke by means of the gas ballast, the partial pressure of the unwanted vapor becomes a very small part of the total pressure of the mixture of gas, vapor and newly supplied air. The vapor is thus prevented from reaching its saturation pressure corresponding to the temperature of the pump and is finally expelled form the pump as a vapor.

2.225 Controlled Ballast Flow

Some degree of variation in ballast flow may be obtained by the amount of opening applied tot he gas ballast. Two or more turns of the gas ballast are sufficient to open it wide. With the gas ballast open, the sound of the exhaust is similar to that of a pump operating against a large leak. Because of the increased pressure introduced into the compression stroke, the pump must work a little hard to function, thus resulting in an increased operating temperature of approximately 8°C over a prolonged period of time. Tests have shown that continuous and prolonged operation for several weeks under these conditions is not injurious to the pump.

2.226 Other Forms of contamination control

The application of the gas ballast is a moderate and very successful method for the removal of condensable vapors. For very heavily laden systems, other means of removal such as oil separators may be required. For mild cases of contamination the simple expedient of a cold trap or a change of oil serve the purpose.

2.23 System Leaks - Impact & Detection

2.231 Large Leaks

The importance of eliminating all leaks in a vacuum system is obvious when it is realized that a leak into the system, at atmospheric pressure, expands in volume by a factor of 750,000 to 10,000,000 or more. The pump must remove this added volume to maintain the desired vacuum. Fortunately a number of effective techniques for leak detection have been developed. Large leaks can be located by pressurizing the system and painting the suspected area with a thick soap solution. Escaping air will produce soap bubbles.

2.232 Small Leaks

Small leaks may also be detected by spraying a suspected area with acetone or gases rich in hydrogen, and observing a sudden change in pressure on an electrical gauge. The difference in calibration of these gauges, for air and other gases, will produce a distinct change in the pressure reading. To use this method of detection, the system must be under vacuum and the gauge sensing tube must be located between the pump and the area to be probed. Use extreme caution, as these materials are highly flammable!

2.233 Fine Leaks

Locating very fine leaks requires a helium-sensitive, mass-spectrometer leak detector. This instrument will locate leaks which cannot be detected by any other method. Numerous fine leaks can have the total effect of a large leak.

2.30 Shutdown Procedures

2.301 Shutdown

A few simple precautions are all that is necessary when shutdown is in order. If a gauge is connected to the system, first isolate the gauge, then turn off the power and open the system to atmosphere. If the pump is removed from the system, cover the intake port with a rubber stopper or suitable cover to protect the pump against contamination and loose particles. If the pump has been contaminated in service and is going to be shelved for a prolonged period it is best to drain the oil and refill with a fresh charge.

Section 3: MAINTENANCE

3.10 Vacuum Problems

3.101 Pressure Determinations

Leakage, contamination and unusual outgassing are the general causes of problems associated with poor vacuum. To operate at maximum efficiency a system must be thoroughly clean. If the system is completely clean and free from leaks, and unwarranted vacuum problems still exist, the pump should be checked. A simple criterion for the condition of a mechanical pump is a determination of its ultimate pressure capability. This can be accomplished by attaching a gauge directly to the pump. The gauge may be any suitable type provided consideration is given to the limitations of the gauge being used. Refer to Paragraph 1-8 for further suggestions. If the pressure is unusually high, the pump may be badly contaminated, low on oil or malfunctioning. On the other hand, if the pressure is only slightly higher than the guaranteed pressure of the pump, an oil change may be all that is required.

3.102 Oil Contamination

The most common cause of a loss in efficiency in a mechanical pump is contamination of oil. It is caused by condensation of vapors and by foreign particles. The undesirable condensate emulsifies with the oil which is recirculated and subject to re-evaporation during the normal cycle of pump activity thus reducing the ultimate vacuum attainable. Some foreign particles and vapors may form a sludge with the oil, impair sealing and lubrication and cause eventual seizure. A gas ballast valve is helpful in removing vapors, especially water, but it is not equally effective on all foreign substances; therefore, periodic oil changes are necessary to maintain efficient operation of the system. The required frequency of changes will vary with the particular system. Experiences with the process will help you determine the normal period of operation before an oil change is required.

3.103 Oil Overheating

This pump is designed to operate continuously below 10 Torr. Continuous operation of this pump above 10 Torr will lead to overheating and eventual pump failure. See Section 2.21, High Pressure Operation.



WARNING

Solvents, such as acetone, used to clean different pumps are extremely hazardous. Inhalation may be fatal or harmful. Acetone is also extremely flammable. Never use acetone near heat or open flame. Use only in a well ventilated area.

3.20 Oil Changes and Oil Level

3.201 Developing a Maintenance Schedule

After studying many examples of pump failure, Welch has found the most common reason is poor condition of the oil. This is why a regular maintenance schedule for the oil is critical to obtain the longest service life out of your pump. Welch recommends that you examine the condition of the oil on a daily basis in the early days of a new process or experiment. You want to look for discoloration of the oil and whether the oil level is rising. The discoloration can indicate deterioration of the oil and a rising oil level can indicate condensation of vapors is occurring in the pump. When changes occur, the oil needs to be changed. If no changes in the oil level or color are observed, extended pump service life is obtained if the oil is changed every three to four months.

3.202 Forced Oil Flushing

When you drain oil through the drain valve, you are not removing the oil and contaminants that are inside the pumping mechanism. You are removing oil only from the oil case. Welch recommends a forced oil flush of pumps be performed at the regular maintenance oil change. The procedure for the forced oil flush is given below.

3.203 Forced Oil Flushing Procedure

1. Check the oil level, if the oil level is well above the fill mark (This may indicate either the pump has been overfilled with oil or has ingested a liquid or a large amount of vapor water or organic solvents). Please go to step 2. If the oil level is even with the fill mark and you do NOT suspect corrosive gases or particulates (hence forth called contaminants) ingested have damaged the mechanism, run the pump for 15 minutes to allow the pump oil to warm up before going to step 2.

2. Turn off motor for the vacuum pump. Drain the oil into a clear plastic container (may need pliers to open drain valve). Look for contaminations settling to the bottom of container. If you see contaminants, you will need to repeat step 3 through 5 several times until the oil comes out clear. The oil you drained from the pump came from the oil case only. There may be contaminants in the pumping mechanism. To be sure all contaminants have been removed, the pump mechanism needs to be flushed.

3. Make sure the belt guard is installed before proceeding further. Attach a short hose to the drain valve which runs into a clear plastic container.

4. Flushing the pump is carried out by adding a cup of vacuum pump oil through the intake port (IN) while the pump is turned on for 15 to 20 seconds. While adding the pump oil, the palm of your hand is placed lightly over the exhaust port (OUT). Look for water coming out of the drain. Turn off the pump.

5. Repeat step 4 until clean oil comes out of the drain hose.

6. Close the drain valve and fill the pump with the amount of vacuum pump oil your pump needs.

7. Plug the intake (IN) port with a rubber stopper. Turn the pump on and run the pump for 10 minutes. Close the gas ballast.

8. Check the vacuum reading of the pump by connecting a thermocouple gauge tube to the pump's intake. If the pump is running nearly as good as when it was new, the total pressure reading you will read on either of these two gauges will be at least 10 micron.

A simple way to connect the gauge tube to the pump is to run the threaded tip of tube through a hole in a rubber stopper. Use pump oil as a lubricant for inserting the tube. The stopper chosen should be bigger than the outer diameter of the intake flange.

3.204 Refilling The Pump

After you are satisfied that the pump has been thoroughly flushed, refill the pump by pouring new oil into the exhaust port. Fill to the indicated level and start the pump with the intake closed. A gurgling noise is characteristic when high pressure air is drawn through the pump. It should disappear quickly as the pressure within the pump is reduced. If gurgling continues, add sufficient additional oil through the exhaust port until gurgling ceases.

3.30 Shaft Seal Replacement

To replace the shaft seal of a pump, drain the oil and remove the pump pulley and key. Remove the screws securing the old seal and pry it loose with a screwdriver or similar wedge, being careful not to mar the surface of the pump body against which the seal fits. Discard the seal and its gasket, inspect all surfaces and repair any damages with a fine abrasive stone. Wipe all sealing areas clean and place a film of oil on both the shaft and the inside bore of the new shaft seal. Using a new gasket, carefully slide the new seal into position and center it on the shaft. It is not necessary to apply any sealant to the gasket. Tighten the mounting screws uniformly and refill the pump with oil. Follow instructions included in repair kit.

3.40 Repairing Oil Leaks

3.41 Location, Cause and Effect

Oil leaks may develop wherever two mating faces are sealed with a gasket. Such seams may fail as the result of deterioration of the gasket material, loosening of the screws caused by temperature variations, or improper care as the result of previous reassembly. Typical gaskets seams in a mechanical pump are located at the oil level window, the shaft seal, the oil drain, and the mating faces of such mechanical surfaces as the intake chamber cover, the oil case, and the exhaust chamber cover. The importance of a gasket seam is determined principally by its function. If it is a vacuum seal, the ultimate performance of the pump is dependent upon it. If it is an oil seal, the pump may be operated satisfactorily for some time without loss of function. Eventually, of course, a great loss of oil may cause harmful damage.

3.402 Repairing Techniques

An oil seam may be sealed by any of several methods. When an O-ring is employed, the surfaces of the O-ring and its groove should be wiped clean. If the O-ring is not badly deformed or scratched it may be reused by sealing with a slight film of vacuum oil or vacuum grease. Thin composition gaskets are generally used for large irregularly shaped areas. A replacement joint of this type should be thoroughly cleaned of all previous gasket material and the mating surfaces cleaned of any nicks.

3.50 Repairing Vacuum Leaks

3.501 Surface Preparation

Good Vacuum seals are an essential and important attribute of a good mechanical pump. A good seal is dependent upon the quality of the mating surfaces as well as the sealant and its preparation. The mating faces should be carefully inspected for any projections or foreign particles which might interfere with proper mating. Slight projections such as nicks and burrs are most easily removed by rubbing with a fine abrasive stone. The surface of the mating parts may be washed with a solvent or alcohol after which they must be thoroughly dried.

3.502 Temporary Repair

Temporary vacuum repairs are often made by covering the known leak with an industrial sealant such as Loctite with PTFE. Such a practice, however, is not recommended for seals of a permanent nature.

3.60 Drive Problems

If for any reason the pump will not operate, turn off the power and check the fuse and electrical connections. Then try the power to the motor only by removing the belt. If the motor operates properly try hand-rotating the pump in the proper direction with the pump intake port open. If both turn freely then replace the belt and check the belt tension. The tension should be sufficient to drive the pump without visible slippage. Any greater tension will cause noise and possible damage to the bearings of both the motor and pump. Make certain that both pulley grooves are clean and free from oil. The pulleys must be fastened securely on their respective shafts, and in parallel alignment.

Section 4: TROUBLE-SHOOTING GUIDE

4.10 Poor Vacuum Readings

1. Disconnect vacuum pump from your vacuum system.
2. Obtain 1 gallon of oil, 1 gallon or larger clear plastic container, clear drain hose (1/4 inch ID by at least 2.5 feet long), rubber gloves, goggles, apron and pliers.
3. Carry out a forced oil flush (See Section 3.3b) if motor can turn pumping mechanism without excessive noise. If pumping mechanism cannot be turned by motor, have pump sent into factory repair center.
4. Check ultimate vacuum with thermocouple gauge. If reading is still unsatisfactory, consult with Welch Technical Service after checking for leaks in your connections.

4.20 Noisy Pump

1. Locate noise source on your vacuum pump (motor, belt, pump).
2. If motor makes noise:
 - . Check for loose bolts on motor mount.
 - . Motor may need to be replaced
3. If belt makes noise:
 - . Pulley may be bent. If so, replace.
 - . Loose belt, tighten by loosening bolts on motor and moving motor away from pump until belt exhibits a 1/2 inch deflection.
4. If pump makes noise: vanes may be sticking, carry out a forced oil flush.
5. If noise level is still unsatisfactory, consult with WELCH Technical Service at (847)676-8800.

4.30 Excessive Oil Mist

1. Check oil level. Maintain the level between the two lines on the oil window during operation. Too high a level will cause excess oil mist.
2. Determine the vacuum level in your system with a thermocouple gauge or manometer. Be sure the pump is operating at a pressure of 10 Torr or lower for continuous operation.



CAUTION
If not, discuss application with Welch Technical service before proceeding to prevent oil from overheating and breaking down resulting pump failing.

3. A system leak(s) or degassing can cause excessive oil mist. Locate and seal the vacuum leaks. High vapor loads may require a larger pump to compensate.
4. An oil eliminator can be installed for coalescing the oil mist from the exhaust gases. If an oil mist eliminator is already installed, the element may need to be replaced if saturated with oil. Open up oil mist eliminator and examine the element; replace if needed.
5. Check the oil condition for any visible change in color or consistency. Contaminants in the oil can add to the amount of oil exhausted. Carry out a forced oil flush if contamination is discovered. (See Section 3.3b.).

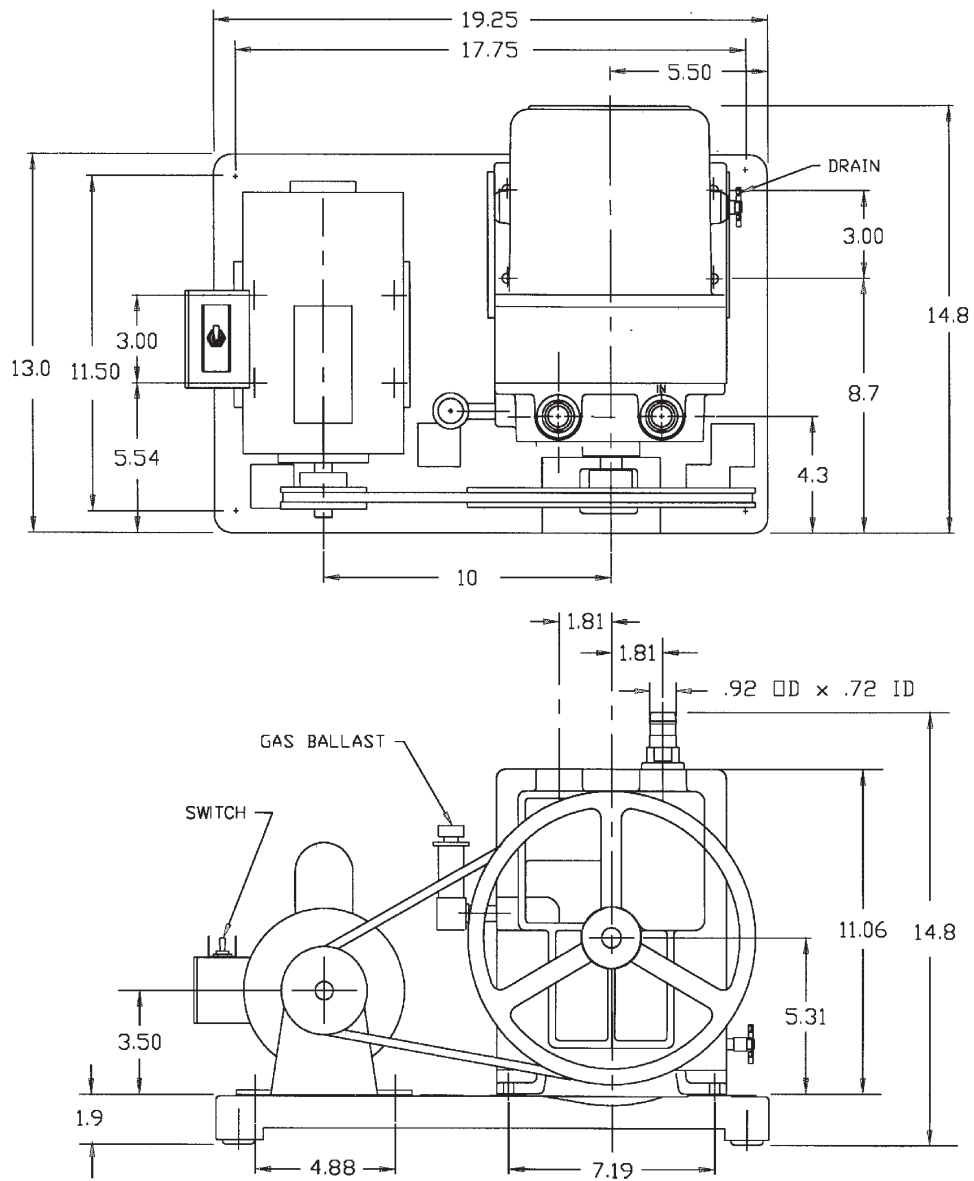
Section 5: QUICK REFERENCE CHART

Motor Options	1376N
Wired for 115V, 60Hz, 1Ph	1376N-01
Wired for 230V, 60Hz, 1Ph	1376N-60
Wired for 230V, 50Hz, 1Ph	1376N-50

Replacement Parts	
Shaft Seal: Lip Seal	1401D -01
Shaft Seal: Mechanical Seal	1401D
Air Filter Screen	41-1692
Intake Chamber Cover Gasket	41-0234
Oil Case Gasket	41-0403
Drain Plug	61-2278
Oil Window	61-2229A
Large Vane	41-1684
Small Vane	41-1487
Large Vane Spring	41-1304
Small Vane Spring	41-1304
Large Vane Spring Holder	41-1685
Small Vane Spring Holder	41-1685
Shaft	41-1683
Upper Exhaust Valve	41-2153
Lower Exhaust Valve	41-2154
Optional Exhaust Filter	1417P-10
Optional Exhaust Filter Element	1417G
Pump Pulley	41-2074
Standard Belt	1405A
Standard Hose Barb Fitting	1393K
Standard Flange Adapter Fitting	1393G
Pressure Release Valve	41-0992
Repair Kits	
Minor Repair Kit	1376K-05
Major Repair Kit	1376K-06
Base and Belt Guard Kit	1371B-01

Specifications	
Free Air Displacement, L/M (CFM)	300 (10.6)
Gas Ballast	Yes
Ultimate Pressure, Torr (mbar)	1 (1.3)x10 ⁻⁴
Number of Stages	2
Rotational Pump (RPM)	525
Oil Capacity, quarts (Liters)	2.5 (2.4)
Net Wt. Unmounted Pump, lb (Kg)	107 (52)
Net Wt. Mounted Pump, lb (Kg)	156 (71)
Standard Flange Size	NW25
Tubing Needed-I.D. Inches (cm)	13/16 (2.1)
Intake Thread Size	1-20
Exhaust Thread Size	1-20
Electrical Requirements 1	115V/230V
Electrical Requirements 2	60Hz
Electrical Requirements 3	1 Phase

Section 6: DIMENSIONAL DRAWING



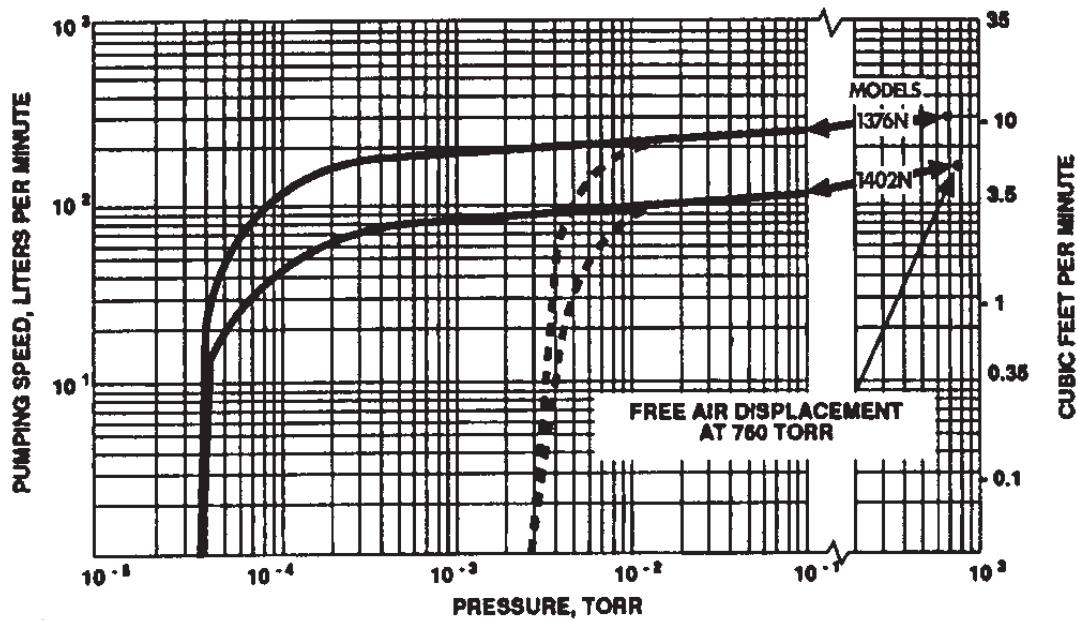
Section 7: PUMPING SPEED CURVES

HIGH EFFICIENCY PUMPING CHARACTERISTIC OF PUMPS

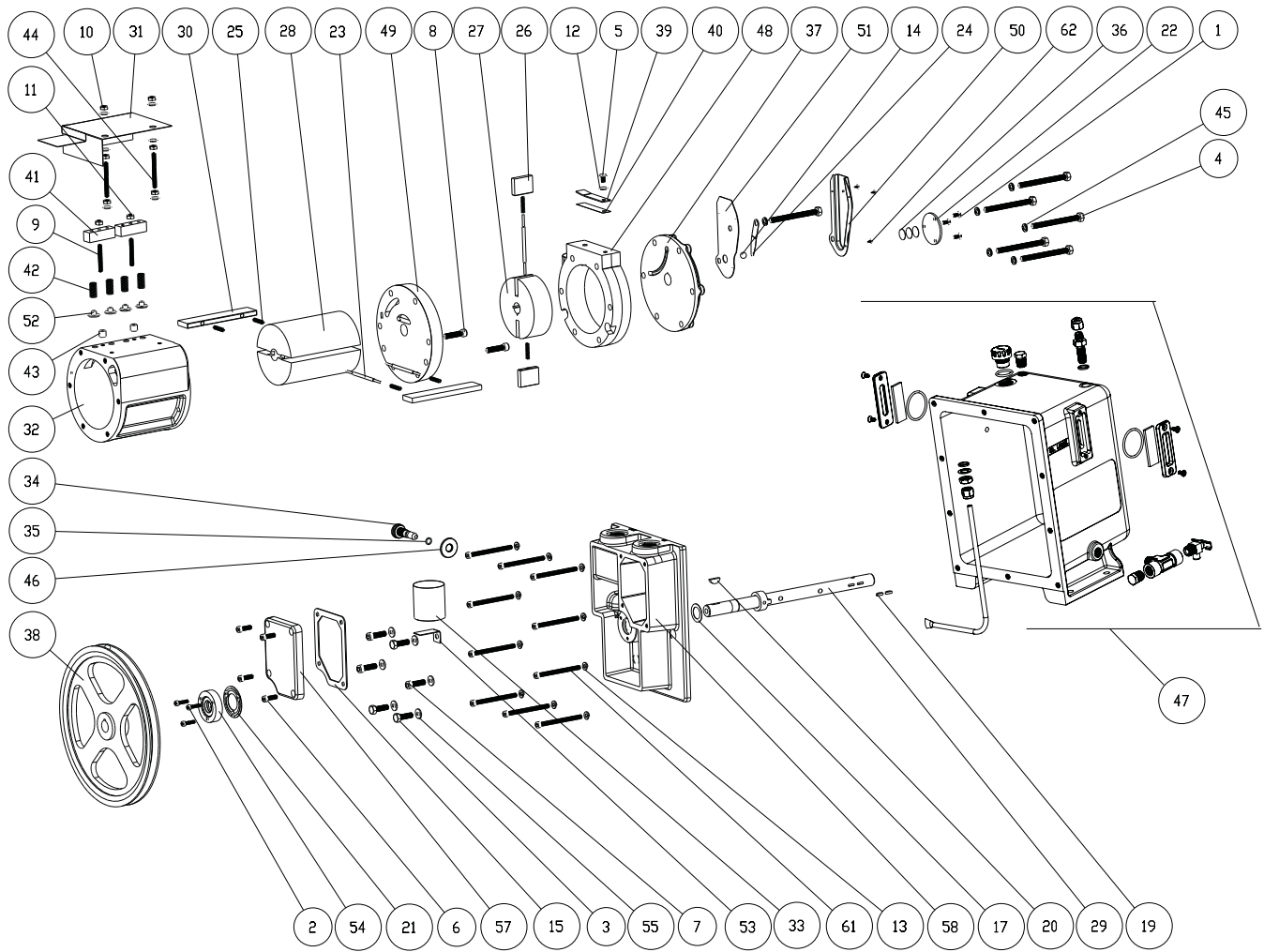
The low RPM design of vacuum pumps makes it possible to maintain high pumping efficiencies into the low micron range. High RPM direct drive vacuum pumps, on the other hand, experience a rapid fall off of pumping speed below 100 microns.

A comparison of the pumping speed curves shown below, versus high RPM pump speed curves conclusively illustrates the superior performance of the pump.

What does that mean for the vacuum pump user? Pumps provide considerable faster pump down time in the low micron range.



Section 8: EXPLODED VIEW FOR MODEL 1376N SERIES



PARTS LIST FOR MODEL 1376

ITEM	QTY	P/N	A*	B*	DESCRIPTION	ITEM	QTY	P/N	A*	B*	DESCRIPTION
1	3	2-00-2706			SCREW PAN HD 10-32 x 3/8" LG.	32	1	41-1688			LARGE RING
2	3	2-00-6712			SCREW SOCKET HD 10-32 x 3/4" LG.	33	1	41-1692	1	1	AIR FILTER, MESH
3	3	2-01-0316			SCREW HEX HD 5/16-18 x 1" LG.	34	1	41-1736			GAS BALLAST VALVE
4	6	2-01-0356			SCREW HEX HD 5/16-18 x 3-1/2" LG.	35	1	41-1742	1	1	O-RING #011 BUNA-N
5	1	2-01-5106			SCREW SOCKET HD 1/4-20 x 3/8" LG.	36	3	41-1766			THRUST DISK
6	4	2-01-6112			SCREW SOCKET HD 1/4-20 x 3/4" LG.	37	1	41-2045			SMALL END PLATE, FINISHED
7	3	C91590			SCREW SOCKET HD 5/16-18 x 1" LG.	38	1	41-2074			PULLEY w/ SET SCREW
8	2	2-01-6320			SCREW SOCKET HD 5/16-18 x 1-1/4 LG.	39	1	41-2153	1	1	EXHAUST VALVE, UPPER
9	2	2-01-8128			SET SCREW 1/4-20 x 1-3/4" LG.	40	1	41-2154	1	1	EXHAUST VALVE, LOWER
10	6	2-31-0112			HEX NUT 1/4-20, STEEL	41	2	61-8313A			VALVE BLOCK S.S.
11	2	2-36-9900			HEX LOCK NUT 1/4-20	42	4	41-2158	4	4	VALVE SPRING
12	7	2-61-0000			WASHER, STEEL 3/16	43	2	61-8315A	2	2	VALVE BLOCK SPACER
13	10	2-63-0193			WASHER, LOCK 1/4" MEDIUM	44	2	41-2175			SETSCREW 1/4-20 x 2.25" LG
14	1	4-40-1200	1	1	STEEL BALL 3/8" DIA.	45	6	41-2363			WASHER 5/16 ID x 1/2 OD
15	1	61-8278A	1	1	GASKET, INTAKE CHAMBER COVER	46	1	41-2757			LOCK NUT
16	2	61-8279B	2	2	GASKET, OIL CASE	+ 47	1	61-8319B			OIL CASE ASSEMBLY
17	1	41-0508	1	1	WASHER, THRUST	48	1	61-8108D			EXHAUST RING
18	1				NOT USED	49	1	61-8250C			CENTER PLATE
19	2	41-0613	2	2	WOODRUFF KEY #404	50	1	61-8309B			PRESSURE RELEASE TUBE #1
20	1	41-0624	1	1	WOODRUFF KEY	51	1	61-8310A			PRESSURE RELEASE TUBE #2
21	1	41-0643			GASKET, SEAL	52	4	61-8314A	4	4	VALVE
22	1	41-0672			SHAFT END PLATE	53	1	61-8329A			BRACKET, INTAKE SCREEN
23	3	41-1685	3	3	SPRING HOLDER	54	1	61-8107A			SHAFT SEAL ASSEMBLY
24	1	41-0992	1	1	PRESSURE RELEASE VALVE	55	6	61-8456A			WASHER 5/16, COPPER
25	6	61-8559A	6	6	VANE SPRING	56	1	61-8465A			ADAPTER NW25
26	2	41-1487	2		VANE, SMALL	57	1	61-8670			COVER, FINISHED
27	1	41-1518			ROTOR, EXHAUST	58	1	61-8684			LARGE END PLATE
28	1	41-1682			LARGE ROTOR	59	1	61-8686			OIL CASE SPACER
29	1	41-1683			SHAFT	60	1	61-9284A	1	1	O-RING #214 Fluoroelastomer
30	2	41-1684	2		VANE, INTAKE	61	10	62-0015			SCREW SOCKET HD 1/4-20 x 3.125" LG
31	1	61-8368B			BAFFLE ASSEMBLY	62	3	62-0259			SCREW #6-1/4, SELF-TAPPING
N/S		1401D	1	1	MECHANICAL SEAL KIT	N/S		1-99-5282	1	1	SEALANT, 6cc

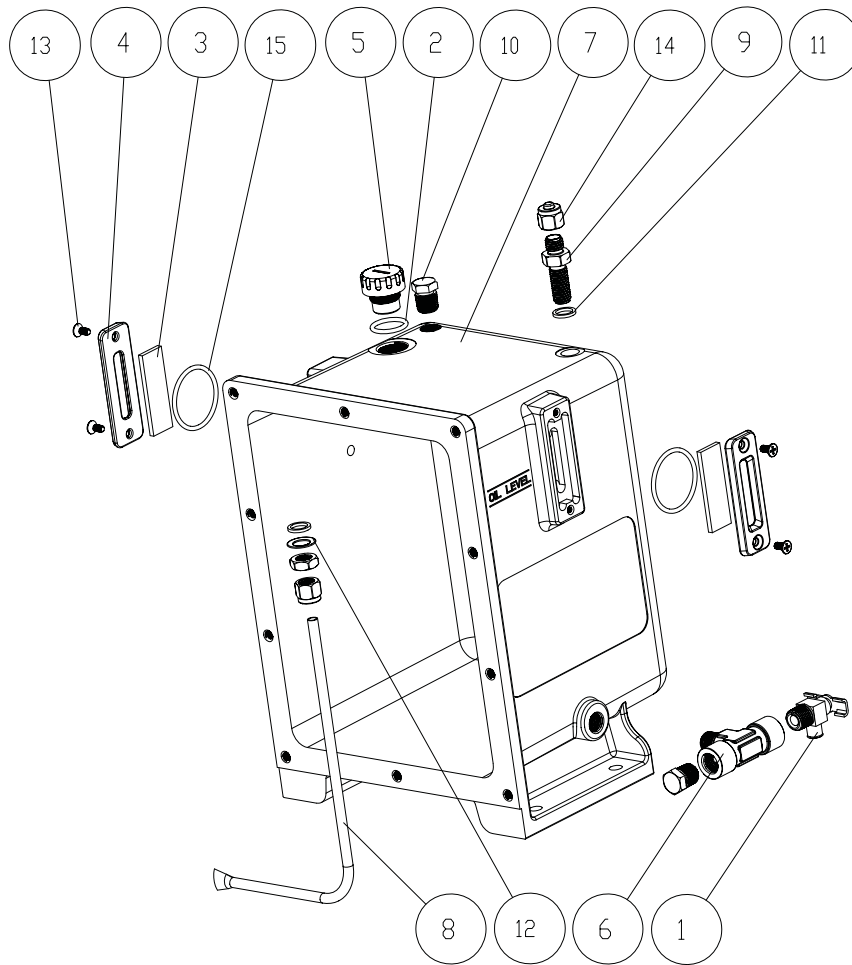
A*: Major Repair Kit Catalog # 1376K-10

B*: Minor Repair Kit Catalog # 1376K-09

+ Item 47 exploded view shown on page 18

1401D is a Mechanical Seal Kit-includes Mechanical Seal, Gasket and 3 screws.

VIEW AND PARTS LIST FOR MODEL 61-8319B



Parts List for Model 61-8319B			
Item	Qty.	P/N	Description
1	1	61-2278	Drain Valve Black/Zinc Plated
2	1	61-2159	O-Ring Fluoroelastomer #116
3	2	61-2229A	Sight Glass Window
4	2	61-2370	Oil Window Cover
5	1	61-2372	Oil Fill Plug
6	1	62-8266	Tee-1/4" NPT Male-Female-Female
7	1	61-8320B	Oil Case
8	1	61-8321B	Plastic Bubbler Tube
9	1	61-8382	Union Bulkhead 1/4" SS
10	2	61-8384	Pipe Plug
11	2	62-0118	O-ring, Tetraseal
12	1	62-0121	Washer
13	4	62-1014	Screw
14	1	62-1141	Nickel Plated Cap
15	2	66-0304	O-Ring Aflas #127

Section 9: ACCESSORY SECTION

Exhaust Filter

Filters oil mist from pump exhaust / Easy Replacement
Reduces pump noise / Filters to 0.3 micron particle size

Standard Exhaust Filter				
Use with pump model	Dimension		Catalog Number	
	Diameter	Height	Filter	Replacement Element
1392, 1399, 1400	2.5	2.5	1417	1417L
1376,1380, 1402,1400	5	6.25	1417P-10	1417G
1397,1374	5	9	1417P-20	1417H-01

Directional Exhaust Filter

Large, high capacity / Screw-in type / 360 Swivel outlet with tubing connector

Directional Exhaust Filter				
Use with pump model	Dimension		Catalog Number	
	Diameter	Height	Filter	Replacement Element
1392, 1399, 1400	2.5	2.5	1417L	1417L
1376,1380, 1402,1400	5	6.25	1417G	1417G
1397,1374	5	9	1417H-01	1417H-01

Exhaust Mist Eliminator

Exhaust oil recyclers capture oil mist expelled from the pump, separated air from oil, and return collected oil to the pump via a line connected to the gas ballast inlet. This process effectively reduces oil consumption and minimizes maintenance requirements by extending the time between oil changes.

Catalog Number	Use with pump model
1416H-01	1400
1416C-01	1405, 1376, 1380, 1400

Requires gas ballast connection kit: Cat. No. 141601 - For models 1400,1405,1376,1380,1402

Coaxial Traps

Reduces oil back streaming / Stainless steel construction / Easy Replacement of Element

ISO Size	Capacity	Diameter	Height	A2	Cat.No.1
NW16	to 4 CFM (140 L/min)	3.75	5.25	8.25	541001
Stainless Steel Element for ISO NW 16 Trap 1					541921
Stainless Steel Element for ISO NW 25 and NW 40 Traps1					541922

Cat. No.1. Element must be ordered with trap.

A2. Distance between ISO NW inlet and outlet connections

Dry Ice Cold Traps

Removable 3 quarter center well for dry ice/alcohol slurry (do not use acetone) / Visible trapping surface

Cold temperature up to 12 hours depending on vapor / Available with straight tube connections

ISO Size	Diameter	Height	A1	I/O Offset	Cat. No	Replacement Seal Cat. No.
Straight Tube						
1/2 O.D.	10.00	8.25	10.75	3.5	1420H-14	545200

A1. Distance between ISO NW inlet and outlet connections

Section 10: MSDS-Sheet for DIRECTORR® PUMP OIL



MATERIAL SAFETY DATA SHEET FOR: DIRECTORR® 8995G GOLD VACUUM PUMP OIL

HMIS Rating: Health: 0 Flammability: 1 Reactivity: 0 Special: X

SECTION 1 - IDENTIFICATION

Chemical Name: Synthetic Hydrocarbon

Synonyms: DIRECTORR® 8995G Gold Vacuum Pump Oil

Formula: NA (Product is refined naturally occurring mixture)

Manufacturer's Name: Gardner Denver Thomas, Inc., Welch Vacuum Technology
4601 Central Avenue
Monroe, LA 71203

Date Prepared: April 23 2009

Telephone Number for General Information: (847) 676-8800

SECTION 2 - HAZARDOUS INGREDIENTS/IDENTITY

Exposure Limits in Air

<u>Component</u>	<u>CAS No.</u>	<u>OSHA PEL</u>	<u>ACGIH TVL</u>
Synthetic Hydrocarbon	68037-01-4	NO	NO

To the best of our knowledge, the above listed component is not hazardous according to OSHA (1910.1200) or one or more state right-to-know lists.

SECTION 3 - PHYSICAL AND CHEMICAL CHARACTERISTICS

Appearance and Odor: Light Straw Color, Slight Odor

Specific Gravity @ 22°C (72°F) (Water = 1): 0.83 @ 22°C (72°F)

Vapor Pressure, Torr @ 25°C: 1x10⁻⁷

Vapor Density (Air = 1): N/A

Water Solubility: Insoluble

Boiling Point (ASTM D-86 Method): 445°F

Reactivity in Water: N/A

Melting Point: N/A

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SECTION 4 - FIRE AND EXPLOSION HAZARDS DATA

Flash Point: 480°F 249°C
Method Used: COC
Flammable Limits: Upper: N/D Lower: N/D
Extinguishing Media: Use water spray, dry chemical, foam or carbon dioxide.
Special Fire Fighting Procedures: For fires involving this material, do not enter any enclosed or confined space without proper protective equipment, including self-contained breathing apparatus.
Unusual Fire and Explosion Hazards: Do not weld, heat or drill container. Residue may ignite with explosive violence if heated sufficiently.

CAUTION: **DO NOT USE PRESSURE TO EMPTY DRUM, OR EXPLOSION MAY RESULT.**

SECTION 5 - PHYSICAL HAZARDS (REACTIVITY DATA)

Stability: Stable under normal conditions.
Hazardous Polymerization: Will not occur.
Conditions to Avoid: Avoid heating to decomposition. User is advised to have a safety expert evaluate the specific conditions of use.
Incompatibility (Materials to Avoid): N/D
Hazardous Decomposition Products: Includes Oxides of Carbon.

SECTION 6 - HEALTH HAZARD DATA

Eyes: Expected to cause no more than minor eye irritation.
Skin: Expected to cause no more than minor irritation following prolonged or frequent repeated contact
Inhalation: Inhalation of Oil mist vapors at elevated temperatures may cause respiratory irritation.
Ingestion: Ingestion harmful if aspirated into the lungs. Do not induce vomiting.

Chemical Listed as Carcinogen or Potential Carcinogen:

IARC Monographs: No OSHA: No National Toxicology Program: No

SIGNS AND SYMPTOMS OF EXPOSURE

Primary Routes of Exposure: Inhalation, skin or eye contact, and ingestion.

FIRST AID MEASURES

If Inhaled: Remove to fresh air. If victim has stopped breathing, give artificial respiration. Seek medical attention.
In Case of Eye Contact: Immediately flush eyes with plenty of cool water for 15 minutes. Do not let victim rub eyes.
In Case of Skin Contact: Wash affected area thoroughly.
If Swallowed: Do not induce vomiting. If victim is conscious and able to swallow, give water to

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A Gardner Denver Product

dilute, do not give sodium bicarbonate, fruit juices, or vinegar. See medical attention.

SECTION 7 - PRECAUTIONS FOR SAFE HANDLING AND USE

Storage and Handling Precautions:	Minimum feasible handling temperatures should be maintained. Periods of exposure to high temperature should be minimized.
Waste Disposal Method:	Under RCRA, it is the responsibility to the user of products to determine at the time of disposal whether product meets RCRA criteria for hazardous waste. This is because product uses, transformations, mixture, processes, etc. may render the resulting material hazardous.
Action to Take for Spills or Leaks:	Wear appropriate respiratory protection and protective clothing as described below. Contain spilled material. Transfer to secured containers. Collect using absorbent media. In the event of an uncontrolled release of this material, user should determine if release is reportable under applicable laws and regulations under RCRA.

SECTION 8 - CONTROL MEASURES

Ventilation:	Mechanical ventilation recommended.
Respiratory Protection:	NIOSH approved organic vapor respiratory when exposed to vapor from heated material
Protective Gloves:	Impervious gloves when prolonged contact cannot be avoided.
Eye Protection:	Chemical type goggles/face shield.
Protective Clothing:	Impervious gloves when prolonged contact cannot be avoided.
Other Protective Measures:	None considered necessary at this time.
Work/Hygienic Practices:	Employees should exercise reasonable personal cleanliness.

All statements, information, and data provided in this Material Safety Data Sheet are believed to be accurate and reliable, but are presented without guarantee, warranty, or responsibility of any kind, expressed or implied on our part. Users should make their own investigations to determine the suitability of the information of products for their particular purpose.

ATTENTION: Misuse of empty containers can be hazardous. Empty containers can be hazardous if used to store toxic, flammable or reactive materials. Cutting or welding of empty containers might cause fire, explosion, or toxic fumes from residues. Do not pressurize or expose to open flame or heat. Keep containers closed and drum bung in place.

D.O.T. IDENTIFICATION NUMBER: N/A

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Section 11: APPLICATION BOOKLET

USING YOUR VACUUM PUMP WITH CORROSIVE GASES

Thank you for choosing the vacuum pump from Welch Vacuum Technology, Inc. This unique vacuum pump line was designed to give you the maximum possible service life when evacuating corrosive gases. However, corrosive gases can cause damage to the most rugged vacuum pump in an improperly configured or improperly operated vacuum system. Please refer to the recommendations made in the following pages for operating your vacuum pump successfully when pumping corrosive gases.

Table of Contents

Part 1 Health & Safety

Part 2 Building a Vacuum System to Handle Corrosive Gases

- A. Selecting The Correct Vacuum Pump Oil
- B. Connecting Your Pump to the Vacuum System
- C. Types of Accessories Available
- D. Insuring An Adequate Exhaust System

Part 3 Operating a Vacuum System Containing Corrosive Gases

- A. Removal of Condensable Corrosive Gases Using the Gas Ballast
- B. Diluting Corrosive Gases
- C. Dry Nitrogen Purging of Oil Case

Part 4 Recommendations for Pumping Corrosive Gases

- A. Strong Acids: Hydrochloric Acid (HCl), Hydrogen Bromide (HBr), Sulfuric Acid (H_2SO_4), Nitric Acid (HNO_3)
- B. Weak Acids: Acetic Acid (HOAC), Carbonic Acid (H_2CO_3)
- C. Halogens: Chlorine (Cl_2), Bromine (Br_2)
- D. Formaldehyde (CH_2O)
- E. Trifluoroacetic Acid ($\text{F}_3\text{CCO}_2\text{H}$)
- F. Ozone (O_3)
- G. Anhydrides:
 - SO_x - Sulfur Trioxide (SO_3) & Sulfur Dioxide (SO_2)
 - Hydrogen Sulfide (H_2S)
- H. Fragments of Sulfur Hexafluoride (SF_6) Carbon Tetrafluoride (CF_4) etc.
- I. Special Note: Pumping oxygen
Perfluoropolyethers Oil Needed In Pump

Part 5 Recommendations for Pumping Particulate-Containing Gas Streams

- A. Particulate Trap With A Filter Element
- B. Oil Filtration System

Part 6 Extending Service Life of through Proper Maintenance

- A. Developing A Maintenance Schedule
- B. Forced Oil Flushing

Part 7 Vacuum Manifold

Part 8 Chemical Properties of Corrosive Gases

Part 9 Troubleshooting Your Pump

Part 1 Health & Safety

The pumping of corrosive gases not only can shorten the service life of a vacuum pump, but also if not operated properly, it can be hazardous to you and personnel around you. Throughout this application booklet, special safety precautions which must be observed during installation and operation of the vacuum pump.

Warnings: A warning signifies that failure to observe the instructions provided can lead to injury or death to personnel.

Cautions: A caution signifies that failure to observe the instruction can result in damage to equipment.

Welch provides these WARNING and CAUTION notes to make you cognizant of the consequences of failing to observe the instructions provided. Failure to observe these instructions can impact your safety and that of others in the vicinity of the pump. In addition, failure to observe these instructions can lead to significantly shortened service life of the vacuum pump.

You must be aware of and understand the proper procedures before working with the vacuum pump. A review of all your operating procedures of your complete vacuum system, not only the vacuum pump, by safety officials at your facility prior to start-up is strongly recommended by Welch.

Part 2 Building a Vacuum System to Handle Corrosive Gases

A. Selecting the Correct Vacuum Pump Oil

Oil has four important roles in your vacuum pump:

- (1) The oil lubricates moving mechanical components such as the lip seal, and vanes.
- (2) The oil provides the seal between rotor and stator.
- (3) The oil facilitates the opening of the exhaust valves during final compression
- (4) The oil removes the heat generated during compression.

Now knowing the oil's role in your vacuum pump, you can see why the oil chosen will have a dramatic impact on the service life of your vacuum pump. For this reason, Welch recommends DIRECTORR® Gold Oil be used with each pump when pumping corrosive gases.

DIRECTORR Gold is a totally new type of hydrocarbon oil which is a formulated oil rather than refined base stock oil. This product was developed to replace costly perfluoropolyether oils such as Fomblin® and Krytox® in non-oxygen enriched systems.

Several reasons exist for why DIRECTORR Gold is a superior hydrocarbon oil for corrosive gas applications compared to standard hydrocarbon oil. These reasons are:

- 1 Less reactive to chemical attack. DIRECTORR Gold is a highly saturated and hydrogenated oil which creates a high purity product. By vacuum distilling off a narrow fraction of this oil, Welch has produced an oil with more single bonds than other oils. Fewer double bonds make it a less reactive oil.
- 2 Exceptional resistance to water emulsification. Since the oil is saturated it exhibits less water emulsification compared to standard distilled pump oils. Since water may be in your corrosive gas stream, less water emulsification facilitates passage of corrosive gases out of the pump rather than residing in water logged oil.
- 3 Low phosphorus content. Phosphorus is one of the most reactive elements present in hydrocarbon oil.

DIRECTORR Gold has less than 1 ppm of phosphorus where as standard vacuum distilled oil typically has 3000 to 4000 ppm. Some corrosive gases will combine with phosphorous and under pump operation breakdown oils forming acidic sludge.



CAUTION

The use of standard Hydrocarbon vacuum pump oil can cause premature failure of pumps



WARNING

DIRECTORR Gold Oil is not inert and should not be used in environments involving a high percentage of oxygen. The use of DIRECTORR Gold Oil for pumping a high percentage of oxygen can lead to a pump fire and injury to personnel.



CAUTION

Failure to use Fomblin Y06/6 in applications where strong acids, halogens or ozone exceed recommended gas flow limits given will lead to degradation of the DIRECTORR Gold Oil and to the pump failing.

If the flow of strong acids or halogens exceeds 10% of gas flow, you must switch to a perfluoropolyethers such as Fomblin Y06/6 (Welch Cat. Nos. 1408C-06, 1 Kg; 1408C-08, 2Kg) - Fomblin is a registered trademark of Ausimont. In addition, if ozone is pumped and its concentration exceeds 100 ppm of the gas flow, a perfluoropolyether oil must be used. Perfluoropolyethers are very resistant to chemical attack by strong acids.

B. Connecting your Pump to the Vacuum System

The choice of connections and fittings can have a very marked effect on the pumping speed at the vacuum chamber. Any connection placed between the pump and the chamber creates an impedance to the flow of gas. This is particularly true at low pressures in the millitorr range where the gas flow is substantially molecular in character. The gas flow is then dependent upon the kinetic activity of the molecules to bring it to the intake of the pump.

It has been shown that the conductance of a tube is proportional to the cube of its diameter and inversely proportional to its length. Thus, it is critical that the connecting lines be as large in diameter and as short in length as practical. For best results, the diameter of the connecting tube should be at least as large as the diameter of the pump intake. To avoid a large reduction in pumping speed at the vacuum chamber. The conductance of the line must be greater than the speed of the pump.

C. Types of Accessories Available for Your Pump

Protective accessories may be needed for heavy corrosive gas loads which may contain particulates. In Section 5, recommendations are given which detail when these accessories should be used. Below is a description of these accessories and how they work.

C 1. Acid Neutralization Trap

The acid neutralization trap features a transparent sump which contains an element which neutralizes hydrous acids. The element consists of alkaline material contained within stainless steel end caps and screens.

The trap comes in two sizes. Cat No. 1420H-21 uses a 4.5 inch deep sump and is used with Model 1400N-01. Cat. No. 1420H-20 uses a 9.5 inch deep sump and is used with Models 1402N-01, 1376N-01, and 1374N-01.

Acid neutralization traps are used in applications where the ultimate pressure required is greater than 0.01 Torr (10 microns of Hg). The acid neutralization trap somewhat limits the achievable ultimate pressure and pumping speed of the pump. The ultimate pressure limitation is brought on by the degassing characteristics of the element. The pumping speed is limited since the trap will provide resistance to gas flow (See section II.B.)

The white alkaline material making up the element turns a bluish-purple when spent. The color change is visible due to the transparent nature of the sump containing it.

If water vapor is evolved from your applications, such as in freeze drying, Welch recommends a cold trap be placed between the vacuum chamber and the acid neutralization trap. The cold trap will knock out the water vapor and prevent it from saturating the acid neutralization trap's alkaline element.



CAUTION

When pumping heavy water vapor loads, failure to place a cold trap between the vacuum chamber and the acid neutralization will lead to rapidly saturated element and reduced effectiveness of the acid neutralization trap.

Welch offers two types of cold traps - dry ice slurry or liquid nitrogen traps. For pump models 1402N-01 or 1376N-01, the dry ice slurry trap cat. No. is 545002 and for the liquid nitrogen trap the cat. No. is 546002. For model 1400N-01, the dry ice slurry trap cat. No. is 545001 and for the liquid nitrogen trap the cat. No. is 546001. For model 1374N-01, the dry ice slurry trap cat. No. 545003 and for the liquid nitrogen trap the cat. No. is 546003. Call Welch Technical Service at 847-676-8800 extension 1 for recommendations on the piping connections need to connect the traps to your vacuum chamber.



CAUTION

Welch recommends isopropyl alcohol, NOT acetone, be used to make the dry ice slurry. Acetone will discolor and eventually weaken the Plexiglas cover on the dry ice slurry trap.

Cat. No. 1420E-02 is the replacement element for acid neutralization trap, Cat. No. 1420H-21, with the 4.5 inch sump. Cat No. 1420E-01 is the replacement element for acid neutralization trap, Cat. No. 1420H-20, with the 9.5 inch sump.

The acid neutralization trap may be installed vertically or horizontally.

C 2. Hermetically Sealed Oil Mist Eliminator

When pumping corrosive gases, you are striving to have them pass with a short residence time through the pump and out the exhaust port. An oil mist eliminator will coalesce the oil mist evolving from the pump and have the oil drain back into the pump. The use of an oil mist eliminator is particularly important when expensive perfluoropolyethers, such as Fomblin Y06/06, are used. The corrosive gases continue to pass through the mist eliminator and out to your exhaust system (for example, hose running to a fume hood).

A hermetically sealed mist eliminator is recommended rather than a standard exhaust filter for corrosive gas applications. Hermetically sealed mist eliminators are designed to coalesce the oil mist but not leak corrosive gases. Standard exhaust filters are not designed to contain the corrosive gases before passing into your exhaust system.



WARNING

Failing to use a hermetically sealed mist eliminator tied to an exhaust system can lead to the leaking of corrosive gases into the work area. The leakage can be harmful to personnel in and around the work area.

Welch offers a compact, hermetically sealed in-line oil mist eliminator - cat no. 1416D for Models 1400N-01, 1402N-01 and 1376N-01. For Model 1374N-01, the cat no. of the mist eliminator is Model 1416F. The oil mist eliminator automatically drains coalesced pump oil back into the pump. The replacement element for Model 1416D is cat. No. 1417Y-05. For Model 1416F the replacement element is cat. No. 1417V-05.

The element comes with both catalog numbers 1416D and 1416F. the element is easily inspected or replaced by snapping open the quick toggle body clamp.

The oil mist eliminator is constructed of stainless steel with a Fluoroelastomer gasket and oil return valve-Fluoroelastomer is a registered trademark of E.I. DuPont. The element material is borosilicate micro fibre. All three materials are highly resistant to corrosive gases.

Connection of the oil mist eliminator to the pump is via a ISO NW25 flange. Connection of the oil mist eliminator to the exhaust system is via a 13/16" ID vacuum hose.

Welch offers a mist eliminator to pump connection kit to clamp the oil mist eliminator to the pump. The pump models 1402N-01 and 1376N-01, the kit-cat. No. 1416E-02 - consists of a NW25 hinge clamp and NW25 centering ring. For 1374N-01, the kit-cat. No. 1416E-03 - consists of a NW40 hinge clamp and NW40 centering ring.

For model 1400N-01, the kit-cat. No. 1416E-01- consists of an adapter that convert the $\frac{3}{4}$ " thread with o-ring seal to ISO nw25, NW25 hinge clamp and NW25 centering ring. For 1374N-01, the kit - can. No. 1416E-03 - consists of a NW40 hinge clamp and NW40 centering ring.

For model 1400N-01, the kit-cat no. 1416E-01 - consists of an adapter that convert the $\frac{3}{4}$ " thread with o-ring seal to ISO NW25, NW25 hinge clamp and NW25 centering ring. You will need to remove the ISO NW16 adapter with o-ring seal on the pump when it arrives with the ISO NW25 adapter.

C 3. Particulate Trap With A Filter Element

In some corrosive gas applications, particulates are generated. A particulate trap with a filter element provides positive protection for pumps when dusty or loose particulates generated in the application can be ingested by the pump.

Welch offers a particulate trap, cat. No. 544002 for Models 1400N-01, 1402N-01 and 1376N-01. Cat No. 544003 is the particulate trap to use with Model 1374N-01. The particulate trap incorporates a cleanable, radial fin filter element. This design gives maximum filter area in a compact vertical fin design. The filter element can be field cleaned with a vacuum cleaner or replaced when the element is damaged or uncleanable.

Filter elements are mainly polyester providing 10 micron solid retention at 98% efficiency. Filter housings are stainless steel and can be quickly serviced without breaking inlet/outlet lines that are in a horizontal in-line configuration.

Like any porous fiber, a small amount of water is absorbed by the filter element during manufacture. When the element is used in a trap, you should expect it will take a few minutes for this trace water to be drawn out. The replacement element cat. No. is 544982 for trap cat. No. 544002. The replacement element cat. No. is 544983 for cat. No. 544003.

D. Insuring an Adequate Exhaust System

In order to protect yourself and your co-workers install an exhaust system which will allow safe removal of corrosive or hazardous gases. The exact details of the design should be developed after reviewing standard designs as given in sources such as:

"Industrial Ventilation, A Manual of Recommended Practice, "American Conference of Governmental Industrial Hygienists, Cincinnati, OH. Publication updated biannually.

The American Vacuum Society's recommended practices for exhaust systems may be found in the following article:

Part 3 Operating a Vacuum System Containing Corrosive Gases

A. Removal of Condensable Corrosive Vapors Using the Gas Ballast

Vacuum systems, which contain undesirable vapors, will cause difficulties. The two major ones are the degrading of the pump oil which is acting as a lubricant and from the standpoint of attaining desirable ultimate pressure.

A vapor is defined as the gaseous form of any substance which is usually a liquid or a solid at standard conditions. Water, acetic acid, and formic acid vapors are examples. When such vapors exist in a vacuum system, the vapors or mixtures of gas and vapor are subject to condensation within the pump. The precipitated liquid may ultimately dissolve, react or become emulsified within the oil. Not only will this lead to premature failure of the pump, but also, the ultimate pressure achievable by the pump will be degraded as a result.

Condensation takes place particularly in the compression stroke of the second stage in the pump. The compression stroke is that portion of the cycle during which the gas drawn from the intake port is compressed to the pressure necessary to expel it past the exhaust valve. Condensation takes place when the ratio between the initial pressure and end pressure of the compression is high. By adding air through the gas ballast valve to the mixture of vapor and gas being compressed, the pressure required for delivery past the exhaust valve is reached with a considerably smaller reduction of the volume of the mixture. Depending upon the amount of air added, condensation of the vapor is either entirely avoided or substantially reduced.

With the gas ballast open, the sound of the exhaust is similar to that of a pump operating against a large leak. Because of the increased pressure introduced into the compression stroke, the pump must work a little harder to function, thus resulting in an increased operating temperature of approximately 8°C over a prolonged period of time. Tests have shown that continuous and prolonged operation for several weeks under these conditions is not injurious to the pump.

The ultimate pressure achievable by the vacuum pump increases by a factor of thirty when the gas ballast is open as measured with a McLeod gauge.

B. Diluting Corrosive Gases

The lower the % of the gas flow into the pump which is corrosive gases the better. Hence, if you have extra pumping capacity in your application and corrosive gases making up more than a few percent the gas load, Welch recommends diluting the gas with dry nitrogen or argon (See specific recommendations for various gases in Section 4). If you are planning a new system, Welch recommends you use a pump with a higher capacity than initially calculated if you plan to dilute the corrosive gases.

The dry nitrogen or argon can be bled into the intake of the pump through a needle valve attached to vacuum piping joint to the vacuum chamber. Be sure not to add too much dry nitrogen or argon such that the total pressure of the system rises above 10 Torr.



CAUTION

Be sure the pump is operating at a pressure of 10 Torr or lower for continuous operation. If not, discuss application with Welch Technical Service before proceeding to prevent oil from overheating and breaking down resulting in the pump failing.



CAUTION

Be sure to use argon or nitrogen which is dry rather than wet. Water vapor mixed with corrosive gases can accelerate corrosion in the pump and lead to shorten service life.

C. Dry Nitrogen Purging of Oil Case

When pumping on corrosive gases, these gases can have a significant residence time in the oil case. The gases become dispersed throughout the oil. The longer the residence time the more the corrosion observed.

Welch provides a 1/4" compression fitting positioned at the top of the oil case which is connected to a bubbler tube in the oil reservoir. When pumping on corrosive gases, Welch recommends passing 2 to 10 cc/minute of dry nitrogen gas through the oil bubbler at a maximum of 2 PSI.

Reasons for using dry nitrogen gas purging through the oil case are:

- 1.) Uniform injection of dry nitrogen into the oil reservoir and lubricating fluid can result in as much as a 10°C lowering of operating temperature and reduced corrosion rate.
- 2.) Continuous degassing of the pump fluid and purging of the oil reservoir typically extends pump oil life.

Part 4 Recommendations for Pumping Corrosive Gases

Experiments and processes that employ corrosive gases are well known for shortening the life of vacuum pumps. Much reason exists for this to happen:

- 1.) Particulates may be formed in the experiment or process. These particulates are then ingested by the vacuum pump. The particulates can grind the moving parts of the forepump out of tolerance.
- 2.) Chemical reactions occurring in the process/experiment and on various surfaces between the chamber and the pump may create a new group of compounds. The effect of these new compounds on the pump will be determined by trial and error.
- 3.) The Corrosive gases may decompose the vacuum pump oil leading to the pump becoming oil starved. An oil starved vacuum pump will eventually seize.

Welch has reviewed some of the common corrosive gases encountered in the laboratory and experimental test reactors. Below are our recommendations on what step you can take to extend the service life of a pump in the presence of corrosive gases.

A. Strong Hydrous Acids: Hydrochloric acid (HCl), Hydrogen bromide (HBr), Sulfuric Acid (H₂SO₄), Nitric Acid (HNO₃).



CAUTION

Hydrous acids are well-known for corroding the interior of the vacuum pump. Particularly if acidified oil is allowed to remain in the pump for extended periods of time.

The first step for reducing the rate of corrosion due to hydrous acids being pumped is to dilute the flow of them into the vacuum pump. By adding dry nitrogen to the hydrous gas stream flowing into the vacuum pump, you can reduce the concentration of the acid passing through the pump. Ideally you want the hydrous acid to occupy less than 1% of the gas flow into the pump. If you go above 5%, we recommend an acid neutralization trap, cat. Nos. 1420H-21 or 1420H-20 (See Section 2 C.).

A cold trap is also a possibility for preventing the ingestion of hydrous acid into the vacuum pump. For most common hydrous acids, a cold trap cooled to -198°C using liquid nitrogen is needed.



WARNING

A cold trap concentrates the hydrous acid. Exercise caution when cleaning trap to avoid acid burns to workers.

Use of the dry nitrogen purge will facilitate the removal of acid from the oil reservoir. Avoid using air as the diluting gas (See Section 3 B.) or through the purge (See Section 3 C.) since oxygen and water in the air will only accelerate the corrosion rate.

The oil should be regularly checked for its pH during the initial start-up days of the experiment or process - and on at least a weekly basis thereafter. The oil can be checked with pH paper. If the pH drops 2 units below the reading you obtain using new oil, the oil should be replaced.

If you find that the oil needs to be changed very frequently, you should consider using oil filtration system cat. No. 1418G (See Section 2 C.) with the cellulose element which can absorb over 250 cc's of hydrous acids.

If the flow of strong exceeds 10% of gas flow, you must switch to a perfluoropolyether oil such as Fomblin YO6/6 (Welch Cat. No. 1408C-06, 1 Kg) - Fomblin is a registered trademark of Ausimont. Perfluoropolyethers are very resistant to chemical attack by strong acids.



CAUTION

Failure to use Fomblin YO6/6 in applications where strong acids are pumped at concentrations above 10% of gas flow will lead to degradation of the DIRECTORR gold oil and to the pump failing.

B. Weak Acids: Acetic Acid (HOAC), Carbonic Acid (H₂CO₃)

Weak acids can cause a vacuum pump to fail just as easily as a strong hydrous acid - particularly if they are above ambient temperature when they enter the vacuum pump. The same recommendations for strong acids are applicable to the weak acids.



CAUTION

Welch does not recommend pumps for the gel drying application unless you are trying to run off of one pump both a centrifugal concentrator and a gel dryer. If you use a pump, you must use a liquid trap and a cold trap to protect the vacuum pump. NOTE: The reason is Welch had developed a gel dryer vacuum system employing a room temperature trap (Cat. No. 1424-61 for 60 Hz operation and cat. No. 1424-51 for 50 Hz operation) specifically for this application. The Welch gel dryer vacuum system does not work with centrifugal concentrators. Please call our technical service for a brochure and complete information.

C. Halogens: Chlorine (Cl_2), Bromine (Br_2).

If water is not present, small gas flows of chlorine or bromine can be pumped without major difficulty. Welch recommends that when dry chlorine and bromine occupy less than 5% of the total gas flow the gas ballast should be opened.

DIRECTORR Gold oil will work well for this gas load.

If the flow of dry chlorine or bromine exceeds 5% of gas flow, Welch recommends you dilute the chlorine or bromine by adding dry nitrogen to the stream (See Section 3 B.). The dilution needs to bring the dry chlorine or bromine gas flow back below 5%.

If the flow of dry chlorine or bromine cannot be brought below 5% of gas flow but is not above 10%, Welch recommends that our oil filtration system with an alumina element be used (See Section 2 C. for information on the oil filtration system.)

If the flow of dry chlorine or bromine goes above 10%, you must switch to a perfluoropolyethers such as Fomblin Y06/6 (Welch Cat. No. 1408C-06, 1 Kg) - Fomblin is a registered trademark of Ausimont. Perfluoropolyethers are very resistant to chemical attack by halogens.



CAUTION

Failure to use Fomblin Y06/6 in applications where chlorine or bromine is pumped at concentrations above 10% of gas flow will lead to degradation of the DIRECTORR gold oil and to the pump failing.

If the flow of chlorine or bromine is not dry (for example chlorine or bromine in humid air), hydrochloric and hydrobromic acid will appear in the gas stream. You must follow the recommendations in Section 4. A for strong acids.

D. Formaldehyde (CH_2O)

Gas loads of formaldehyde making up more than a few percent of the gas pumped can degrade DIRECTORR Gold oil.

There are a number of ways that you can protect your pump from formaldehyde. The simplest is to dilute the gas flow (See Section 2 B.) An alternate approach is to use a cold trap (See Section 2 B.)

E. Trifluoroacetic Acid ($\text{F}_3\text{CCO}_2\text{H}$)

Trifluoroacetic acid is an extremely corrosive gas. A common application where this acid is employed is freeze drying. Welch recommends an acid neutralization trap, cat no. 1420H-21 or 1420H-20, (See Section 2 C.) be used whenever this gas is pumped. If in your application you will be pumping a heavy water load, such as freeze drying, a cold trap should be used (See Section 2 C. for details and an explanation as to why) between the freeze dryer and the acid neutralization trap.



CAUTION

When pumping heavy water vapor loads, failure to place a cold trap between the vacuum chamber and the acid neutralization trap will lead to rapidly saturated element and resulting in reduced effectiveness of the acid neutralization trap.

If the acid neutralization trap affects the pumping speed and ultimate pressure adversely in your application, Welch recommends the use Welch oil filtration system, cat. No. 1418G, with an alumina element, cat. No. 1418G-02.

F. Ozone (O_3)

Ozone is a strong oxidant and very unstable.



WARNING

Ozone is an explosive hazard in its liquid form. Do not attempt to use a cold trap to condense out the ozone. Prior to working with ozone, read a handbook on hazardous materials (for example, Dangerous Properties of Industrial Materials, Sixth Edition, by N. Irving Sax, Van Nostrand Reinhold Company Inc. NY, NY 1003, 1984) to determine if any gases you will be pumping react dangerously with ozone.

When pumping ozone, keep the concentration passing into the pump below 100 ppm. This can be accomplished either by miniaturizing the experimental process to reduce the quantity of ozone used or by dilution of the ozone flow by dry nitrogen.

Ozone is well known for chemically attacking vacuum pump oil. DIRECTORR gold oil used in a is a highly saturated oil that resists this attack. However you need to monitor the oil closely. An oil filtration system may be need if you are seeing rapid degradation of the oil at the 100 ppm. A cellulose element should be used with the oil filtration system (See Section 2 C. for more details on oil filtration system available from Welch).

If you will be pumping ozone at levels above 100 ppm of gas flow, you must switch to a perfluoropolyethers such as Fomblin Y06/6 (Welch Cat. No. 1408C-06, 1 Kg) - Fomblin is a registered trademark of Ausimont. Perfluoropolyethers are very resistant to chemical attack by ozone.



CAUTION

Failure to use Fomblin Y06/6 in applications where ozone is pumped at concentrations above 100 ppm will lead to rapid degradation of the DIRECTORR gold oil and pump failure.

To switch from DIRECTORR Gold oil To Fomblin, the pump must be totally disassembled and all parts cleaned of oil. The pump must then be assembled using Fomblin. Welch can carry out the conversion for you through our repair department. Call our factory at 847-676-8800 ext. 1 for details.

G. Anhydrides: SO_x - Sulfur Trioxide (SO_3) and Sulfur Dioxide (SO_2), Hydrogen Sulfide (H_2S)

These gases in the presence of water have the same corrosive characteristics as the strong hydrous acids. The same recommendations for strong acids are applicable to the anhydrides in the presence of water.

H. Fragments of Sulfur Hexafluoride (SF_6), Carbon Tetrafluoride (CF_4) etc.

Sulfur hexafluoride is a stable molecule except those gas cylinders of it normally contain variable quantities of low sulfur fluorides. These low sulfur fluorides can hydrolyze in the presence of water to form hydrogen fluoride (HF) - a compound notorious for its toxicity and ability to corrode. Carbon tetrafluoride (Freon 14) is also somewhat stable except that it reacts with aluminum - pump oil cases are made of aluminum, but are PTFE lined.

Carbon tetrafluoride is soluble in oil so the pump should be allowed to run for 10 to 15 minutes prior to pumping this gas. This will allow the pump to reach it operating temperature. When the pump is at its operating temperature, this will minimize the effect on a rise in ultimate pressure due to the presence of carbon tetrafluoride in the oil. Also, the gas-ballast should be opened during operation to also help keep carbon tetrafluoride at a minimum in the oil.

Sulfur hexafluoride and carbon tetrafluoride are commonly run through electrical or microwave discharges to create highly reactive radicals. These radicals can be extremely corrosive in their own right but in the presence of water can turn into hydrogen fluoride (HF).

I. Special Note: Pumping oxygen

Whenever mixtures containing oxygen or pure oxygen are used a nonflammable vacuum pump oil such as Fomblin Y06/6. DIRECTORR Gold is a synthetic saturated hydrocarbon oil and is flammable.



WARNING

Do not use DIRECTORR gold oil when pumping gases containing more than 30% oxygen. The use of DIRECTORR gold which is supplied with the pump is a Flammability Hazard if more than 30% oxygen mixtures are pumped.

When gases pumped into a pump exceed 30% oxygen of gas flow, the pump must be prepared with FOMBLIN Y06/6 (Ausimont registered trademark). Contact the Welch factory for advice or to have your pump prepared with FOMBLIN Y06/6 if you will be pumping greater than 30% oxygen gas flows.

Part 5 Recommendations For Pumping Particulate-Containing Gas Streams

A. Particulate Trap With A Filter Element

A particulate trap provides positive protection for vacuum pumps when dusty or loose particulates are pumped on. These particulates are formed in some chemical reactions involving corrosive gases in applications such as coating, powder materials processing, etching, etc. A particulate trap with filter element is available through Welch (See Section 2 C.)

The particulate trap will reduce the effective pumping speed of a pump-particularly as the element collects particulates. You can see 50% loss of the pumping speed for pressures below 1 Torr. This is why some prefer to use an oil filtration system to remove the particulates once they get into the vacuum pump without hurting the pumping speed.

B. Oil Filtration System

Many applications in chemistry, material science or metallurgy generate abrasive particulates. These particulates are ingested by the vacuum pump and will lead to a deterioration over a period of time in the operating characteristics of the pump as most evident in the ultimate pressure. A particulate trap or an oil filtration system is used to remove these particulates to minimize this effect.

If you cannot use in your application a particulate trap because it reduces the pumping speed too much or the corrosive gas attacks the polyester element, Welch recommends the use of an oil filtration system. In addition, some elements will also remove acidic compounds from the oil. See Section 2 C. for details.

Part 6 Extending Service Life of through Proper Maintenance

A. Developing A Maintenance Schedule

After Studying many examples of pump failure, Welch has found the most common reason is poor condition of the oil. This is why a regular maintenance schedule for the oil is critical to obtain the longest service life out of your pump. Welch recommends that you examine the condition of the oil on a daily basis in the early days of a new process or experiment. You want to look for discoloration of the oil and whether the oil level is rising. The discoloration can indicate deterioration of the oil and a rising oil level can indicate condensation of vapors is occurring in the pump. Once you know how long it takes for the oil to breakdown in your application or become contaminated, review the Welch accessories mentioned which are listed in Section 2 C to see which will work best in your application or choose this time as your oil change interval.

B. Forced Oil Flushing

When you drain oil through the drain valve, you are not removing the oil and contaminants that are inside the pumping mechanism. You are removing oil only from the oil case. Welch recommends a forced oil flush of pumps be performed at the regular maintenance oil change. The procedure for the forced oil flush is given below:

1. Check the oil level

- a. If the oil level is well above the fill mark, this may indicate either the pump has been overfilled with oil or has ingested a liquid or a large amount of vapor (water or organic solvents). Please go to step 2.
- b. If the oil level is even with the fill mark and you do NOT suspect corrosive gases or particulates (henceforth called contaminants) ingested have damaged the mechanism, run the pump for 15 minutes to allow the pump oil to warm up before going to step 2.

2. Turn off motor for the vacuum pump. Drain the oil into a clear plastic container (may need pliers to open drain valve). Look for contaminants settling to the bottom of container. If you see contaminants, you will need to repeat step 3 through 5 several times until the oil comes out clear. The oil you drained from the pump came from the oil case only. There may be contaminants in the pumping mechanism. To be sure all contaminants have been removed, the pump mechanism needs to be flushed.

3. Make sure the belt guard is installed before proceeding further. Attach a short hose to the drain valve which runs into a clear plastic container.

4. Flushing the pump is carried out by adding a cup of vacuum pump oil through the intake (IN) port while the pump is turned on for 5 to 20 seconds. While adding the pump oil, the exhaust (OUT) port should be blocked by the palm of your hand. Look for water coming out of the drain. Turn off the pump.
5. Repeat step 4 until only clean oil comes out the drain hose.
6. Fill the pump with the amount of DIRECTORR Gold vacuum pump oil your pump needs (Consult owners manual).
7. Plug the intake (IN) port with a rubber stopper. Turn the pump on and run the pump for 10 minutes. Close the gas ballast.
8. Check the vacuum reading of the pump by connecting a thermocouple gauge tube to the pump's intake. If the pump is running nearly as good as when it was new, the total pressure reading you will read on either of these two gauges will be at least 10 micron.

A simple way to connect the gauge tube to the pump is to run the threaded tip of tube through a hole in a rubber stopper. Use pump oil as a lubricant for inserting the tube. The stopper chosen should be bigger than the outer diameter of the intake flange.

Part 7 Vacuum Manifold

Application Note on Vacuum Manifolds

Vacuum manifolds are commonly used for the final drying of samples removed from a rotary evaporator. Organic solvents and/or acids left behind during the distillation process are removed over several hours or more depending on the sample size. A foreline cold trap (see page 28) is always recommended to minimize the ingestion of the solvents. An acid neutralization trap is also recommended between the cold trap and the pump when strong acids are present in the sample. When the drying is finished for the day, it is very important to either turn the pump off and remove/clean the trap or isolate the trap from pump using a valve. The reason for this is to prevent sublimation of condensed solids or vaporized liquids from the cold trap recondensing in the pump.

The use of large capacity pumps (greater than 40 L/min) on vacuum manifolds does shorten the oil change interval. The reason is the larger pump will accelerate the sublimation process. It is common to see at the end of a drying run when a large capacity pump is used that no condensables are in the trap because the chemicals have been drawn into the pump. There is a common misperception that a large pumping capacity pump will shorten the drying time. Due to tubing restrictions in the manifold and stopcock, this is not the case. Drying time differences between a large and a small pump occur only when the manifold system is leaky! Leaky vacuum systems should be repaired.

Part 8 Chemical Properties of Corrosive Gases

Before beginning any work with corrosive gases, you need to know the chemical properties of the corrosive gases you will be working with. Welch strongly recommends you and your in-house safety committee review their chemical properties and the safe way of handling. This application booklet is not intended to provide this information so we recommend you consult the appropriate handbook. Examples are:

Hazardous Chemicals Desk Reference, by N. Irving Sax & Richard J. Lewis, Sr., 1987, Van Nostrand Reinhold Company, Inc., NY NY 10003 Dangerous Properties of Industrial Materials, Sixth Edition, by N. Irving Sax, 1984, Van Nostrand Reinhold Company, Inc. NY NY 10003 CRC Handbook of Laboratory Safety, 5th edition, 1980. CRC Press, Boca Raton, FL 33431.

Part 9 Troubleshooting Your Pump

A. Poor Vacuum Reading

1. Disconnect vacuum pump from your vacuum system.
2. Obtain 1 gallon of DIRECTORR Gold Oil, 1 gallon or larger clear plastic container, clear drain hose (1/4 inch ID by at least 2.5 feet long), rubber gloves, goggles, apron and pliers.
3. Carry out a forced oil flush if motor can turn pumping mechanism without excessive noise (See Section 6 B). If pumping mechanism cannot be turned by motor, have pump sent into factory repair center.
4. Check ultimate vacuum with thermocouple gauge. (See Section 7 B. Step 8 for how to do this.) If reading is still unsatisfactory, consult with Welch Technical Service after checking for leaks in your connections.

B. Noisy Pump

1. Locate noise source on your vacuum pump (motor, belt, pump).
2. If motor makes noise:
 - Check for loose bolts on motor mount.
 - Loose belt, tighten by loosening bolts on motor and moving motor away from pump until belt exhibits a 1/2 inch deflection.
4. If pump makes noise:
 - Vanes may be sticking, carry out a forced oil flush (See Section 7 B.).
5. If noise level is still unsatisfactory, consult with WELCH Technical Service at 847-676-8800.

C. Excessive Oil Mist

1. Check oil level. Maintain the level between the two lines on the oil window during operation. Too high a level will cause excessive oil mist.
2. Determine the vacuum level in your system with a thermocouple gauge or manometer. Be sure the pump is operating at a pressure of 10 Torr or lower for continuous operation

If not, discuss application with Welch Technical Service before proceeding to prevent oil from overheating and breaking down resulting in the pump failing.

3. A system leak(s) or degassing can cause excessive oil mist. Locate and seal the vacuum leaks. High vapor loads may require a larger pump to compensate.
4. An oil mist eliminator can be installed for coalescing the oil mist from the exhaust gases. If an oil mist eliminator is already installed, the element may need to be replaced if saturated with oil. Open up oil mist eliminator and examine the element; replace if needed.
5. Check the oil condition for any visible change in color or consistency. Contaminants in the oil can add to the amount of oil exhausted. Carry out a forced oil flush if contamination is discovered (See Section 6 B).

WELCH-ILMVAC
Vacuum Pump Repair Facility

5621 W. Howard Street
Niles, IL 60714

Phone: (847) 676-8800 (Technical Support)

Fax: (847) 677-8606

E-Mail: gdwelchvacuum@gardnerdenver.com

Web-Page: www.welchvacuum.com

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