owner's manual

Model 1400 vacuum pump

Exchange Service

7300 North Linder Avenue
Skokie, Illinois 60076
(312) 677-0600

1617 East Ball Road
Anaheim, California 92803
(714) 772-3550

5915 Peeler Street
Dallas, Texas 75235
(214) 357-9381

35 Stern Avenue
Springfield, New Jersey 07081
(201) 376-7050

285 Garyray Drive
Weston, Ontario M9L 1P3
(416) 741-5210

PHYSICS-111-LAB. 286D.
REPAIR & CALIBRATION
SERVICE COPY
DO NOT REMOVE

SARGENT-WELCH
SCIENTIFIC COMPANY
VACUUM PRODUCTS DIVISION

GENERAL OFFICES 7300 N. LINDER AVENUE
SKOKIE, ILLINOIS 60076; PHONE: 312 677-0600
I-10. TRAPS

I-10a. The Need for a Trap

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

I-10b. 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 reevaporation of the condensate. The opening of the Dewar flask 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 refrigerant and allow the trap to warm up. Remove the trap from the system and rinse off the condensate with a suitable solvent. Thoroughly clean and dry the trap before reinstalling in the system.

I-11. TYPES OF LUBRICANTS

All Sargent-Welch mechanical vacuum pumps are normally tested with DuoSeal 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 contained in the pump and replace with the fresh oil. DuoSeal 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 Sargent-Welch pumps applies only when DuoSeal 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.

II. OPERATION

II-1. STARTING PROCEDURES

II-1a. Starting a DuoSeal 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 I-6.

II-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 the DuoSeal pumps except the Model 1404.

II-1c. Oil Level Determination

The amount of oil suitable for efficient and satisfactory performance should be determined after the pump has reached its operating temperature. Initially, however, the pump should be filled with fresh oil while the pump is idle. Fill the pump until the oil level falls between the two oil level marks. If after a short period of operation the level should fall, it is likely the result of oil entering some of the interior pockets of the pump. If a gurgling sound occurs, additional oil must be added. In general, the oil level will be higher during high pressure operation. Mechanical pumps will gurgle in varying degrees under four conditions of performance: (a.) when operating at high pressure as in the beginning cycles of evacuation of a chamber; (b.) when the oil level in the pump reservoir is lower than required; (c.) when a large leak is present in the system; and (d.) when the vented-exhaust valve is open. Awareness of these possibilities will save time in setting up a system. Best performance of a mechanical pump is generally obtained after sufficient time has been allowed for the pump to come to operating temperature.

II-1d. Starting Model 1392

To operate the Model 1392 series of pumps after making the necessary connections, switch on the mechanical pump to enable it to evacuate the system to 500 millitorr or less. Then activate the coolant for the diffusion pump and turn on the heater. The pressure in the system will increase temporarily as entrained gases within the oil are evolved. Allow about 30 minutes for the diffusion pump to reach operating temperature and full pumping capacity. If the system pressure does not decrease after the operating temperature has been reached, the system should be checked for leaks. As a precaution against exposing the hot oil to abnormal pressures, it is best to turn off the heater when checking for leaks.
II-1e. Starting Model 1404

The Model 1404 pump is shipped without oil because it does not have an oil-tight exhaust cover. The proper oil level mark may be seen by removing the top plate which is fastened with two screws. Add oil to the indicated level and refasten the top plate.

II-2. LEAK DETECTION

II-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.

II-2b. Small Leaks

Small leaks in glass systems may be located by probing with a high frequency coil of the Tesla type. This instrument is an ungrounded, high-potential spark coil with a pointed electrode. The discharge spark from the coil will seek and pass through any minute opening and produce a faint pink glow at the location of the hole. If using a Tesla coil, the electrode point should be held about ½ inch from the glass and should be kept in constant motion. It is not recommended for use in very thin-walled systems or in locations adjacent to glass-to-metal seals. 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!

II-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.

II-3. SHUTDOWN PROCEDURES

II-3a. DuoSeal 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 pump is removed from the system, cover the intake port with a rubber stopper or suitable cover to protect the pump against contamination and loose particles. If the pump has been contaminated in service and is going to be shelved for a prolonged period it is best to drain the oil and refill with a fresh charge.

II-3b. Diffusion Pump Shutdown

When a pump of the Model 1392 series is shut down the following precautions should be taken. Turn off the diffusion pump heater and continue to cool the pump until the pump boiler is cool to the touch. The coolant supply may then be removed and the mechanical pump stopped. Atmospheric pressure may then be admitted to the system. CAUTION. To avoid decomposition of the diffusion pump oil it should not be exposed to any pressure above one torr while it is hot. If the pressure in the boiler should rise above one torr, turn off the pump heater immediately and continue cooling the pump.

II-4. THE PRINCIPLE OF VENTED EXHAUST

II-4a. The Effects of Unwanted Vapors

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.

II-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 past the exhaust valve. Condensation takes place when the ratio between the initial pressure and the end pressure of the compression is high, that is, when the mixture of vapor and gas drawn from the intake port is compressed from a low pressure to a high pressure. By adding air through the vented exhaust 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.
II-4c. Pump Function Without Vented Exhaust

In a pump functioning on a contaminated system and operating without the vented exhaust feature, compression within the stage takes place in the normal manner until the saturation pressure of the contaminating vapor contained with the mixture of gas and vapor is reached. The saturation pressure of water vapor is that pressure and corresponding temperature at which the dew point of the vapor is reached and condensation occurs. The saturation pressure of water vapor at an ambient temperature of 20°C is 17.5 torr, while at 60°C, the approximate operating temperature of a pump, the saturation pressure is 149 torr. The external side of the exhaust valve is subjected to atmospheric pressure. Consequently a compressive force somewhat greater than atmospheric pressure is required to open the valve and permit expulsion of the gas. Sometimes 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.

II-4d. Pump Function With Vented Exhaust

On the other hand, when ballast air at atmospheric pressure is supplied to the compression stroke by means of the vented-exhaust valve, 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.

II-4e. Controlled Ballast Flow

Some degree of variation in ballast flow may be obtained by the amount of opening applied to the vented-exhaust valve. Two or more turns of the valve are sufficient to open it wide. With the valve 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.

II-4f. Other Forms of Contamination Control

The application of the vented-exhaust valve 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.

III. MAINTENANCE

III-1. VACUUM PROBLEMS

III-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 I-9 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.

III-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 reevaporation 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 vented-exhaust valve is helpful in removing vapors, especially water, but it is not equally effective on all foreign substances; therefore, periodic oil changes are necessary to maintain efficient operation of the system. The required frequency of changes will vary with the particular system. Experience with the process will help you determine the normal period of operation before an oil change is required.

(Continued on Page 11)