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# OWNER'S MANUAL FOR CHEMSTAR® VACUUM PUMPS MODELS:

**1374N**

**1376N**

**1400N**

**1402N**



**Installation  
Operation  
Maintenance  
Warranty  
MSDS Sheet For Pump Oil  
Specifications  
Parts List and Expl. Views  
Applications Booklet**



## **WARNING**

**Never Block the Exhaust Port. If the exhaust 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.**

For outside U.S. and Canada, contact your local Rietschle Thomas sales office, see back page

**Part No. 67-0544R3.2  
Printed in USA**

# CHEMSTAR® OWNERS MANUAL

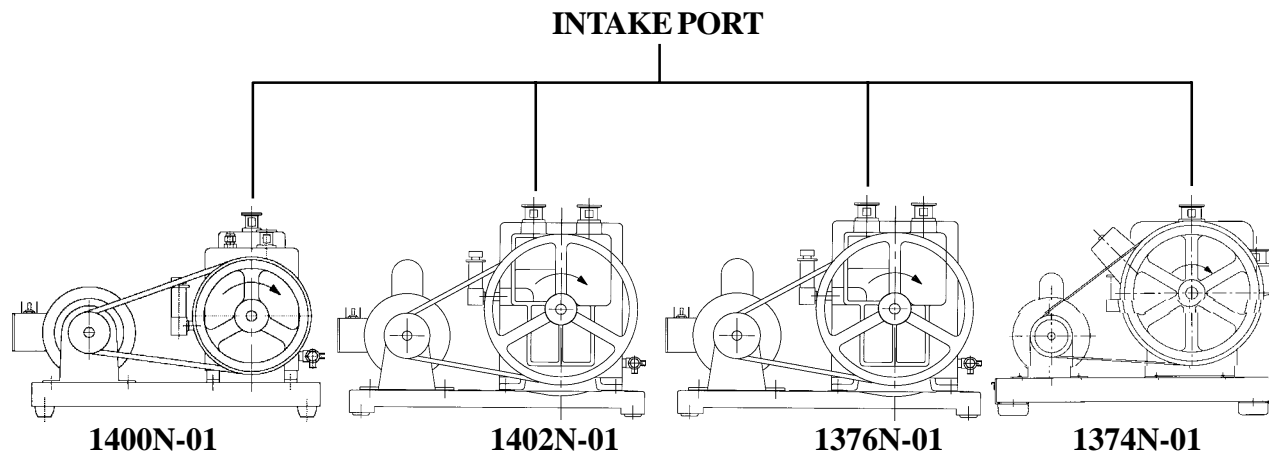
## CONTENTS

Section	Page
1. Installation	3
2. Operation	6
3. Maintenance	8
4. Quick Reference Charts	10
5. Pumping Speed Curves	10
6. Dimensional Drawings (with rotation)	11
7. Exploded Parts Listing	12
8. MSDS for Welch 8995G Gold Vacuum Pump Oil	20
9. Accessory Section	22
11. Application Booklet – CHEMSTAR® and Corrosive Gases	23
12. Warranty Information	36

### Stainless Steel ISO NW Intake and Exhaust Fittings

The Pumps come with ISO NW fitting on both the intake and exhaust ports. The fittings make it easy to use Welch modular piping to connect the pump to your system and allow easy disassembly. For users who prefer to use rubber hose, a rubber hose adapter for the intake fitting is provided.

Be sure prior to start-up, you have properly identified the intake port on the pump (see Schematics Below). **NEVER BLOCK THE EXHAUST PORT.** If the exhaust port is blocked, this will lead to a pressure build up in the pump resulting in the pump body bursting and possible injury to the pump operator. Be sure to call Welch technical service prior to start-up at (847)-676-8800 if you have any questions.



## Section 1: INSTALLATION

### 1.1 Introduction

This manual has been compiled not only for the care and maintenance of the CHEMSTAR 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.

### 1.2 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 Technology, Inc. be sure to include your order numbers for quick identification. Do not return the pump to the factory without first calling for a returned goods number.

### 1.3 Pump Mounting

#### 1.3a 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 CHEMSTAR pumps should be mounted in a horizontal plane.

#### 1.3b 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.

### 1.4 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 locations should include such determining factors as the length and size of connections, the number of bends and the type of exhaust connections.

### 1.5 Exhaust Provisions

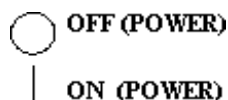
Exhaust connections will be determined by the type of system to be exhausted and the desired cleanliness of the atmosphere surrounding the pump. **SEE APPLICATION BOOKLET WITHIN OWNER'S MANUAL FOR COMPLETE DETAILS ON OIL MIST ELIMINATORS AND EXHAUST SYSTEMS FOR CORROSIVE GASES.**

### 1.6 Electrical Power

#### 1.6a 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 of 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.

#### Identification Symbols:



## **1.6b 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 60 Hz motors. Single-phase motors will normally have automatic overload protection. Motors of 1-1/2 horsepower or larger supplied with DuoSeal 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.

## **1.7 Vacuum Connections**

### **1.7a Choice of Connections**

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.

### **1.7b The Effects of Conductance**

It has been shown that the conductance of a tube is proportional to the cube of its diameter 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.

### **1.7c Metal Joints**

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

### **1.7d 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 rubber 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.

### **1.7e 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.

## **1.8 Vacuum Gauges**

The type of vacuum gauge to be used is determined largely by the pressure range to be measured. Pressures in the ranges produced by CHEMSTAR pumps can be covered by McLeod, Thermistor, Pirani or Thermocouple gauges. The McLeod gauge is used where high accuracy of measurement is required. The Pirani, Thermistor and Thermocouple gauges are electrical and give continuous readings of the total pressure. They are preferred where rapid pressure changes occur. The McLeod gauge does not measure condensable vapors; therefore, if vapors are present it will generally read lower in pressure than electrical gauges. For higher vacuums in systems employing diffusion, turbo-molecular or ion pumps, the hot filament ionization of the Philips gauge is used.

## **1.9 Traps**

### **1.9a 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 Dewier 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 contaminants. A variety of cold traps are available from Welsh Vacuum Technology, Inc. **SEE APPLICATION BOOKLET WITHIN MANUAL THAT PROVIDES ADDITIONAL DETAILS ON WHEN TO USE TRAPS.**

### **1.9b 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 rewarmed it may allow re-evaporation of the condense. 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 condense with a suitable solvent in a fume hood. Thoroughly clean and dry the trap before reinstalling in the system.

## **1.10 Types Of Lubricants**

All CHEMSTAR mechanical vacuum pumps are normally tested with DIRECTORR Gold oil and shipped with a full charge to prevent unnecessary contamination. An additional supply of oil is furnished with each pump with instructions to drain and discard the oil contaminated in the pump and replace with the fresh oil. DIRECTORR Gold oil has been especially prepared and is ideally suited for use in mechanical vacuum pumps because of its desirable viscosity, low vapor pressure and chemical stability.

The vacuum guarantee on all CHEMSTAR pumps applies only when DIRECTORR gold oil is used. Other lubricants for special applications are available including various lubricants for oxygen compatibility, lubricants for use with diffusion pumps as well as other special requirements. **SEE APPLICATIONS BOOKLET IN OWNERS MANUAL FOR OTHER LUBRICANTS USED FOR SPECIAL APPLICATIONS SUCH AS OXYGEN SERVICE.**

## **Section 2: OPERATION**

### **2.1 Starting Procedures**

#### **2.1a Starting a CHEMSTAR 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 acquired. 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 Paragraph 1.6.

#### **2.1b Cleanliness**

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

### **2.2 Leak Detection**

#### **2.2a 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.

#### **2.2b 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!

#### **2.2c 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.

### **2.3 Shutdown Procedures**

#### **2.3a CHEMSTAR Pump Shutdown**

A few simple precautions are all that is necessary when a 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 pumps removed from the system, over 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.

### **2.4 The Principle of Gas Ballast**

#### **2.4a The 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 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.

#### **2.4b The 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 compressed 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 is compressed from a low pressure to a high pressure. 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; thus, depending upon the amount of air added, condensation of the vapor is either entirely avoided or substantially reduced.

#### **2.4c Pump Function Without 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 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 20C is 17.5 torr, while at 60C, 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 thus providing continued contamination of the system.

#### **2.4d 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 from the pump as a vapor.

#### **2.4e Controlled Ballast Flow**

Some degree of variation in ballast flow may be obtained by the amount of opening applied to the 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 8C 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.

#### **2.4f 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 may serve the purpose.

## **Section 3: MAINTENANCE**

### **3.1 Vacuum Problems**

#### **3.1a 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.

#### **3.1b 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 subjected to re-evaporation during the normal cycle of pump activity thus reducing the ultimate vacuum attainable. Some foreign particles and vapors may form sludges 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 will vary with the particular system. Experience with the process will help you determine the normal period of operation before an oil change is required. **SEE APPLICATION BOOKLET WITHIN MANUAL THAT PROVIDES ADDITIONAL DETAILS ON PREVENTING OIL CONTAMINATION.**

#### **3.1c Oil Overheating**

This pump designed to operate continuously below 10 Torr. Continuous operation of this pump above 10 Torr will lead to overheating and eventual pump failure.

### **3.2 Oil Changes and Oil Level**

#### **3.2a Draining the Pump**

An oil change is not easily accomplished when the pump is warm and the oil is less viscous. Use a container large enough for the oil in the particular pump. Stop the pump, and open the drain valve. A thorough job may be accomplished by tipping the pump slightly if this is possible. The small residue remaining in the pump may be forced out by hand-rotating the pump pulley with the exhaust port partially closed and the intake port open. Closing the exhaust port completely under these conditions will create excessive pressure at the drain valve which may cause the oil being drained to splatter.

#### **3.2b Flushing the Pump**

**SEE APPLICATION BOOKLET WITHIN OWNER'S MANUAL THAT DESCRIBES FORCED OIL FLUSHING PROCEDURES TO REMOVE CONTAMINANTS FROM PUMPING MECHANISM.**

#### **3.2c Refilling the Pump**

After you are satisfied that the pump has been thoroughly flushed, refill the pump by pouring new DIRECTORR Gold 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.



### **3.3 Repairing Oil Leaks**

#### **3.3a 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 gasketed 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 gasketed 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.

#### **3.3b Repairing Technique**

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.

### **3.4 Repairing Vacuum Leaks**

#### **3.4a 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.

#### **3.4b Temporary Repair**

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

### **3.5 Drive Problems**

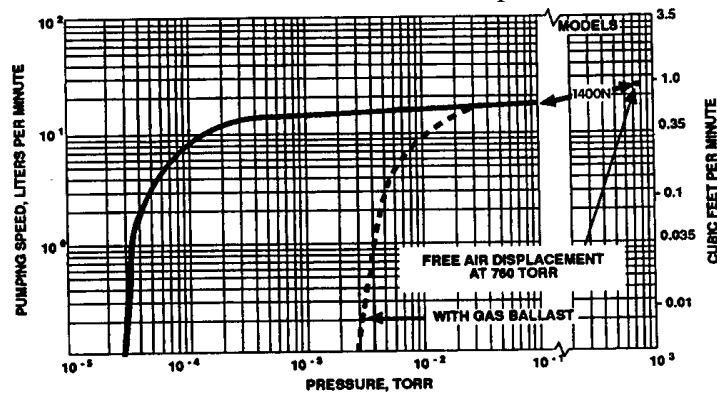
If for any reason the pump will not operate, turn off the power and check the fuse and electrical connections. Then try the power to the motor only by removing the belt. If the motor operates properly try hand-rotating the pump in the proper direction with the pump intake port open. If both turn freely then replace the belt 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: QUICK REFERENCE CHARTS

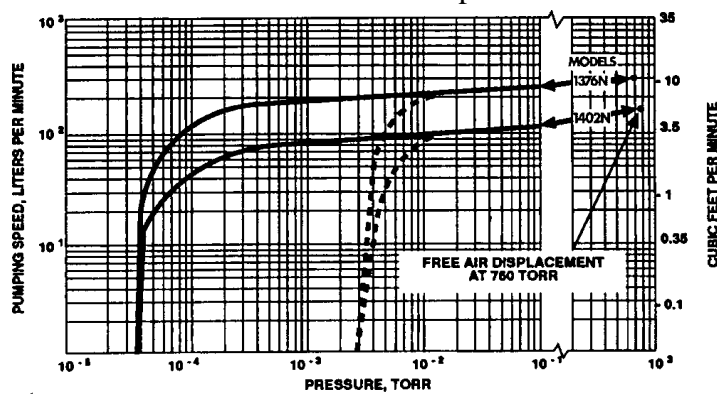
<b>CHEMSTAR VACUUM PUMP SPECIFICATIONS</b>				
<b>Description</b>	<b>1400N</b>	<b>1402N</b>	<b>1376N</b>	<b>1374N</b>
Free Air Displacement, L/M (CFM)	25 (0.9)	160 (5.6)	300 (10.6)	650(23)
Number of Stages	2	2	2	2
Gas Ballast	Yes	Yes	Yes	Yes
Ultimate Pressure, Torr (mbar)	1(1.3)x10 <sup>-4</sup>	1(1.3)x10 <sup>-4</sup>	1(1.3)x10 <sup>-4</sup>	1(1.3)x10 <sup>-4</sup>
Rotational Pump RPM	580	525	525	510
Oil Capacity, quarts (liters)	0.62(0.59)	2.25(2.1)	2.5(2.37)	1.25(1.2)
Net Wt. Unmounted Pump, lb (kg)	33(15)	82(37)	107(49)	138(63)
Net Weight Mounted Pump, lb (kg)	58(26)	112(61)	156(71)	220(100)
Optional Exhaust Filter	1417	1417A	1417A	1417B
Optional Exhaust Filter Element	1417L	1417G	1417G	1417H
Pump Pulley	41-2191	41-2074	41-2074	41-1492
Standard Belt	1400A	1405A	1405A	1374A
Standard Hose Barb Fitting	1393J	1393K	1393K	1393L
Tubing Needed, I.D., in. (cm.)	0.44(1.1)	0.81(2.1)	0.81(2.1)	1.62(4.1)
Standard Flange Adapter Fitting	1393F	1393G	1393G	1393H
Standard Flange Size	NW16	NW25	NW25	NW40
Intake Thread Size	3/4-20	1-20	1-20	1.75-20
Exhaust Thread Size	3/4-20	1-20	1-20	1.75-20
<b>CHEMSTAR ORDERING INFORMATION</b>				
<b>Electric Specification</b>	<b>Catalog Number</b>			
Wired for 115V, 60Hz, 1Ph				
with N. American 115V Plug	<b>1400N-01</b>	<b>1402N-01</b>	<b>1376N-01</b>	<b>1374N-01</b>
Wired for 230V, 60Hz, 1Ph				
with N. American 230V Plug	<b>1400N-60</b>	<b>1402N-60</b>	<b>1376N-60</b>	<b>1374N-60</b>
Wired for 220V, 50Hz, 1Ph				
with Euro. (Schuko) Plug	<b>1400N-50</b>	<b>1402N-50</b>	<b>1376N-50</b>	<b>1374N-50</b>

## Section 5: PUMPING SPEED CURVES

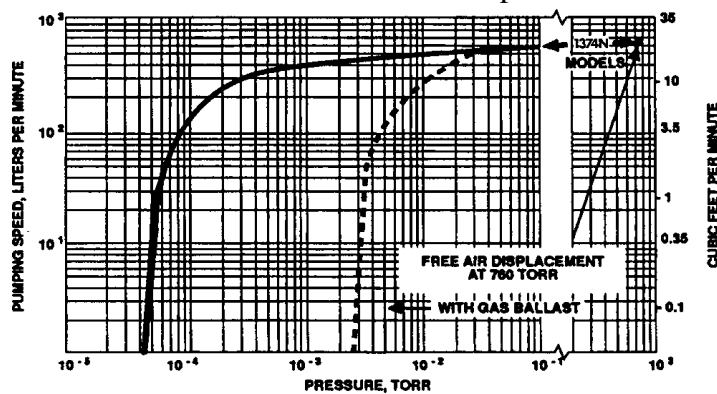
Vacuum Pump 1400N



Vacuum Pump 1376N/1402N



Vacuum Pump 1374N



### HIGH EFFICIENCY PUMPING CHARACTERISTIC OF DUOSEAL® PUMPS

The low RPM design of DuoSeal 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.

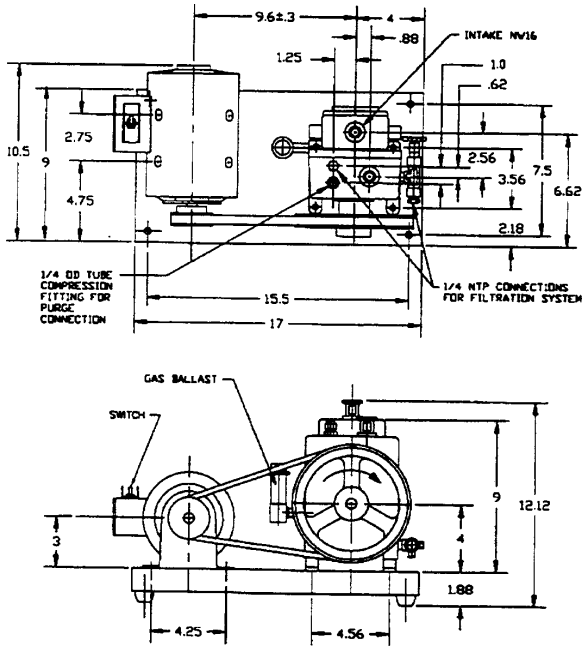
A comparison of the DuoSeal pumping speed curves shown below, versus high RPM pump speed curves conclusively illustrates the superior performance of the DuoSeal pump.

What does that mean for the vacuum pump user? DuoSeal pumps provide considerable faster pumpdown in the low micron range.

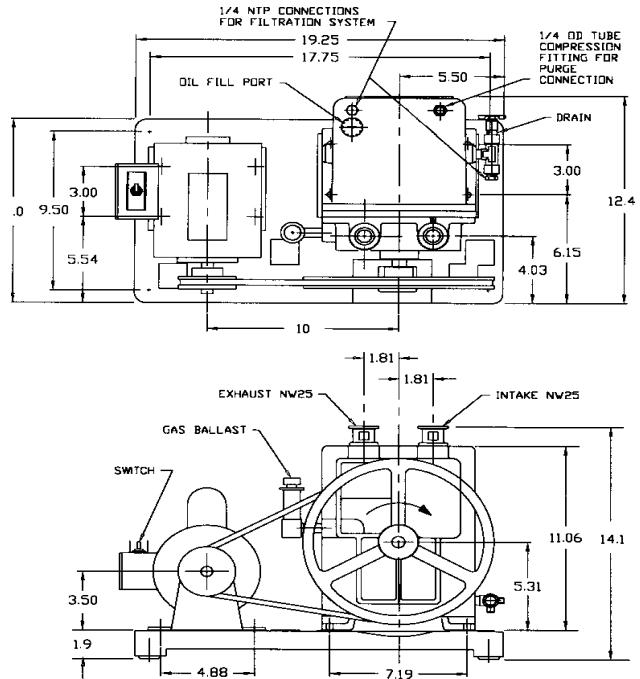
# Section 6: MOUNTED PUMPS DIMENSIONAL DRAWINGS

All Dimensions are in Inches

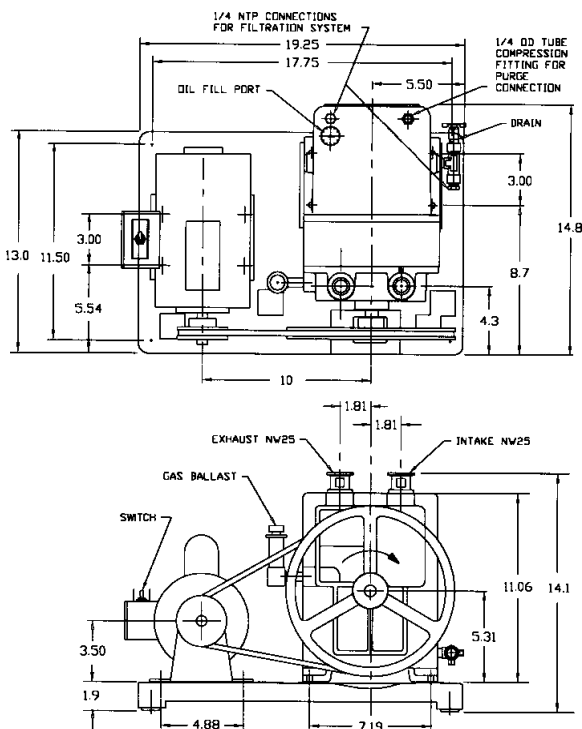
## Model 1400N-01



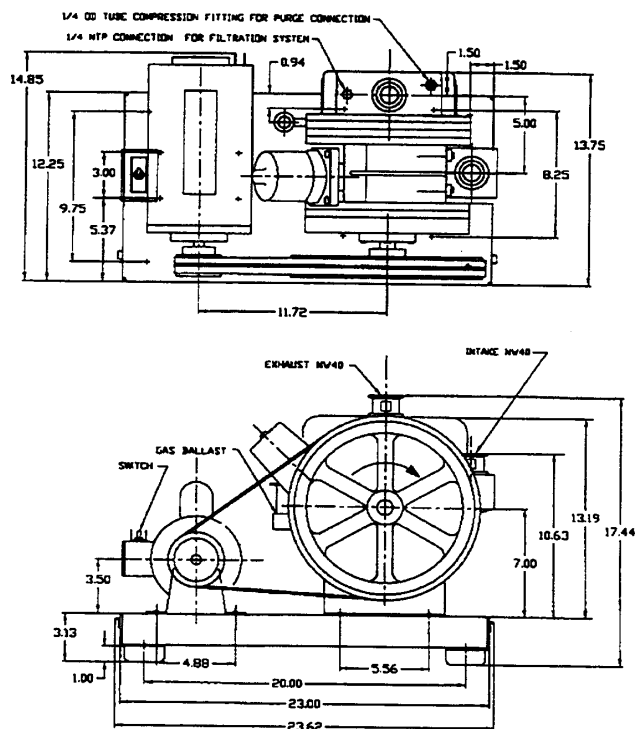
## Model 1402N-01



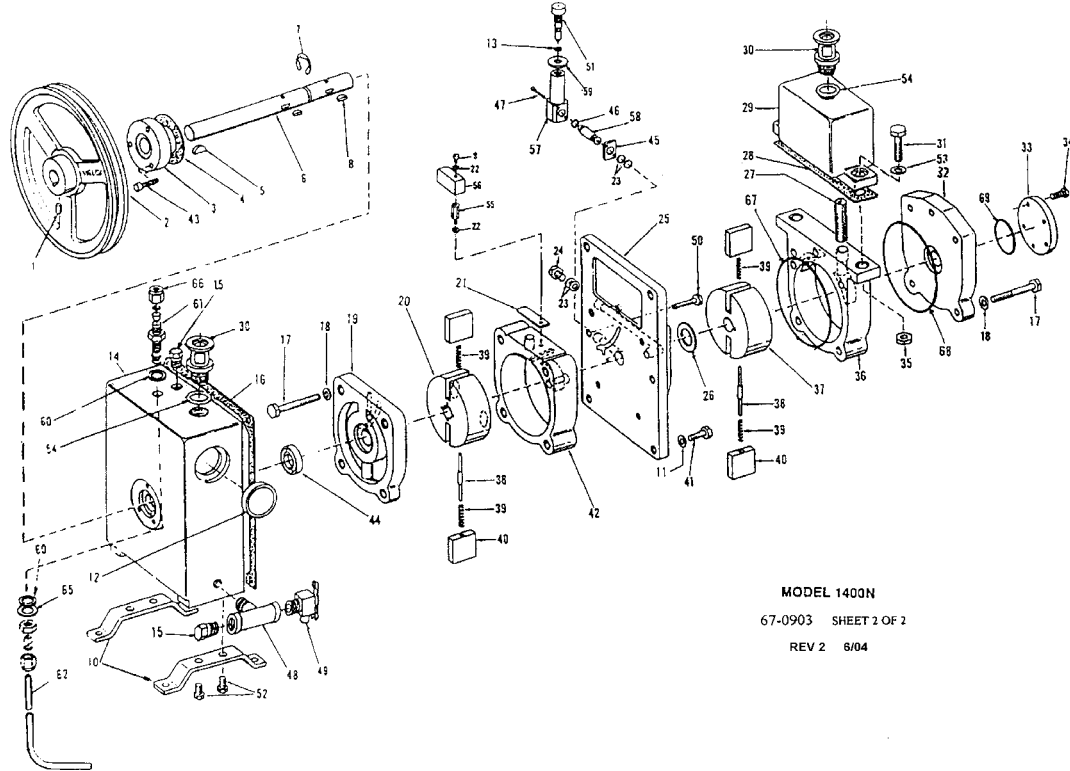
## Model 1376N-01



## Model 1374N-01



# Section 7: PARTS LIST AND EXPLODED VIEWS



MODEL 1400N  
67-0903 SHEET 2 OF 2  
REV 2 6/04

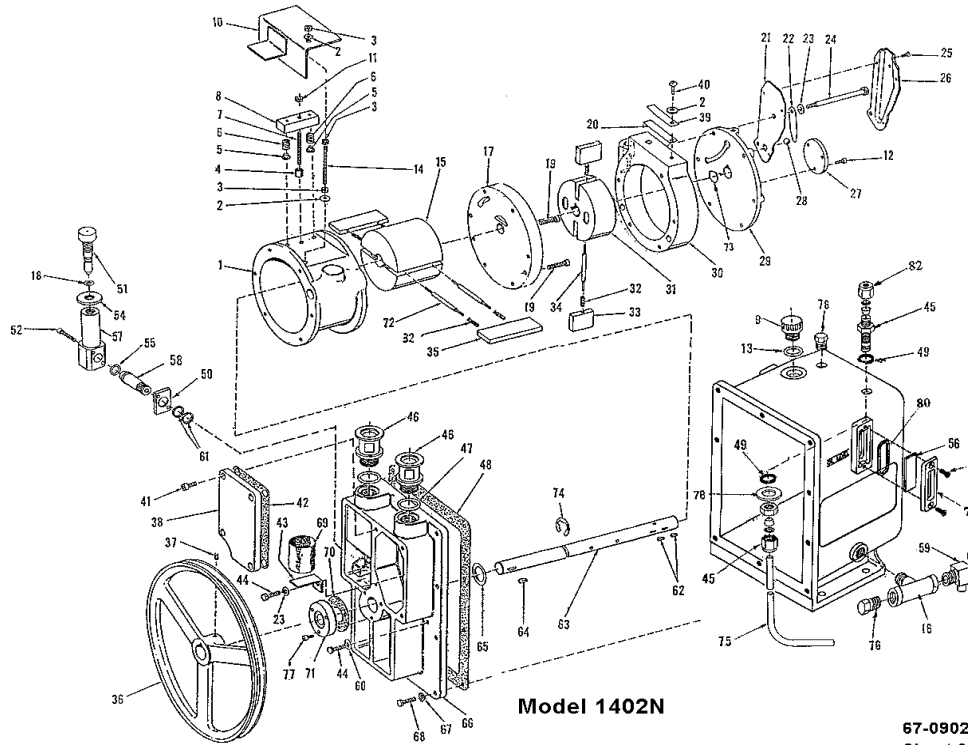
## PARTS LIST FOR 1400N

ITEM	QTY	P/N	A*	B*	DESCRIPTION	ITEM	QTY	P/N	A*	B*	DESCRIPTION
1	1	2-01-9306			Soc. Hd. Screw 5/16 - 18x3/8	36	1	61-8674			Intake Ring
2	1	41-2191			Pulley Including Set Screw Item 1	37	1	41-1041			Intake Rotor
3	1	41-3696			Shaft Seal	38	2	41-1063	2	2	Spring Holder
4	1	41-0643			Shaft Seal Gasket	39	4	61-8559A	4	4	Vane Spring
5	1	41-0624	1	1	Pulley Key	40	4	41-1059	4		Vane, Metal
6	1	41-1060			Shaft	41	5	2-01-0112			Hex. Hd.. Cap Screw 1/4 - 20x3/4
7	1	41-1150	1	1	Retaining Ring	42	1	41-1042			Exhaust Ring
8	2	41-0613	2	2	Woodruff Key	43	3	2-00-6712			Soc Hd Screw 10-32x3/4
9	1	2-00-2704			Fil. Hd. SS Screw 10-32x1/4	44	1	41-0578	1	1	Lip Seal
10	2	61-8682			Leg	45	1	61-8102A			Flange For G.B. Valve
11	6	41-1138			Washer, Copper 7/16 OD	46	1	61-8103	1	1	O-Ring Viton
12	1	41-3753			Oil Sight	47	2	61-8362			Soc. Hd. Screw 8 - 32x1
13	1	41-1742	1	1	O-Ring #011	48	1	61-8266			Tee 1/4 NTP
14	1	61-8548C			Oil Case Assy. (see note below)	49	1	41-1734			Drain Valve
15	2	61-8384			Plug, 1/4 NTP	50	1	2-01-0120			Hex. Hd. Cap Screw 1/4 - 20x1-1/4
16	1	61-8355B	1	1	Oil Case Gasket	51	1	41-1736			Gas Ballast Valve incl. item 13
17	9	2-01-0332			Hex. Hd. Cap Screw 5/16 - 18x1-1/2	52	4	2-01-0308			Hex. Hd. Screw 5/16 - 18x1/2
18	9	41-2363			Washer	53	2	2-61-0571			Steel Washer .071 x 3/8 I.D.
19	1	41-1045			Back Endplate	54	2	61-2159A	1	1	O-Ring, Viton #116
20	1	41-1040			Exhaust Rotor	55	1	61-8348A	1	1	Baffle Stud
21	1	61-1239	1	1	Exhaust Valve	56	1	61-8347B			Exhaust Baffle
22	2	2-71-0040	2	2	Brass Washer #10	57	1	61-8100A			Valve Adapter
23	8	41-1056			Aluminum Washer	58	1	61-8101A			Connector
24	1	41-1039			Vented Exhaust Plug	59	1	41-2757			Locknut
25	1	61-8678			Center Plate	60	2	62-0118	2	2	O-Ring, Tetr., #013
26	1	41-1285			Steel Washer	61	1	61-8382			Union
27	1	41-0890	1	1	Air Filter	62	1	61-8327B			Bubbler Tube
28	1	41-0383	1	1	Gasket, Intake Chamber	65	1	62-0121			Washer, SS
29	1	61-8676			Intake Chamber	66	1	62-1141			Plug
30	2	61-8464A			Adapter, NW16	67	1	61-8665	1	1	O-Ring, M2 .5x86, Viton
31	2	2-01-0524			Hex. Hd. Cap Screw 3/8 - 16x1-1/2	68	1	61-9378	1	1	O-Ring, #152, Viton
32	1	61-8701			Back Endplate	69	1	66-0183	1	1	O-Ring, #120, Viton
33	1	61-8672			End Cap			1401E-01	1	1	Shaft Seal Kit**
34	5	2-00-2706			Hex. Hd. Screw 10 - 32x3/8			1-99-5282	1	1	Sealant, 6cc
35	2	2-31-2521			Hex. Nut 3/8x16						

Note: Oil Case Assy. Item # 14 Includes Items # 10, 12, 15, 30, 48, 49, 52, 54, 60, 61, 62, 65 & 66

A\*: MAJOR REPAIR KIT CAT# 1400K-10  
B\*: MINOR REPAIR KIT CAT# 1400K-09

\*\* 1401E-01 is a shaft seal repair kit, it includes a shaft seal, gasket, and 3 screws



Model 1402N

67-0902  
 Sheet 2 of 2  
 Rev. 11 6/04

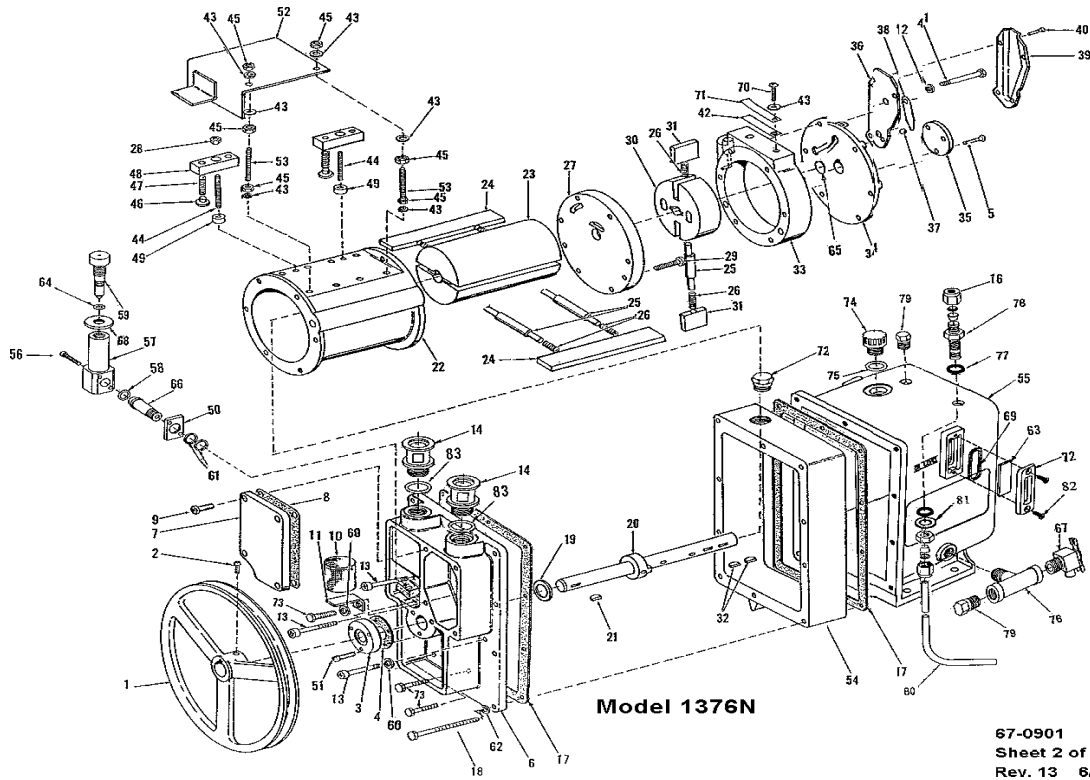
PARTS LIST FOR 1402N

ITEM	QTY	P/N	A*	B*	DESCRIPTION	ITEM	QTY	P/N	A*	B*	DESCRIPTION
01	1	61-8113C			Intake Ring	43	1	61-8329A			Air Filter Bracket
02	3	2-61-0000			Steel Washer 3/16 size	44	6	2-01-0316			Hex Head Cap Screw 5/16-18x1
03	3	2-31-0112			Hex Steel Nut	45	1	61-8382			Union
04	1	61-8315A	1	1	Valve Block Spacer	46	2	61-8465A			Intake Adapter NW25
05	2	61-8314A	2	2	Valve	47	2	61-9284A	2	2	O-ring, Fluoroelast. #214
06	2	41-2158	2	2	Valve Spring	48	1	61-8279B	1	1	Oil Case Gasket
07	1	2-01-8128			Headless Steel Set Screw	49	2	62-0118	2	2	O-Ring, Fluoroelast. #013
08	1	61-8313A			Valve Block	50	1	61-8102A			Flange for Gas Ballast Valve
09	1	61-2372			Filler Plug	51	1	41-1736			Gas Ballast Valve
10	1	61-8316A			Baffle Plate	52	2	61-8362			Socket Head Screw 8-32x1
11	1	2-36-9900			Nut, Lock 1/4-20	53	1	61-8319B			Oil Case Assy. Incl. Item 16,45,49,56,59,75,76,78,79,80,81
12	3	2-00-2706			Fil. Head Screw 10-32x3/8						Lock Nut
13	1	61-2159A	1	1	O-Ring, Fluoroelast. #1116	54	1	41-2757			O-ring, Fluoroelast. #905-75
14	1	41-2175			Headless Steel Setscrew	55	1	61-8103	1	1	Glass Window
15	1	41-2092			Intake Rotor	56	2	61-2229A			Gas Ballast Valve Adapter
16	1	61-8266			Tee 1/4 NPT	57	1	61-8100A			Gas Ballast Valve Connector
17	1	61-8250C			Center Plate	58	1	61-8101A			Drain Valve
18	1	41-1742	1	1	O-ring, Fluoroelast. #011	59	1	41-1734			Washer Copper 5/16
19	2	2-01-6320			Socket Head Screw 5/16-18x1-1/4	60	6	61-8456A	6	6	Washer
20	1	41-2154	1	1	Lower Exhaust Valve	61	2	41-1056			Woodruff Key
21	1	61-8310A			Pressure Release Duct, Part 2	62	2	41-0613	2	2	Shaft
22	1	41-0992	1	1	Pressure Release Valve	63	1	41-2093			Woodruff Key
23	6	41-2363			Washer	64	2	41-0624	2	2	Thrust washer
24	6	2-01-0356			Hex Head Screw 5/16-18x3-1/2	65	1	41-0508	1	1	Large End Plate
25	3	62-0259			Self Tap Screw #6x1/4 Type 'A'	66	1	61-8669			Split Lock Washer
26	1	61-8309B			Pressure Release Duct Part 1	67	10	2-63-0193			Hex Head Cap Screw 1/4-20x3/4
27	1	41-0672			End Cap	68	10	2-01-0114			Air Filter
28	1	4-40-1200	1	1	Steel Ball 3/8	69	1	41-0660	1	1	Seal Gasket
29	1	41-2045			Small End Plate	70	1	41-0643			Shaft Lip Seal Kit include items 70 & 77
30	1	61-8108D			Exhaust Ring	71	1	1401D-01	1	1	Spring Holder - Intake
31	1	41-1518			Exhaust Rotor	72	2	41-1685	2	2	Thrust Disc
32	6	61-8559A	6	6	Vane Spring	73	3	41-1766	3	3	Truarc Ring
33	2	41-1487	2	2	Small Vane	74	1	4-06-0754	1	1	Bubbler Tube
34	1	41-0696	1	1	Vane Spring Holder-Exhaust	75	1	61-8321B			Plug 1/4 NTP
35	2	41-0959	2	2	Large Vane	76	2	61-8384			Socket Head Screw 10-32x3/4
36	1	41-2074			Pulley inc. set screw, Item 37	77	3	2-00-6712			SS Washer
37	1	2-01-9306			Socket Head Set Screw	78	1	62-0121			Cover, Window
38	1	61-8670			Large End Plate Cover	79	2	61-2370			O-Ring, Fluoroelast. #127
39	1	41-2153	1	1	Upper Exhaust Valve	80	2	66-0304	2	2	Flat Head Screw 8-32x1/2
40	1	2-01-5106			Round Head Steel Screw 1/4-20x 3/8	81	4	61-2232			Plug
41	4	2-01-6112			Socket Screw 1/4-20x3/4	82	1	62-1141			Sealant, 6cc
42	1	61-8278A	1	1	Intake Chamber Cover Gasket			1-99-5282	1	1	

A\*: MAJOR REPAIR KIT CAT # 1402K-10

B\*: MINOR REPAIR KIT CAT # 1402K-09

\*\* 1401D-01 is a shaft seal kit and includes a shaft seal, gasket, and 3 screws



67-0901  
 Sheet 2 of 2  
 Rev. 13 6/04

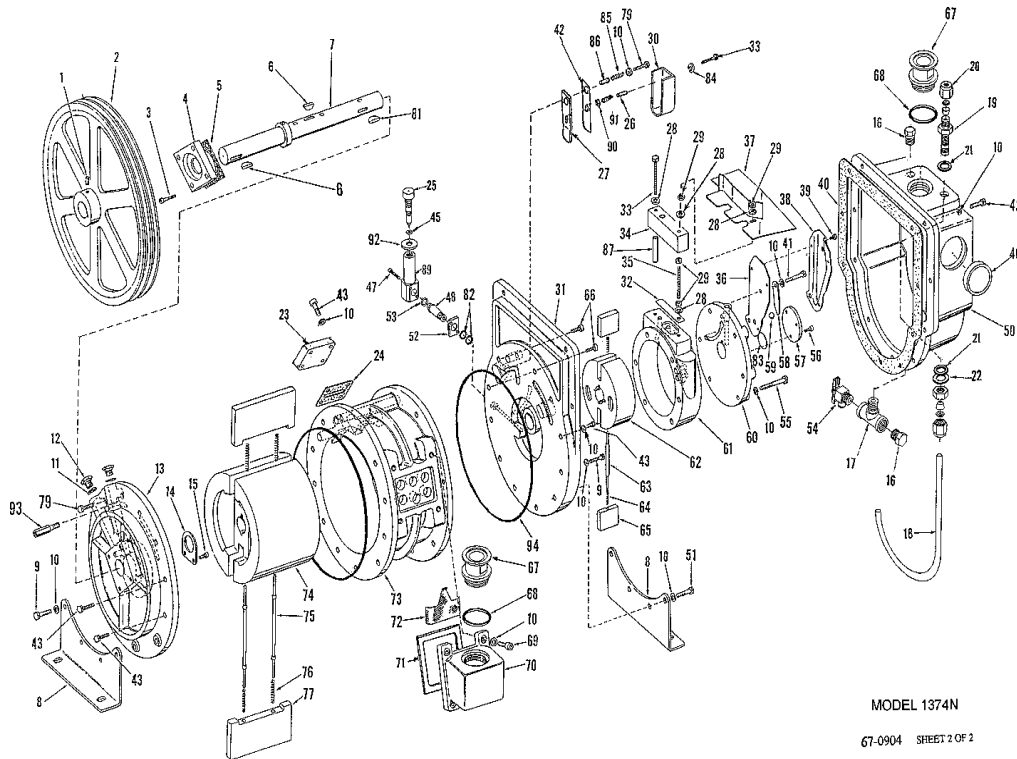
### PARTS LIST FOR 1376N

ITEM	QTY	P/N	A*	B*	DESCRIPTION	ITEM	QTY	P/N	A*	B*	DESCRIPTION
01	1	41-2074			Pulley incl. item 2	44	2	2-01-8128			Set Screw 1/4-20x1-3/4
02	1	2-01-9306			Socket Head Set Screw 5/16-18x3/8	45	6	2-31-0112			Hex Nut 1/4-20x3/16x7/16
03	1	1401D-01	1	1	Shaft Lip Seal Kit includes items 4 & 5**	46	4	61-8314A	4	4	Block Valve
04	1	41-0643			Seal Gasket	47	4	41-2158	4	4	Valve Spring
05	3	2-00-2706			Fil. Head Screw 10-32x3/8	48	2	61-8313A			Valve Block
06	1	61-8684			Large End Plate	49	2	61-8315A	2	2	SS Valve Block Spacer
07	1	61-8670			Intake Cover	50	1	61-8102A			Flange For G.B. Valve
08	1	61-8278A	1	1	Intake Cover Gasket	51	3	2-00-6712			Socket Head Screw 10-32x3/4
09	4	2-01-6112			Socket Head Screw 1/4-20x3/4	52	1	61-8368B			Baffle Plate
10	1	41-1692	1	1	Intake Screen	53	2	41-2175			Setscrew (Special)
11	1	61-8329A			Intake Screen Bracket	54	1	61-8686			Oil Case Spacer
12	6	41-2363			Washer	55	1	61-8319B			Oil Case Assy.incl.63,67,76,77,78,79,80
13	3	2-01-6316			Socket Head Screw 5/16-18x1	56	2	61-8362			Socket Head Screw 8-32x1
14	2	61-8465A			Adapter NW25	57	1	61-8100A			Gas Ballast Valve Adapter
16	1	62-1141			Plug	58	1	61-8103	1	1	O-Ring, Fluoroelast. #905
17	2	61-8279B	2	2	Oil Case Gasket- Fluoroelast.	59	1	41-1736			Gas Ballast Valve incl. item 64
18	10	62-0015			Socket Head Screw 1/4-20x3-1/8	60	6	61-8456A			Washer Copper 5/16
19	1	41-0508	1	1	Thrust Washer	61	2	41-1056			Washer
20	1	41-1683			Shaft	62	10	2-63-0193			Split Lock Washer 1/4
21	1	41-0624	1	1	Pulley Key	63	2	61-2229A			Glass Window
22	1	41-1688			Large Ring	64	1	41-1742	1	1	O-Ring, Fluoroelast. #011
23	1	41-1682			Large Rotor	65	3	41-1766			Thrust Disk
24	2	41-1684	2	2	Large Vane	66	1	61-8101A			Gas Ballast Connector
25	3	41-0696	3	3	Spring Holder	67	1	41-1734			Drain Valve
26	6	61-8559A	6	6	SS Vane Spring	68	1	41-2757			Lock Nut
27	1	61-8250C			Center Plate	69	2	66-0304	2	2	O-Ring, Fluoroelast. #127
28	2	2-36-9900			Lock Nut 1/4-20	70	1	2-01-5106			Round Head Screw 1/4-20x3/8
29	2	2-01-6320			Socket Head Screw 5/16-18x1-1/4	71	1	61-8311A	1	1	SS Upper Exhaust Valve
30	1	41-1518			Exhaust Rotor	72	2	61-2370			Cover, Window
31	2	41-1487	2	2	Small Vane	73	3	2-01-0316			Hex Head Screw 5/16-18x1
32	2	41-0613	2	2	Woodruff Key	74	1	61-2372			Filler Plug
33	1	61-8108D			Exhaust Ring	75	1	61-2159A	1	1	O-Ring, Fluoroelast. #115
34	1	41-2045			Small End Plate	76	1	61-8266			Tee 1/4 NTP
35	1	41-0672			End Cap	77	2	62-0118	2	2	O-Ring, Fluoroelast. #013
36	1	61-8310A			Pressure Release Duct Part 2	78	1	61-8382			Union
37	1	4-40-1200	1	1	Steel Ball	79	2	61-8384			Plug 1/4 NTP
38	1	61-8262A	1	1	SS Pressure Release Valve	80	1	61-8321B			Bubbler Tube
39	1	61-8309B			Pressure Release Tube Part 1	81	1	62-0121			SS Washer
40	3	62-0259			Bd. Head Sheet Metal Screw #6x1/4	82	4	61-2232			Flat Hd Screw 8-32x1/2
41	6	2-01-0356			Hex Head Screw 5/16-18x3-1/2	83	2	61-9284A	2	2	O-Ring, Fluoroelast. #214
42	1	61-8312A	1	1	SS Lower Exhaust Valve			1-99-5282	1	1	Sealant 6cc
43	3	2-61-0000			Steel Washer 1/4 size						

A\*: MAJOR REPAIR KIT CAT # 1376K-10

B\*: MINOR REPAIR KIT CAT # 1376K-09

\*\* 1401D is mechanical seal kit includes mechanical seal, gasket and 3 screws



MODEL 1374N

G7-0904 SHEET 2 OF 2

REV. 2 6/04

### PARTS LIST FOR 1374N

ITEM	QTY	P/N	A*	B*	DESCRIPTION	ITEM	QTY	P/N	A*	B*	DESCRIPTION
01	1	2-01-9306			Set Screw 5/16-18x3/8	47	2	61-8362			Soc Hd Screw 8-32x1
02	1	41-1492			Pulley incl. Item 1	48	1	61-8101A			Connector for GB Valve
03	4	2-01-6116			Soc Hd Screw 1/4-20x1	50	1	61-8264B			Oil Case Assy. Incl. Items 16, 17, 18, 19, 20, 21, 22, 46, 54, 67 & 68
04	1	1401F-01	1	1	Shaft Seal incl. (1)Item5&(4)Item3						Soc Hd. Screw 5/16-18x1-3/4
05	1	61-8601A			Seal Gasket	51	4	62-0213			Flange For GB Valve
06	2	41-1490	2	2	Woodruff Key	52	1	61-8102A			O-Ring #3-905 Viton
07	1	41-1484			Shaft & Collar	53	1	41-1734	1	1	Drain Valve
08	2	61-8694	2	2	Leg	54	1	41-1734			Soc Hd Screw 5/16-18x2-3/4
09	7	2-01-6324			Soc Hd. Screw 5/16-18x1-1/2	55	5	62-0222			Flat Hd Screw 10-32x3/8
10	38	41-2363			Steel Washer	56	3	2-00-2706			Shaft End Cap
11	3	41-1137			Plug Washer	57	1	41-0672			SS Pressure Relief Valve
12	2	41-1136			Plug	58	1	41-0992	1	1	Steel Ball 3/8 Dia
13	1	61-8769			Large End Plate	59	1	4-40-1200	1	1	Small End Plate
14	1	41-0055			Spacer	60	1	41-1500			Exhaust Ring
15	2	2-00-2704			Fil Hd Screw 10-32x1/4	61	1	41-1497			Exhaust Rotor
16	2	61-8384			Pipe Plug 1/4 NTP	62	1	41-1499			Small Spring Holder
17	1	61-8266			Tee 1/4 NTP	63	1	41-0696	1	1	Small Vane Spring
18	1	61-8321B			Bubbler Tube	64	2	61-8559A	2	2	Small Vane Metal
19	1	61- 8382			Bulkhead Union 1/4 Tube	65	2	41-1487	2		Hex Hd Screw 5/16-18x1
20	1	62-1141			Plug	66	2	2-01-0316			Adapter NW40
21	2	62-0118	2	2	O-Ring, Tetra. #013	67	2	61-8466A	2	2	O-Ring #224 Viton
22	1	62-0121			Washer, SS	68	2	61-8475			Soc Hd Screw 5/16-18x7/8
23	1	61-8270A			Cover	69	4	2-01-6314			Intake Chamber
24	1	61-8606A	1	1	Valve Gasket	70	1	61-8690			Intake Chamber Gasket
25	1	41-1736			Gas Balast Valve incl. Item 45	71	1	61-8602A	1	1	Screen Filter
26	1	41-2258			Hardened Sleeve 1/4 Size	72	1	41-0937	1	1	Large Ring
27	1	61-8538A	1	1	Valve Backer	73	1	61-8690			Large Rotor
28	4	2-61-0000			Steel Washer 3/16 Bolt Size	74	1	41-1478			Large Spring Holder
29	4	2-31- 0112			Hex Steel Nut 1/4-20x7/16	75	2	41-1489	2	2	Large Vane Spring
30	1	61-8604A			Discharge Valve Cover	76	4	61-8609A	4	4	Large Vane Metal
31	1	61-8688			Center Plate	77	2	41-1477	2		Soc Hd Screw 5/16-18x1-1/4
32	1	41-2161	1	1	SS Exhaust Valve	79	2	2-01-6320			Key for Small Rotor
33	2	2-01-0120			Hex Hd Screw 1/4-20x1-1/4	81	1	41-1516	1	1	Aluminum Washer
34	1	61-8592B			Cover	82	4	41-1056	4	4	Spacer Disk
35	1	2-01-8132			Headless Screw 1/4-20x2	83	1	41-1469	1	1	Split Lock Washer 1/4
36	1	61-8310A	1	1	Pressure Release Tube Part 2	84	1	2-63-0193			Coil Spring
37	1	61-8595B			Baffle Assy.	85	1	61-8607A			Hardened Sleeve 5/16 Size
38	1	61-8309B	1	1	Pressure Release Tube Part 1	86	1	41-2257			Spacer
39	3	62-0259			Bd Hd Screw #6x1/4	87	1	61-8605A	1	1	GB Valve Adapter
40	1	61-8603C	1	1	Viton Oil Case Gasket	89	1	61-8100A			SS Washer 11/32x11/16x1/16
41	1	2-01-0344			Hex Hd Screw 5/16-18x2-3/4	90	1	2-69-7007			Coil Spring
42	1	61-8539A	1	1	Valve Flapper	91	1	61-8608A	1	1	Lock Nut
43	22	2-01-6316			Soc Hd. Screw 5/16-18x1	92	1	41-2757			Guard Stud
45	1	41-1742	1	1	O-ring #011 Viton	93	1	41-2165	1	1	O-Ring #372 Viton
46	2	41-3753			Oil Sight	94	1	61-8712	1	1	Sealant, 6 cc
								1-99-5282	1	1	

A\*: MAJOR REPAIR KIT CAT. # 1374K-12  
 B\*: MINOR REPAIR KIT CAT. # 1374K-11

G7-0904  
 Sheet 1 of 2  
 Rev. 2 6/04



## Section 8: MSDS for Welch 8995G Gold Vacuum Pump Oil



### MATERIAL SAFETY DATA SHEET

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: Welch Rietschle Thomas  
7301 North Central Ave.  
Skokie, IL 60077

Date Prepared: March 10, 2004

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<sup>-7</sup>

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

THE INFORMATION HEREIN IS GIVEN IN GOOD FAITH, BUT NO WARRANTY, EXPRESS OR IMPLIED, IS MADE.

**Revision Date: 02/10/04**

**Rev. 2**

**P/N: 67-0293A** 1 of 3



#### 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.
<b>CAUTION:</b>	<b>DO NOT USE PRESSURE TO EMPTY DRUM, OR EXPLOSION MAY RESULT.</b>

#### 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:	<u>Do not induce vomiting.</u> If victim is conscious and able to swallow, give water to dilute, do not give sodium bicarbonate, fruit juices, or vinegar. See medical attention.

THE INFORMATION HEREIN IS GIVEN IN GOOD FAITH, BUT NO WARRANTY, EXPRESS OR IMPLIED, IS MADE.

Revision Date: 02/10/04

Rev. 2

P/N: 67-0293A 2 of 3

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## 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.**

THE INFORMATION HEREIN IS GIVEN IN GOOD FAITH, BUT NO WARRANTY, EXPRESS OR IMPLIED, IS MADE.

**Revision Date: 02/10/04**

**Rev. 2**

**P/N: 67-0293A 3 of 3**

## Section 9: ACCESSORY SECTION

### Coaxial Traps

- Reduces oil backstreaming
- Stainless steel construction
- Easy replacement of elements

ISO Size	Capacity	Diameter	Height	A <sup>2</sup>	Cat. No. <sup>1</sup>
NW16	To 4 CFM (140 L/min)	3.75	5.25	8.25	541001
NW 25	To 12 CFM (340 L/min)	5.50	5.25	8.25	541001
NW40	To 25 CFM (710 L/min)	5.50	5.25	8.25	541001
Copper Element for ISO NW 16 Trap <sup>1</sup> .					541001
Stainless Steel Element for ISO NW 16 Trap <sup>1</sup> .					541001
Copper Element for ISO NW 25 and NW 40 Traps <sup>1</sup> .					541001
Stainless Steel Element for ISO NW 25 and NW 40 Traps <sup>1</sup> .					541001

1. Element must be ordered with trap.
2. Distance between ISO NW inlet and outlet connections.

### Modular Sieve Traps

- Blocks backstreaming by absorbing hydrocarbons.
- Regenerates charge using built-in heater.
- Removes trace amounts of water vapor.

ISO Size	Capacity	Diameter	Height	A <sup>2</sup>	Cat. No. <sup>1</sup>
NW16	To 8 CFM (140 L/min)	4.50	6.38	9.00	543001
NW 25	To 8 CFM (226 L/min)	4.50	6.38	9.00	543002
NW40	To 17 CFM (481 L/min)	4.50	9.00	9.00	543003
Synthetic Zeolite Charge <sup>1</sup> .					543950
Activated Alumina Charge <sup>1</sup> .					543960

1. Element must be ordered with trap.
2. 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 load
- Available with straight tube connections

ISO Size	Diameter	Height	A <sup>1</sup>	I/O Offset	Cat. No.	Repl. Seal Cat. No.
NW 16	10	8.25	11.06	3.5	545001	545200
NW 25	10	8.25	11.06	3.5	545002	545200
NW 40	10	8.25	11.06	3.5	545003	545200
<b>Straight Tube</b>						
½ O.D.	10	8.25	10.75	3.5	1420H-14	545200

1. Distance between ISO NW inlet and outlet connections.

### Liquid Nitrogen Cold Traps

- A highly efficient method of trapping condensable vapors
- Produces a lower mechanical vacuum pump base pressure
- Allows quick clean-up of the trapping surface with the two-piece clamped body design

ISO Size	Capacity	Diameter	Height	A <sup>1</sup>	Cat. No.
NW 16	0.75 Liter	5.5	11.00	7.0	546001
NW 25	0.75 Liter	5.5	11.00	7.0	546002
NW 40	1.65 Liter	7.5	13.75	9.0	546003

1. Distance between Iso NW inlet and outlet connections.

Dimensions are in inches.

**USING YOUR CHEMSTAR® PUMP  
WITH CORROSIVE GASES  
3<sup>rd</sup> Edition**

**Applications Booklet**

## USING YOUR CHEMSTAR VACUUM PUMP WITH CORROSIVE GASES

Thank you for choosing the CHEMSTAR 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 CHEMSTAR vacuum pump successfully when pumping corrosive gases.

### Table of Contents

#### Section 1. Health & Safety

#### Section 2. Building a Vacuum System to Handle Corrosive Gases

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

#### Section 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

#### Section 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 ( $F_3CCO_2H$ )
- 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\*\*\*

#### Section 5. Recommendations for Pumping Particulate-Containing Gas Streams

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

#### Section 6. Extending Service Life of CHEMSTAR through Proper Maintenance

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

#### Section 7. Chemical Properties of Corrosive Gases

#### Section 8. Troubleshooting Your CHEMSTAR Pump

## Section 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 CHEMSTAR 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.

## Section 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 CHEMSTAR vacuum pump. For this reason, Welch recommends DIRECTORR® Gold Oil be used with each CHEMSTAR 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 CHEMSTAR pumps**



#### WARNING

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

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.



#### **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 CHEMSTAR pump failing.**

### **B. Connecting your CHEMSTAR 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 CHEMSTAR Pump**

Protective accessories may be needed for heavy corrosive gas loads which may contain particulates. In Section 4, recommendations are given which detail when these accessories should be used. Below is a description of these accessories and how they work.

#### **C 1. Oil Filtration System**

The oil filtration system, Cat. No. 1418G, is designed for removing oil from the oil back to the oil reservoir. The whole process occurs via tubes that connect the oil filtration system to the CHEMSTAR pump. The oil filtration system works continuously while the CHEMSTAR pump is pumping on the corrosive gases.

This compact, portable, self-contained oil filtration system does not affect the pumping speed or ultimate pressure obtainable by the CHEMSTAR pump it is attached to. The system actually will work to maintain the CHEMSTAR pump's performance when pumping corrosive gases by keeping the oil clean.

Depending on the element chosen, the oil filtration system will continuously remove acids, alkali and/or particulates. The elements available are as follows:

Cellulose Element, Cat. No. 1418G-01. Oil Filtration System Cat. No. 1418G comes with the cellulose element. The element is 100% cellulose. The element is designed for use with DIRECTORR Gold oil where moderate amounts of particulate and acidic contamination are generated. The element should **NOT** be used with perfluoropolyethers such as Fomblin Y06/06. The cellulose element will remove essentially all abrasive particulates 0.1 micrometers and larger. The cellulose element will also simultaneously absorb up to 250 cc of hydrous acids, ammonium hydroxide and water.

Activated Alumina element, Cat No. 1418G-02. The element is designed for applications where substantial quantities of acidic contamination are generated. The fabric making up the element is hydrophilic and has been impregnated with a slurry of finely divided activated alumina. The element will also remove particulates that 0.1 micrometers and larger. The element will absorb ammonium hydroxide, hydrous acids and water. The element will also absorb or neutralize Lewis Acids such as aluminum chloride (AlCl<sub>3</sub>). The element is suitable for use with DIRECTORR Gold oil and perfluoropolyethers such as Fomblin Y06/06.



The specifications for the oil filtration system model 1418G are as follows:

<b>Electrical Requirements:</b>	115/230V, 50/60 Hz, 1 Ph
<b>Oil Required To Charge System:</b>	Less than 1 Liter
<b>Connecting Tubing:</b>	5 ft. long, 3/8" ID, High Pressure Synthetic Material, Rated at 300° Synthetic Material, Rated at 300°F
<b>Hose Ends:</b>	Quick-Snap, Dripless Disconnects, 1/4" NPT female
<b>Pressure Gauge:</b>	0 to 100 PSI
<b>Motor:</b>	1/20 HP, TEFC, Thermal Overload Protected
<b>Oil Flow Rate:</b>	0.4LPM@1650 RPM
<b>Overall Size:</b>	11 "L x 6"W x 10" H (27.9 cm L x 15.2 cm W x 25.4 cm H)
<b>Shipping Weight:</b>	18 lbs. (8.2 Kg)

## C 2. 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 CHEMSTAR Model 1400N-01. Cat. No. 1420H-20 uses a 9.5 inch deep sump and is used with CHEMSTAR 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 CHEMSTAR 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 2 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 CHEMSTAR 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 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 3. 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 CHEMSTAR 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 CHEMSTAR 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 VitonR gasket and oil return valve-Viton 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 CHEMSTAR 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 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 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 4. 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 CHEMSTAR 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 is 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 remove 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:

### **Section 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 CHEMSTAR 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 ration 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 CHEMSTAR 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 bleed into the intake of the CHEMSTAR 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 corrosive 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.

## Section 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 CHEMSTAR pump in the presence of corrosive gases.

### A. Strong Hydrous Acids: Hydrochloric acid (HCl), Hydrogen bromide (HBr), Sulfuric Acid (H<sub>2</sub>SO<sub>4</sub>), Nitric Acid (HNO<sub>3</sub>).



#### 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 Y06/6 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 CHEMSTAR pump failing.**

**B. Weak Acids: Acetic Acid (HOAC), Carbonic Acid (H<sub>2</sub>CO<sub>3</sub>)**

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 CHEMSTAR 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 CHEMSTAR 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<sub>2</sub>), Bromine (Br<sub>2</sub>).**

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 YO6/6 (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 CHEMSTAR 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<sub>2</sub>O)

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 CHEMSTAR 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 (F<sub>3</sub>CCO<sub>2</sub>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.#1418G, with an alumina element, Cat.#1418G-02.

#### F. Ozone (O<sub>3</sub>)

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 CHEMSTAR is a highly saturated oil that resists this attack. However you need to monitor the oil closely. An oil filtration system may be needed 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 CHEMSTAR pump failure.**

To switch from DIRECTORR Gold oil To Fomblin, the CHEMSTAR 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<sub>x</sub> - Sulfur Trioxide (SO<sub>3</sub>) and Sulfur Dioxide (SO<sub>2</sub>), Hydrogen Sulfide (H<sub>2</sub>S)

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<sub>6</sub>), Carbon Tetrafluoride (CF<sub>4</sub>) 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 - CHEMSTAR pump oil cases are made of aluminum, but are Teflon 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 its 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 CHEMSTAR pump exceed 30% oxygen of gas flow, the CHEMSTAR pump must be prepared with FOMBLIN Y06/6 (Ausimont registered trademark). Contact the Welch factory for advice or to have your CHEMSTAR pump prepared with FOMBLIN Y06/6 if you will be pumping greater than 30% oxygen gas flows.

## **Section 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 CHEMSTAR 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.

## **Section 6. Extending Service Life of CHEMSTAR 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 CHEMSTAR 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 CHEMSTAR 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 DUOSEAL 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.
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.

## **Section 7. 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, 5<sup>th</sup> edition, 1980. CRC Press, Boca Raton, FL 33431.



## Section 8. Troubleshooting Your CHEMSTAR 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 6 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.
  - Motor may need 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. (See Section 7 B.)
5. If noise level is still unsatisfactory, consult with WELCH Technical Service at 847-676-8800, extension 1.

### 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

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

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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)

## **WARRANTY**

This Welch Vacuum product is warranted to be free from defects in material and workmanship. The liability of Welch Rietschle Thomas under this warranty is limited to servicing, adjusting, repairing or replacing any unit or component part which in the judgment of Welch Rietschle Thomas has not been misused, abused or altered in any way causing impaired performance or rendering it inoperative. No other warranties are expressed or implied. The method of executing this warranty: servicing, adjusting, repairing or replacing shall be at the discretion of Welch Rietschle Thomas. Vacuum pumps that have been used for any period, however short, will be repaired under this warranty rather than replaced.

The warranty is effective for one year from the date of original purchase when:

1. The warranty card has been completed and returned.
2. The product is returned to the factory or other designated service centers, freight prepaid.
3. The product in our judgment is defective through no action or fault of the user.

If the product has become defective through misuse, abuse, or alteration, repairs will be billed regardless of the age of the product. In this event, an estimate of the repair costs will be submitted and authorization of these charges will be required before the product is repaired and returned.

To reduce additional charges and delays either within or outside of the warranty period, contact Welch Rietschle Thomas @847-676-8800 for a return authorization number. Products without a return authorization number will be refused by our receiving department. Before shipping, properly pack the pump, insure it against loss or damage, and on the outside of the pump packaging and the packing slip write in the return authorization number. Pumps damaged due to improper packaging are the customer's responsibility.