

DRYTEK LLC.



Operation Manual

Of

DRYTEK Dry Screw Vacuum Pump

PS Series

DRYTEK LLC.

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We reserve the right for design change without notice in advance.

C114-HBME-PS-10-A

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Safety Notes

This operation manual provides the installation, operation, basic maintenance and service information for all the PS types of DRYTEK vacuum pumps. Before using this pump, the user should read the contents listed below carefully.

Anyone operating this pump should have the knowledge about the vacuum systems, and be able to identify and avoid any potential danger related to the pump. Improper operation may lead to damage and a serious accident. Before installation and operating the pump, the user should understand well the pump's construction, operating procedure and the hazards. If there is any problem about the operation, safety and maintenance of the pump, please contact DRYTEK.

Related important notices will be remarked with the sign “**DANGER!**”, “**WARNING!**”, and “**CAUTION!**”, please refer to the following definition:



DANGER!

The sign defines an imminently hazardous situation will occur, and cause death or serious injury, if violating the rules.



WARNING!

The sign defines a potential hazard will occur, and might cause death or serious injury, if violating the rules.



CAUTION!

The sign defines an imminently hazardous situation will occur, and might cause minor or moderate injury, if violating the rules.

Important Precautions



DANGER!

Only the qualified personnel are allowed to unload and lift the pump. When elevating the pump, no personnel should be under the object.



CAUTION!

Be careful not to overturn the pump when pushing or pulling the pump sideways.



WARNING!

Only a qualified electrician should perform electrical work. Before beginning wiring or maintenance work, make sure to cut and lock out the electrical power.



WARNING!

Before removing and cleaning the vacuum or exhaust pipes, please use N2 gas to dilute the flammable or toxic material in the piping, and keep the toxic material away from the personnel.



WARNING!

After installing the piping, please perform a leak check to prevent leaks of the flammable, dangerous or toxic gases, and to avoid air getting into the pump. It will cause improper chemical reactions if gases get into the pump.



WARNING!

Before the application of different processes, the pump is requested for a overhaul to avoid the interaction of the residuals in the pump.



WARNING!

The pump casing, exhaust piping and heating piping are extremely hot during operation and remain hot for some time after stopping. Keep the personnel away from the hot area.



CAUTION!

Do not modify the pump or any of its parts without DRYTEK 's approval. DRYTEK will stop the warranty or compensation, if the damage to the pump or to the vacuum system is caused by any private modification or replacement.

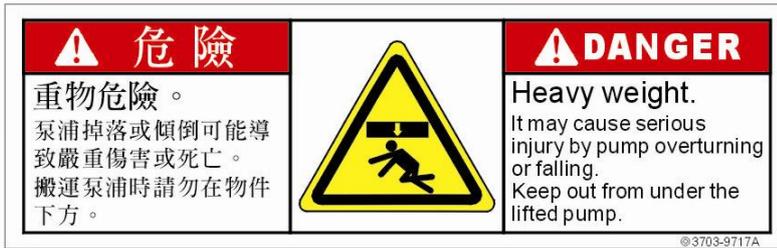


CAUTION!

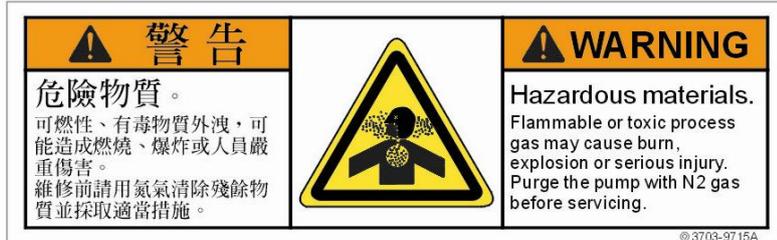
All the wastes, including vacuum oil, vacuum grease and PC boards, should be properly treated according to the local and national environmental regulations.

The following safety warning labels appears on the housing of the pump:

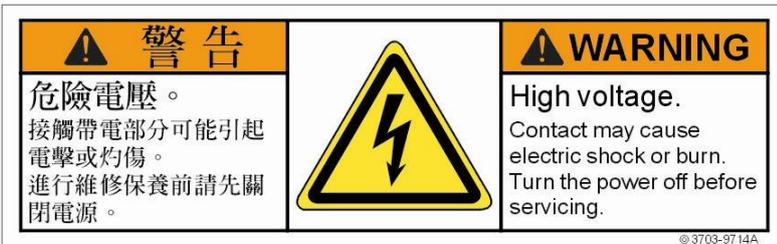
1. Heavy weight danger



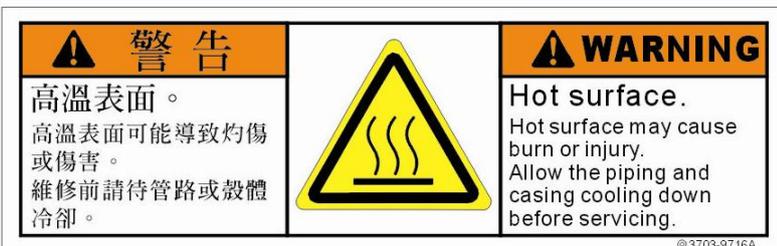
2. Hazardous materials warning



3. High voltage warning



4. Hot surface warning



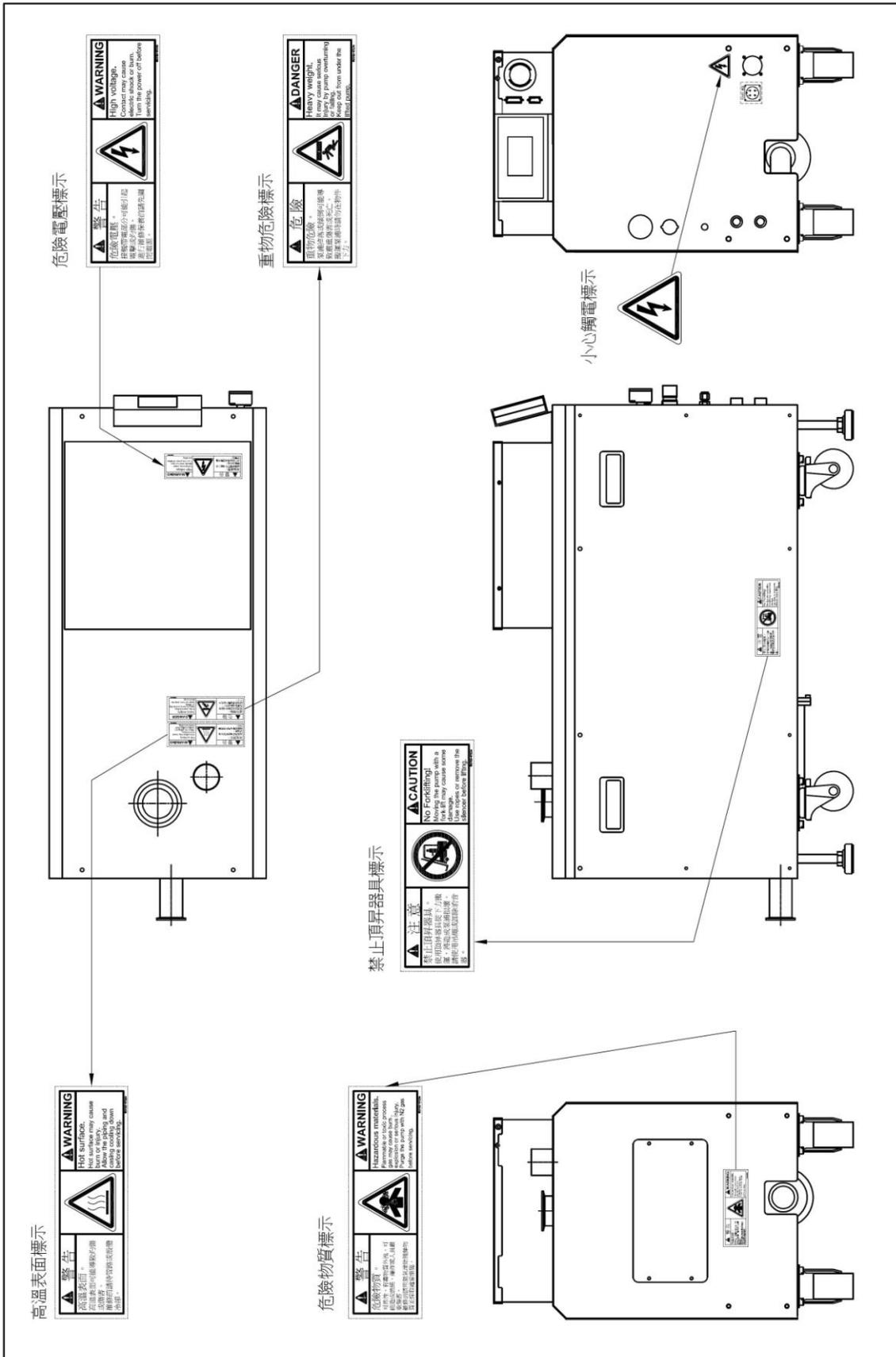
5. No Forklifting caution!



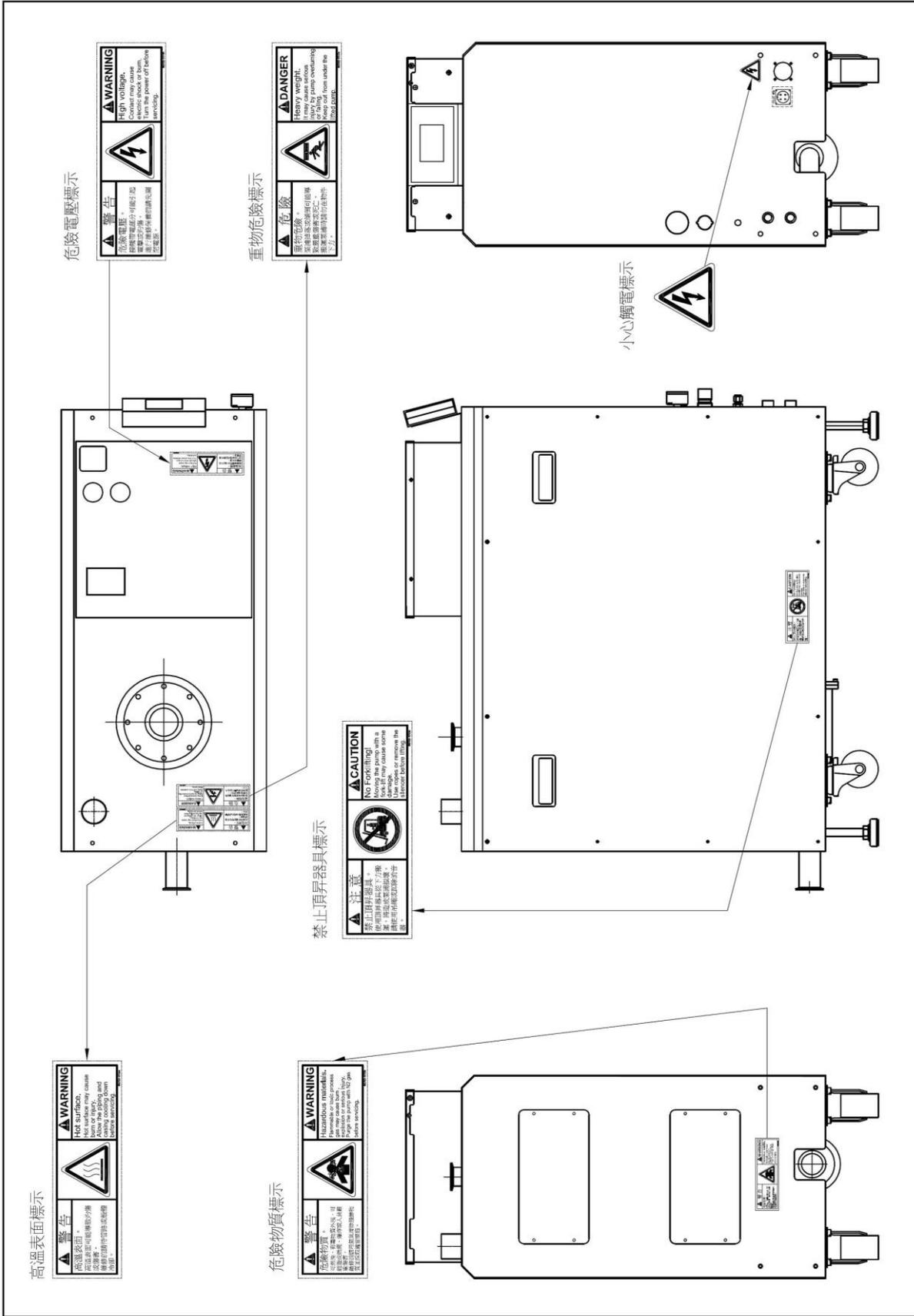
6. Electric shock caution



PS80-A, PS160-A, PS180-A



PS602-A, PS902-A, PS1302-A, PS1802-A



高溫表面標示

警告
 Hot surfaces cause severe or fatal injury. Allow the pump to cool down before servicing.

警告
 High voltage. Contact may cause severe or fatal injury. Turn the power off before servicing.

危險電壓標示

警告
 High voltage. Contact may cause severe or fatal injury. Turn the power off before servicing.

危險物質標示

警告
 Hazardous materials may be present. Use proper handling procedures. Refer to the MSDS for more information.

禁止頂昇器具標示

注意
 No Forklifting
 Moving the pump with a forklift may cause damage to the pump or the motor.

重物危險標示

危險
 Heavy lifting. Contact may cause severe or fatal injury. Turn the power off before servicing.

小心觸電標示

警告
 High voltage. Contact may cause severe or fatal injury. Turn the power off before servicing.

Inspection and Transportation

1. Checking for the pump specification

Please check the specification on the nameplate of the pump and confirm that pump supplied agrees with your purchase.

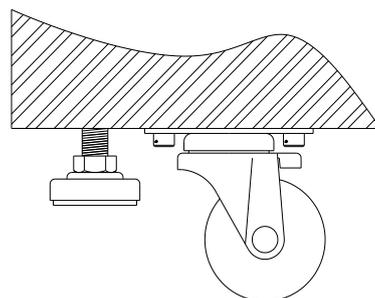
2. Checking for the accessories

Please check if all the parts attached are complete. When there is any damage or when components are missing, please contact us immediately. All the DRYTEK vacuum pumps are attached with:

- (1) Operation Manual, one copy
- (2) Warranty report, one copy
- (3) Test report, one copy
- (4) One electric power connector (MS3106A 22-22S)
- (5) One centering ring with mesh
- (6) One set of quick-connect couplers for cooling water

3. Attention for moving the pump

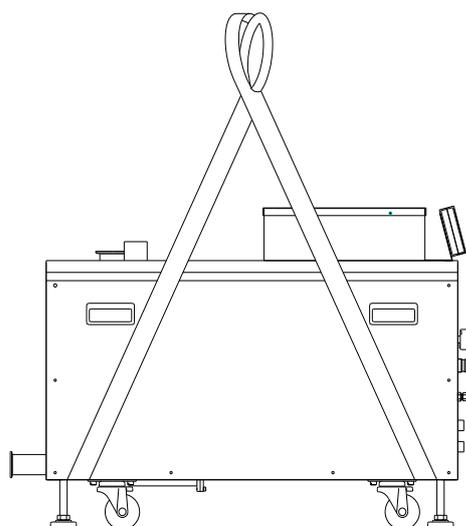
For a convenient installation, four mobile support units, each consisting of a caster and a height-adjustment foot (shown in the drawing at the right), are attached at the frame of the pump. Before moving the pump, make sure to check the four adjustment feet are already at their highest positions.



4. Attention for hoisting the pump

A silencer is installed on the bottom of the pump, and no forklift is allowed to move the pump. It is recommended to use a hoisting. Attention for hoisting the pump:

- (1) Use two nylon slings, 3m long, 50mm wide with a maximum loading of 2 Tons.
- (2) Before hoisting, check if the slings are in the position between the casters and the adjustment feet (shown in the drawing at the right), to ensure the pump will not slide aside during hoisting.
- (3) The slings should be at the center position of the hoisting, do not let the pump tend to one side.
- (4) The tension for the slings should be equal at the both sides.



Note: If it is necessary to move the pump by a forklift, the silencer should be removed.

Quick Installation

[Installation]

- (1) Check the voltage of the main power supply is correct; check the capacity of the no fuse breaker (NFB) in the power supply cabinet match the list below:

Model \ Voltage	200~220V		380~440V	
	NFB	Cable Size	NFB	Cable Size
PS80	20A	3.5mm ²	15A	2.0 mm ²
PS160、PS180	30A	5.5mm ²	20A	3.5 mm ²
PS602	40A	5.5mm ²	30A	3.5 mm ²
PS902、PS1302、PS1802	50A	8.0mm ²	40A	5.5 mm ²

- (2) Adjust the adjustment feet on the pump frame until the movable wheels are from the ground at 3-5mm, and then tighten the M16 nuts to fix the pump.
- (3) Check the oil level of the gear box in screw pump and booster pump (if any), the level should be required at 2/3 of the oil-sight glass.
- (4) Connect the vacuum system with the pump.
- (5) Connect the exhaust system.
- (6) Connect the cooling water supply.
- (7) Connect the N2 supply.
- (8) Check if the NFB on the pump is turned off or the emergency stop button is pushed down. Connect the main power supply, and the recommended cable size is listed above.
- (9) If started by remote operation, please connect wires to the SEMI port.

[Start]

- (10) Turn on the cooling water and check piping for water leaks.
- (11) Turn on the N2 gas supply. Check or adjust the N2 pressure regulator, and set the pressure to 0.05MPa.
- (12) Turn on the power switch in the pump controller, or release the emergency stop button.
- (13) Ensure the cooling water flow is proper. The minimum requirement is 3 l/min.
- (14) Adjust the regulator of the N2 piping in the pump, so that N2 gas is within the range, refer to Table 3.2.
- (15) When the control mode of the pump is LOCAL, push “START” button to start the pump; and push “STOP” button to stop the pump.
- (16) Check if operating current is normal or not.
- (17) After the pump has run for 4 hours, check the temperature of the motor and pump casing is normal or not.

1. Introduction

1.1 Pump Module

DRYTEK has two major kinds of dry vacuum pump: one is the Single Screw Pump (DP), and the other is Roots Booster Pump (BP) + Screw Pump (DP). They all belong to positive-displacement rotary pumps. During operating, the pump rotors do not contact each other; therefore, there is no need of grease for lubricating or for sealing, and thus no concerns for the oil gas back-permeating issue for the pump. Furthermore, a special material could be coated over the surface of rotors and the pump casing, enabling the pump to be used for the application of the special process with anti-acid and anti-alkali concerns. (Optional)

Another feature for DRYTEK dry vacuum pump is that the rotor is one-body type for the screw and the rotation shaft. The mechanism itself is able to deliver the sediment; thus, the pump can endure the harsh process which causes extensive dust. Meanwhile, the structure of the pump is simple, with few of spare parts, easy to be dismantled and assembled, saving the maintenance cost for the user.

The explanation for the components of PS602-A is shown in Fig. 1.1 below.

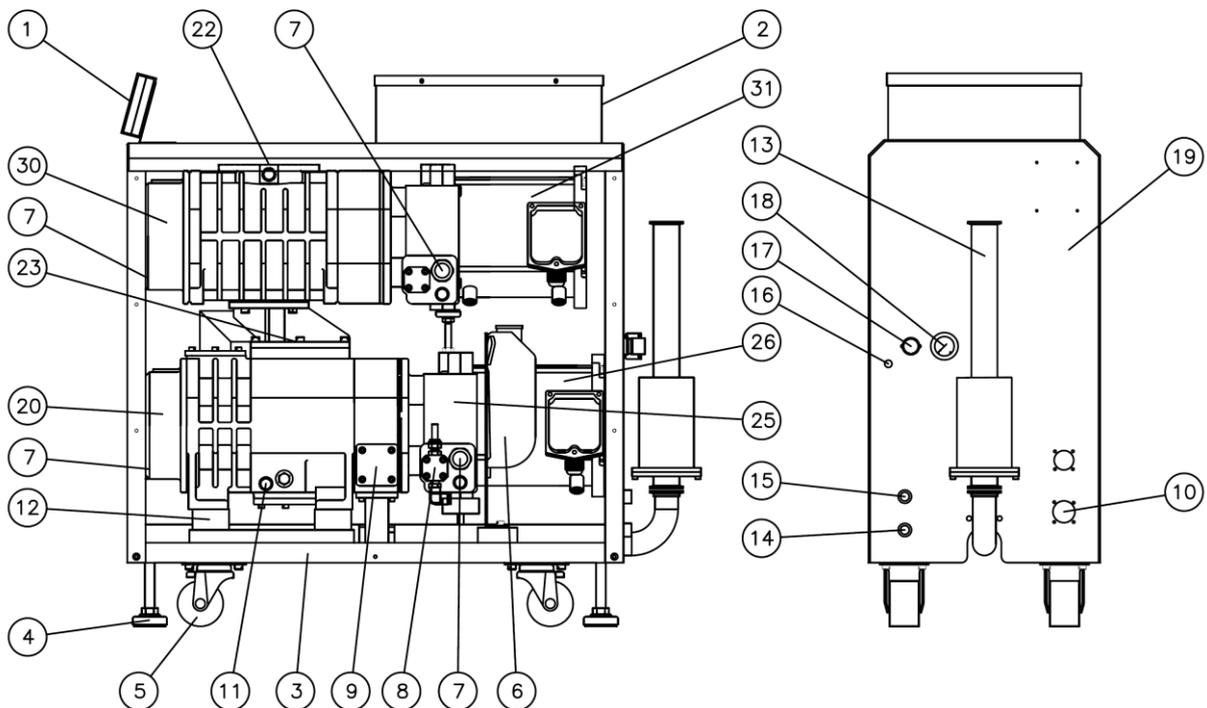


Figure 1.1 : PS602-A Pump Configuration

1. LCD controller

11. Casing Temperature sensor

21. Casing

2. Electrical box	12. Shock-absorbing pad	22. Pump inlet
3. Pump frame	13. Silencer	23. Main cooler
4. height-adjustment foot	14. Cooling water inlet	24. High pressure side plate
5. Caster	15. Cooling water outlet	25. Gear box
6. Expansion vessel	16. N2 gas inlet	26. Canned Motor
7. Oil level indicator	17. N2 Pressure regulator	27. N/A
8. Gear box cooler	18. N2 pressure gauge	28. N/A
9. Pump outlet(side)	19. Front panel	29. N/A
10. Power supply receptacle	20. Low pressure side oil box	30. BP Low pressure side oil box
		31. BP Canned Motor

1.2 Cooling Water System (See Fig.1.2)

From Fig. 1.2, the cooling water system has two kinds of cooling methods in two paths:

Path 1: Indirect cooling: Cooling the water jacket of DP pump casing

The flow path is 5'→(Option: TSV)→7→8→9. If the pump has a thermostatic valve(TSV) 6, the cooling water flow is regulated by the valve 6 with a temperature sensor (TC). The adjustment of the valve varies the operating temperature and must be set to suit your operating conditions.

Path 2: Direct Cooling: Cooling the motors, and DP gear box

The flow path is 1'→2→3→(if w/BP, →2'→3')→4→5. The water cools the DP and BP motors and the DP gear box.

If there is no thermostatic valve 6, the joint 5 is connected to joint 5', and otherwise joint 5 is connected to joint 9 and joint 5' is connected to 1'. The minimum of the cooling water required is 3 l/min.

There is another pipe connecting the water jacket with the expansion vessel. The expansion vessel is used for balancing the pressure in the water jacket with the atmosphere.

The casing and gear box are cooled by coolant which provides an indirect cooling-down effect, and other connectors for cooling water pipe line are made of stainless material. Thus, there will be completely no issue to pollute the cooling water from the facilities. If there is no booster pump, the cooling water outlet of DP motor 3 will connect directly with inlet 4 of the gear box cooler.

1.3 N2 Gas System (See Fig.1.2)

From Fig. 1.2, the pressurized N2 gas comes into the pump via the inlet 21. Adjust the regulation pressure to the specified value, and supply the correct amount of N2 gas to the pump. The recommended value is shown in Table 3.2. The controller could read and monitor the flow value by the N2 flow meter. The N2 piping could be divided into three sets of pipe lines:

Gas line A (dilution):

The main purpose is to decrease the partial pressure of the process gas in the pump, to reduce corrosion due to process gas, and to retard the accumulation of reaction byproducts. The N2 gas can be adjusted by the flow regulator 25, and the non-return valve 26 can prevent the process gases from getting into N2 pipe line. With an N2 heater (Optional), the hot N2 gas is supplied to the pump, and can reduce the byproducts further more.

Gas line B (sealing):

To improve the sealing, the N2 gas is injected between the transmission and the process gas. The N2 gas will come into the rotating shaft in the high pressure side plate through the non-return valve 27.

Gas line C (optional):

The purpose is to monitor the exhaust pressure, and to avoid an overload of the pump causing by a blocking.

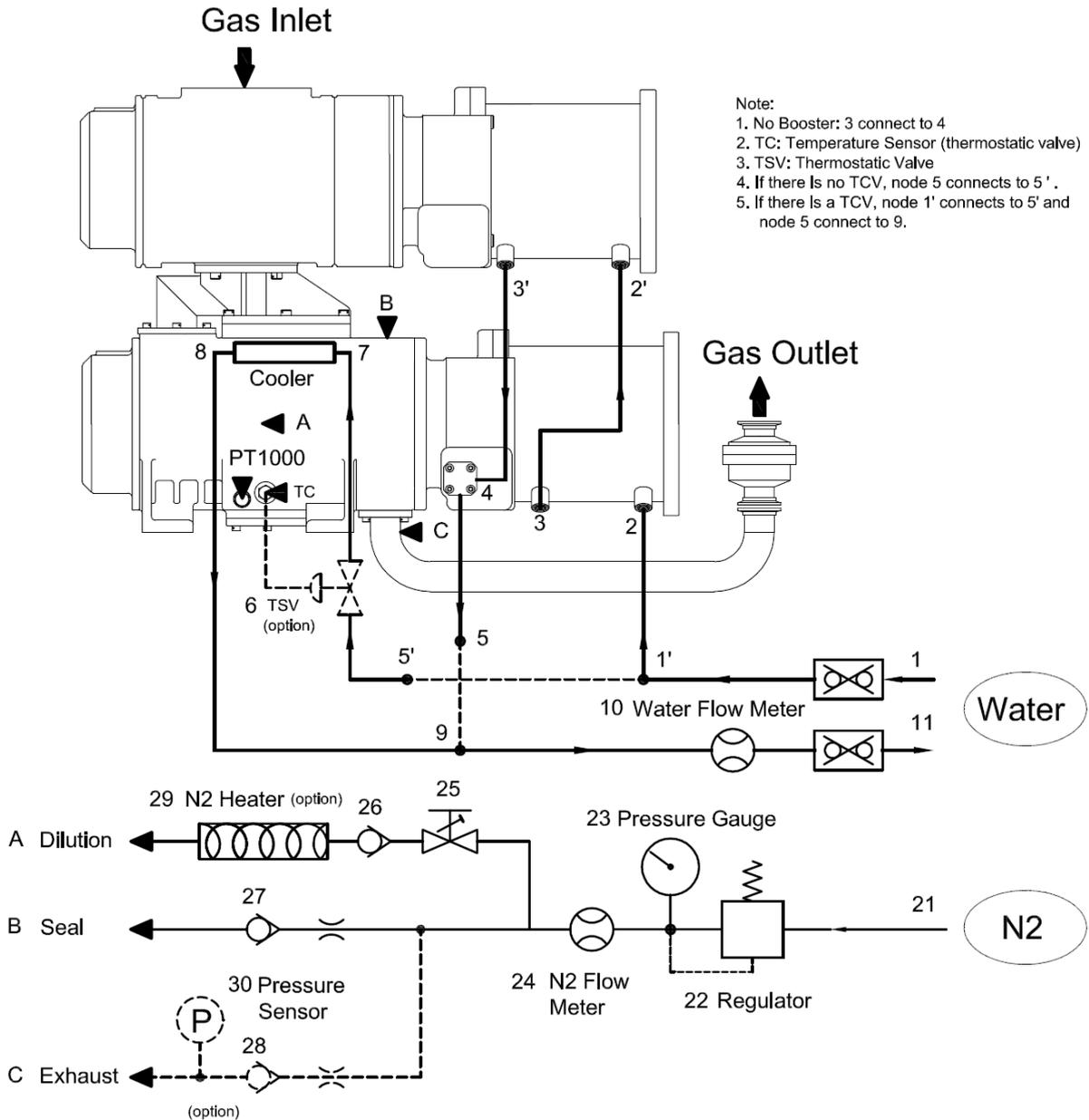


Figure 1.2 Pump Cooling Water and N₂ System

- | | | |
|--|------------------------------|--------------------------|
| 1. Cooling water inlet(supply) | 21. N2 gas inlet | A. Inlet of the dilution |
| 2. Cooling water inlet of DP motor | 22. Pressure regulator | B. Inlet of the sealing |
| 3. Cooling water outlet of DP motor | 23. Pressure gauge | C. Pump exhaust |
| 2'. Cooling water inlet of BP motor | 24. N2 mass flow meter | |
| 3'. Cooling water outlet of BP motor | 25. Flow regulator | |
| 4. Cooling water inlet of gear box cooler | 26, 27, 28 Non-return valve | |
| 5. Cooling water outlet of gear box cooler | 29. N2 gas heater (option) | |
| 6. Thermostatic valve | 30. Pressure sensor (option) | |
| 7. Cooling water inlet of the main cooler | | |
| 8. Cooling water outlet of the main cooler | | |
| 10. Water flow meter | | |
| 11. Cooling water outlet(return) | | |

1.4 Front Panel(Water /Gas / Electrical Panel)

The Layout for the Front Panel (Water /Gas / Electrical Panel) is shown in the Figure 1.1. The connectors 14, 15 for cooling water 4, 5 are RC3/8", and can connect with quick-connect couplers; the connector for the N2 gas inlet is Swagelok 1/4". The maximum pressure for the N2 regulation is 0.2 MPa, and the pressure is indicated in the pressure gauge 1. Refer to the Table 3.2 for adjusting the N2 pressure, and Section 3.5.1 for the power supply wiring.

1.5 Control System

The controller for DRYTEK screw vacuum pump consists of Earth Leakage Breaker(ELB), Magnetic switch, controller and temperature controller (option). It can monitor and record the operating status of the pump. It also has a LCD controller, RS485 port and SEMI port. The protection provided by the control system has two levels: Warning and Alarm.

When a warning message appears, the pump will not shut down. When an Alarm message appears, the pump will shut down immediately. With the monitoring of the control system, the user could know the pump operating status well, can do the maintenance in advance of a real breakdown, and can prevent a sudden out-of-service of the pump from suffering with other losses. The record message of "Warning" and "Alarm" could be available for the user to do a trace checking and to judge the problem of the shutdown.

The LCD controller could provide with the parameter setting, indication of operating status, the warning and alarm messages, starting or stopping the pump. The SEMI port(SEMI E73-0299) could provide the remote operation with external signals, and could start or stop the pump. In addition, the RS485 port is also available for a monitoring by a PC.

2. Technical Data

2.1 Technical Specification List

Model*2		Unit	PS80	PS160	PS180	PS602	PS902	PS1302	PS1802
Pumping Speed (50Hz/60Hz)		l/min	1300 / 1600	2150 / 2600	2500 / 3000	8300 / 10000	12500 / 15000	17500/21000	25000/30000
		m ³ /hr	80 / 96	130 / 156	150 / 180	500 / 600	750/900	1050/1260	1500/1800
		cfm	47 / 57	77 / 92	88 / 106	294 / 353	441 / 530	618 / 742	883 / 1060
Ultimate Pressure		Torr	$\leq 7.5 \times 10^{-3}$			$\leq 7.5 \times 10^{-4}$			
		mbar	$\leq 1 \times 10^{-2}$			$\leq 1 \times 10^{-3}$			
		Pa	≤ 1			≤ 0.1			
Canned Motor	Frequency	Hz	50/60						
	Voltage	V	220~440 (3Phase)						
	Rated Power	hp	4	6	4+4	6+4	6+6		
		kW	2.98	4.47	2.98+2.98	4.47+2.98	4.47+4.47		
Connection	Inlet		NW50		ISO100(bolted)		ISO160(bolted)		
	Outlet		NW40		NW40		NW40		
Cooling Water	Min Flow	l/min	3						
	Max Pressure	kg/cm ²	4						
	Pressure Dif.	kg/cm ²	1						
	Temperature	°C	18~25						
	Connection		RC 3/8"						
N2	Purge Pressure	MPa	0.05~0.2*1						
	Purge Flow	slm	5~60*1						
	Connection		Swagelok 1/4"						
Dim.	L×W×H ³	mm	814×380×663	895×405×678	920×425×650	814×380×908	895×405×943	920×425×957	920×425×1047
Weight		kg	280	300	320	450	520	540	545
Noise		dB(A)	<68	<70	<70	<70	<70	<70	<70
Control			SEMI E73-0299						
System Max. Leak-rate		mbar.l/s	1×10^{-5}						
Operation Temp.		°C	5°C~40°C						
Operation Moisture		RH	<90%						
Lubrication Oil	Brand		Krytox VPF 1525 Fomblin Y LVAC 25/6						
	Quantity	L	0.8			0.8+0.8			

*1. For different applications, the pressure and flow will have some change. Please refer to Table3.2.

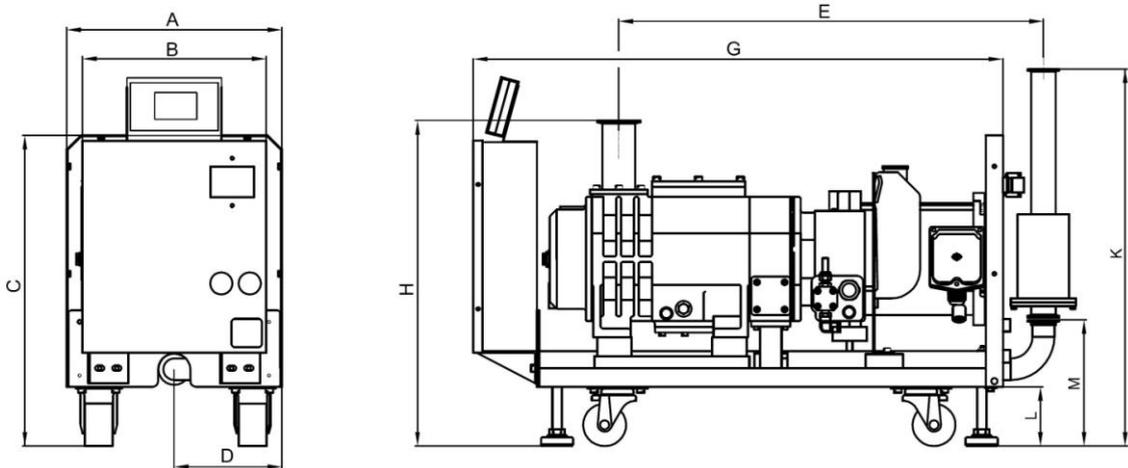
*2. Model classification and its application description

Model	Equipped Accessory	Application Fields
PS XXX-N (N Type)	Without Frame and Cover Type: Standard Equipped(included Controller) + Purge System + Defric Coating + Standard Silencer	Vacuum Coating, Vacuum Oven, Thermal Process, Pharmaceutical, Chemical, etc
PS XXX-A (A Type)	With Frame and Cover Type: Standard Equipped(included Controller) + Purge System + Teflon Coating + Standard Silencer	Semiconductor, TFT/LCD, LED and Solar Cell industry, etc

*3. -A type dimension

2.2 Dimension

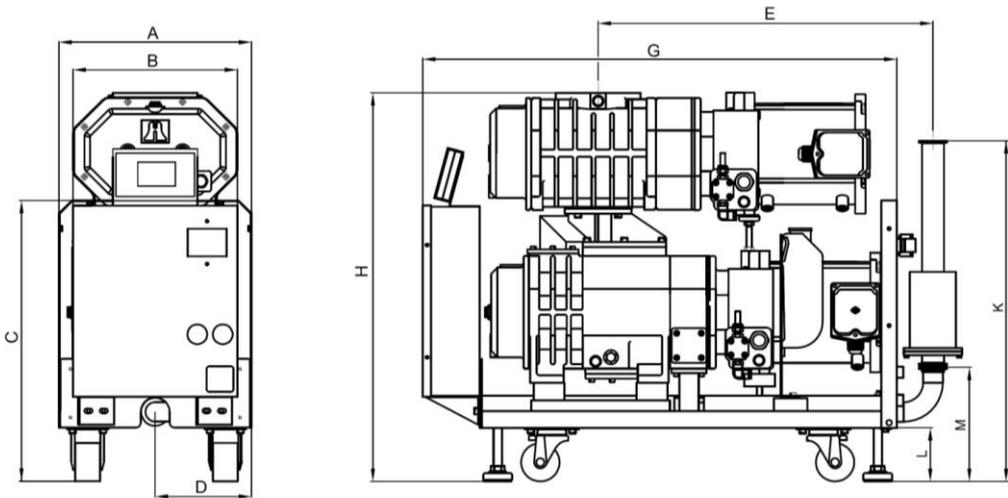
N Type



Unit: mm

Model	A	B	C	D	E	G	H	K	L	M
PS80-N	375	320	550	190	740	923	576	668	105	224
PS160-N	400	350	567	180	897	1006	582	645	105	201
PS180-N	420	350	540	190	897	1031	560	627	73	184

Figure 2.1 PS80-N, PS160-N, PS180-N dimensions

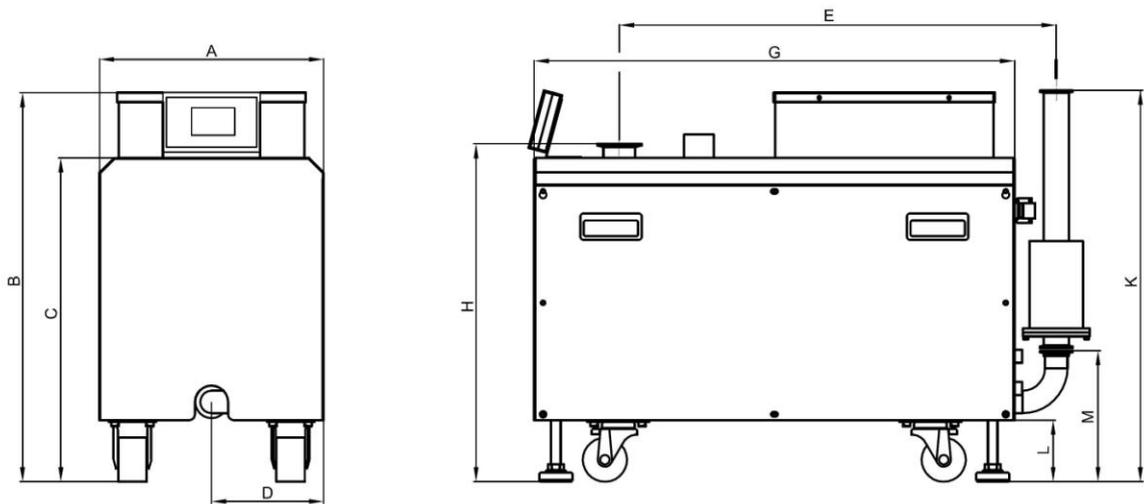


Unit: mm

Model	A	B	C	D	E	G	H	K	L	M
PS602-N	375	320	550	190	652	923	779	668	105	224
PS902-N	400	350	567	180	813	1006	807	645	105	201
PS1302-N	420	350	540	190	734	1031	822	627	73	184
PS1802-N	420	350	540	190	734	1121	822	627	73	184

Figure 2.2 PS602-N, PS902-N, PS1302-N, PS1802-N dimensions

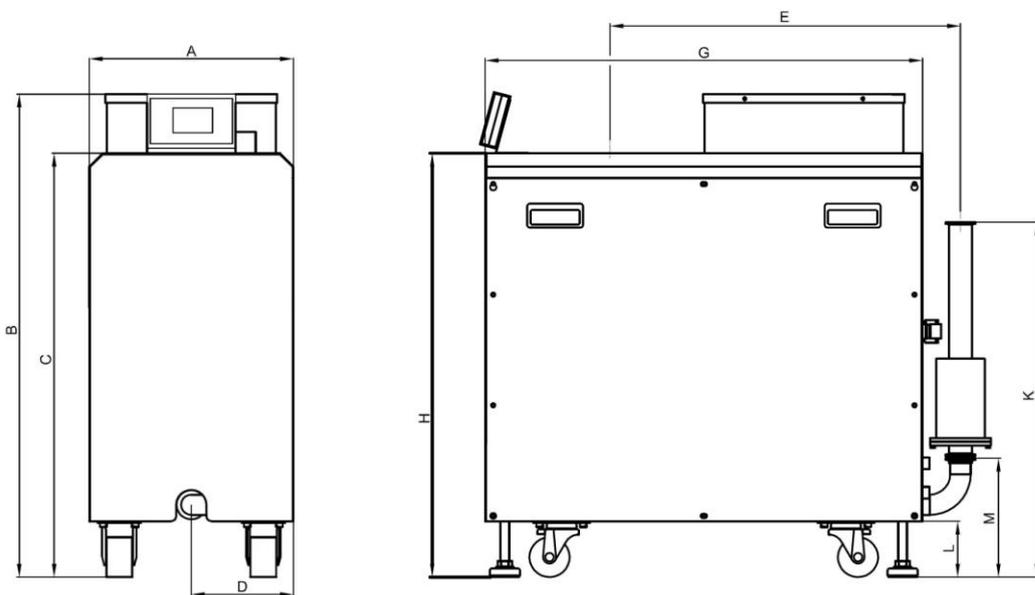
A Type



Unit: mm

Model	A	B	C	D	E	G	H	K	L	M
PS80-A	380	663	552	190	740	814	576	668	105	224
PS160-A	405	678	567	180	837	895	582	645	105	201
PS180-A	425	650	539	190	883	920	560	627	73	184

Figure 2.3 PS80-A, PS160-A, PS180-A dimensions



Unit: mm

Model	A	B	C	D	E	G	H	K	L	M
PS602-A	380	908	797	190	652	814	797	668	105	224
PS902-A	405	943	832	180	813	895	832	645	105	201
PS1302-A	425	957	845	190	734	920	846	627	73	184
PS1802-A	425	1047	846	190	734	920	846	627	73	184

Figure 2.4 PS602-A, PS902-A, PS1302-A, PS1802-A dimensions

2.3 Pumping Speed Curves

2.3.1 PS80, PS160, PS180

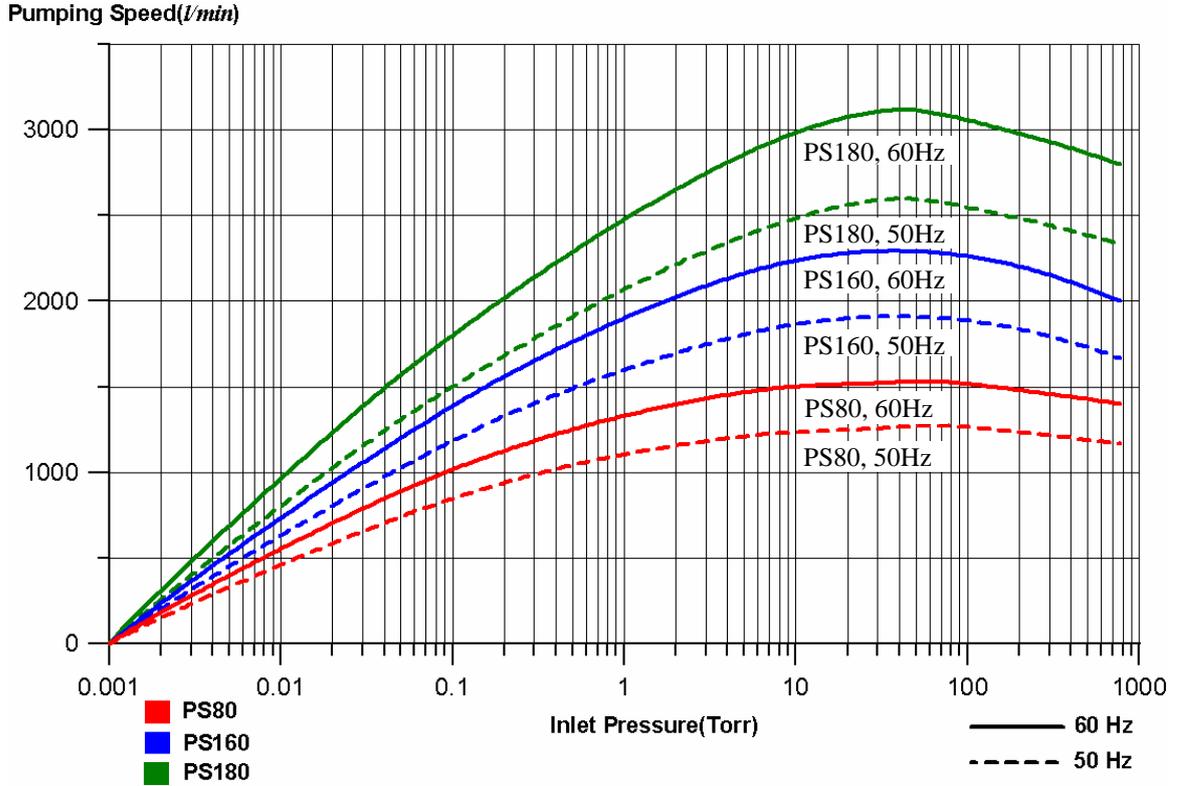


Fig. 2.5 PS-80, PS-160, PS-180 Pumping Speed Curves

2.3.2 PS602, PS902, PS1302, PS1802

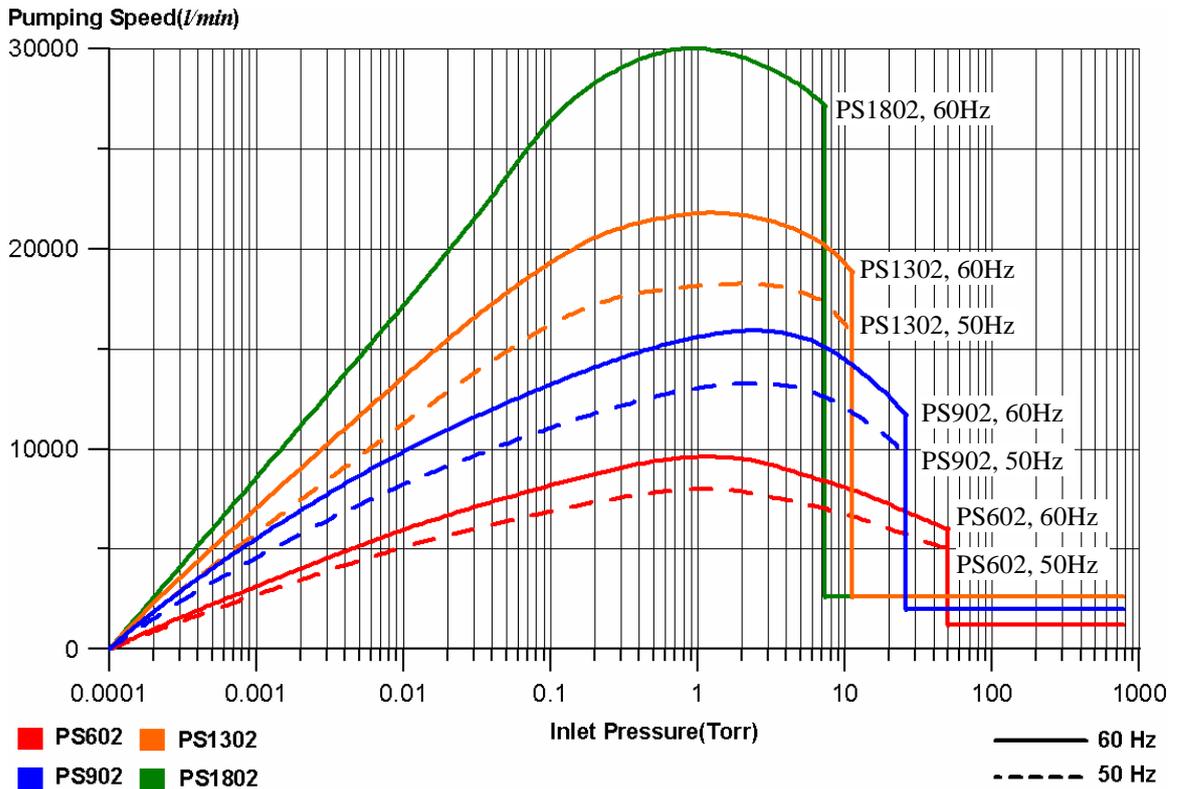


Fig.2.6 PS-602、PS-902、PS-1302、PS-1802 Pumping Speed Curves

3. Installation

3.1 Notes



WARNING!

Before installing and using this pump, please read this manual carefully and operate according to the explanation in the content, in order to prevent a hazard and damage to the pump.



CAUTION!

Be careful not to overturn the pump when pushing or pulling the pump sideways.

[Attention for Electrical Safety]

- (1) User must make sure that the grounding wire is connected, and the grounding function meets the electric rules.
- (2) Every pump should be connected to the power supply with a power cable and the connector provided with the pump respectively. The wire size should be matched to the power consumption of the pump.
- (3) Check the voltage of the power supply is correct; and the rated current of the NFB in user’s facility meets the Table listed below.

Table 3.1 Recommended rated current of the NFB and cable size

Model \ Voltage	200~220V		380~440V	
	NFB	Cable Size	NFB	Cable Size
PS80	20A	3.5mm ²	15A	2.0 mm ²
PS160、PS180	30A	5.5mm ²	20A	3.5 mm ²
PS602	40A	5.5mm ²	30A	3.5 mm ²
PS902、PS1302、PS1802	50A	8.0mm ²	40A	5.5 mm ²

3.2 Environment and Location

Environment Requirements

- (1) The vacuum pump should be installed indoors, with a good ventilation and sufficient illumination; it should not be installed in a place which is highly-polluted, very humid, full of corrosive gases, metal dust, with a direct sun shining and getting soaked easily by the rain.
- (2) The temperature of the environment for installing the pump should not exceed 40°C, and the installing site should stay away far enough from the boiler and any other equipment that would be heat-transpiring.
- (3) The space on top and around the pump should be kept for over 900mm, at least, for a maintenance purpose.
- (4) The pump installed indoors should prevent a hot-gas short circulation, or inter-effected by the heat-exhausting from the equipments; therefore the location for the vacuum pump should be considered cautiously.

Location Requirements

- (5) The pump should be installed on the floor which can stand the weight of the pump. A shock-absorbing pad should be used between the frame of the pump and the floor for a better ground holding and less impact of the floor vibration.

Adjusting Height of Pump

- (6) Adjust the adjustment feet on the pump frame until the moveable wheels are 3-5mm away from the ground; then tighten the M16 nuts to fix the pump.

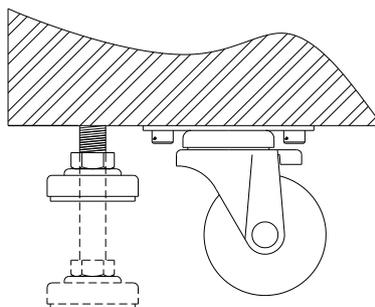


Figure 3.1 The adjustment foot and caster

3.3 Oil Level Inspection



The oil level should be checked monthly at least; the vacuum oil should be regularly changed every year or half a year, subject to the situation of the process application. When filling the vacuum oil, make sure the pump has stopped completely.

See Fig. 1.1. The oil level in the gear box and the low pressure side oil box of the vacuum pump (DP, BP) should be higher than 1/2 of the oil indicator, refer to Fig. 3.2 below. If under 1/2 of the oil indicator, new vacuum oil should be re-supplied. Please refer to chapter 6 service and maintenance.

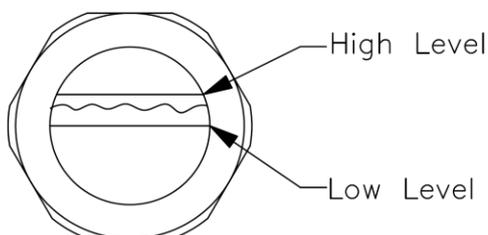


Figure 3.2 Oil Indicator

3.4 Piping

3.4.1 Vacuum and Exhaust Piping



Check for leaks after installing the pump. A leak may cause to the dangerous discharge of hazardous substances or to unpredictable reactions with air admitted into the pump.



The exhaust pipes of the pump should be connected properly with exhaust gas treatment equipments to avoid the leakage of the toxic or dangerous gas.



Open the valve on the exhaust piping before starting the pump. If the system has an exhaust gas scrubber, open its inlet and outlet valves. Operating pump with these valves closed will pressurize the exhaust and overload the pump.

[Connection for Vacuum System]

Pay attention to the following rules when connecting the vacuum pump and the vacuum system:

- (1) For a lowest vacuum and a best pumping speed, suggest to have the shortest pipe, the least elbow, if possible, with a biggest diameter to reduce the pipe line loss. The inlet port should use a bellows to reduce the vibration and the stress from the pipe lines.
- (2) When choosing and installing the vacuum pumps for the harsh process or for the process of special applications, like furnace process, toxic or explosive gas process, please check in advance with the engineers of DRYTEK; when necessary, suggest installing a trap at pump inlet or outlet port to prevent any safety accidents.
- (3) The supports should be, as much as possible, installed under the vacuum pipe lines; to avoid shear strength at the joints of the pipe lines, and a leakage thus caused.

[Connection for Exhaust System]

Figure 2.1~2.4 indicate the profiles for all the DRYTEK vacuum pumps, and the exhaust flange for exhaust pipe is NW40. Attentions for connecting pump and the exhaust system are listed as follows:

- (1) When there is high pressure from the exhaust system, please check if the silencer of the vacuum pump and the exhaust pipes for the facilities are blocked or not.
- (2) A section of bellows should be used for the exhaust pipe line to reduce the vibration and the stress from the pipe lines connecting.
- (3) When using explosive, corrosive or toxic gas for the process, the pump exhaust system must not contact the atmosphere.
- (4) The supports must be installed under the exhaust pipe line to avoid any leakage caused by shear strength at the connecting parts of the pipe lines.

A leak check will surely be performed after the installation of the vacuum pump or when finding any leakage. When proceeding with the leak check for the vacuum pump or the vacuum system, please pay attention to check any emission of gas (moisture, residual of organic solvent) which will cause virtual leaks of the vacuum system. The Recommended maximum leak rate value for a N₂ leakage test or other ways of test is 1×10^{-5} mbar · l/s

3.4.2 Cooling Water Piping



CAUTION!

Never stop supplying the cooling water during the pump operation, otherwise, the components of the pump will be over-heating and then will be broke down.

After the pump is stopped, please keep cooling down the pump with the cooling water for more than ten minutes; after that, cease to supply the cooling water.



WARNING!

After the power supply switch is turned on, do not pull off the cooling pipe lines inside the pump; otherwise the cooling water will spill out and cause a circuit short and an electrical fatality accident of personnel. .

The water ports are quick-connect couplers (RC3/8”), and the maximum endurable pressure is 4 kg/cm². The water flow meter is installed inside the pump for a monitoring and protection purpose. Please refer to chapter 4 for settings. The operating steps are as follows.

- (1) According to the directions of water inlet and outlet from the pump, connect the male and female quick joints to the front panel.
- (2) Supply the cooling water and check any leakage from the joints and the pipe lines.
- (3) Check, with the LCD controller, if the water flow is over the minimum of 3 L/min. If not, please increase the flow.
- (4) Do not connect pump cooling water loops in series. Select piping to ensure sufficient flow through each pump.

3.4.3 N₂ Gas Piping

The inlet port for N₂ gas is a Swagelok 1/4” stainless connector. The pressure of the N₂ gas can be adjusted by the pressure regulator to a suitable pressure, and the range is 0.05MPa ~ 0.2MPa. The N₂ flow for dilution could be controlled by the flow regulator in the pipe line and the mass flow can be shown in the LCD controller.

DRYTEK vacuum pumps could be available for a variety of process which the amount of the

sediment thus produced will also be different. In order to reduce corrosion due to process gas and retard the accumulation of reaction byproducts, adjust the N2 pressure and flow to the appropriate value. Please refer to Table 3.2.

Table 3.2 Recommended N2 pressure and flow for different processes

Process	N ₂ Inlet Pressure	N ₂ Mass Flow
Load-lock Transfer Metrology...	0.05 MPa	3-5 L/min
PVD Process	0.05 MPa	3-20 L/min
PECVD CVD LPCVD ICP Etch	0.1 MPa (Max. 0.2 MPa)	20-50 L/min (or more)

3.5 Electrical Connection

- (1) Please refer to the national and local electrical regulations, and decide the proper specification for the wire and NFB to ensure the safety of electricity usage.
- (2) The voltage for the power supply should be kept within ±10% of the rating voltage; the voltage gap of the three-phase voltages should be within 3%.

3.5.1 Power Supply Connection



CAUTION!

Keep the power supply to the pump turned off until you have finished the wiring work.
Before wiring, let the NFB turned off, and the emergency stop button pushed down.

The socket is on the Front Panel of the pump. See Fig. 3.3 below for connector pin assignments.

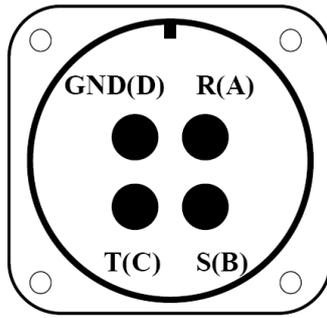


Figure 3.3 Power supply socket

3.5.2 Interface Connection

According to the semiconductor industrial standard E73-0299, the vacuum pump has one set of 15-Pin Female D-sub connector for connecting with the process equipment (see Fig. 3.5). The functions and pin assignments are shown in the Table 3.3 below. Please refer to Fig. 3.6 for sequence and Fig. 3.7 for wiring.

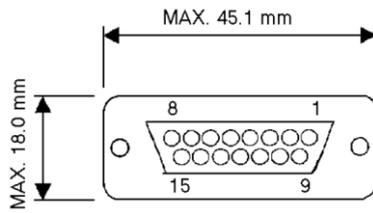


Figure 3.5 SEMI Port Connector

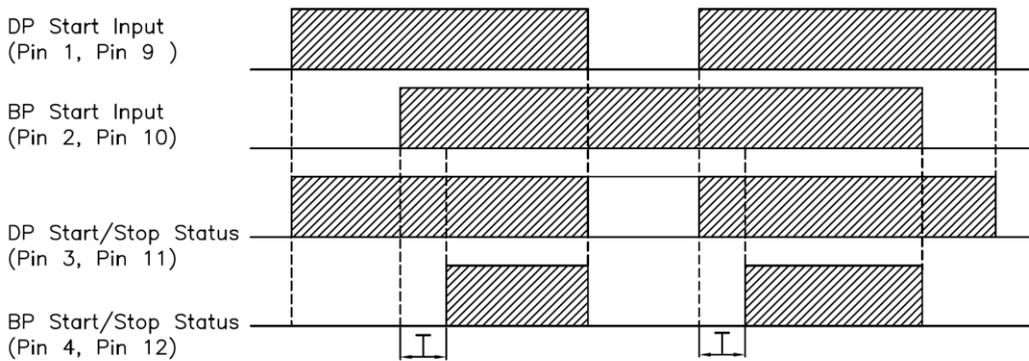
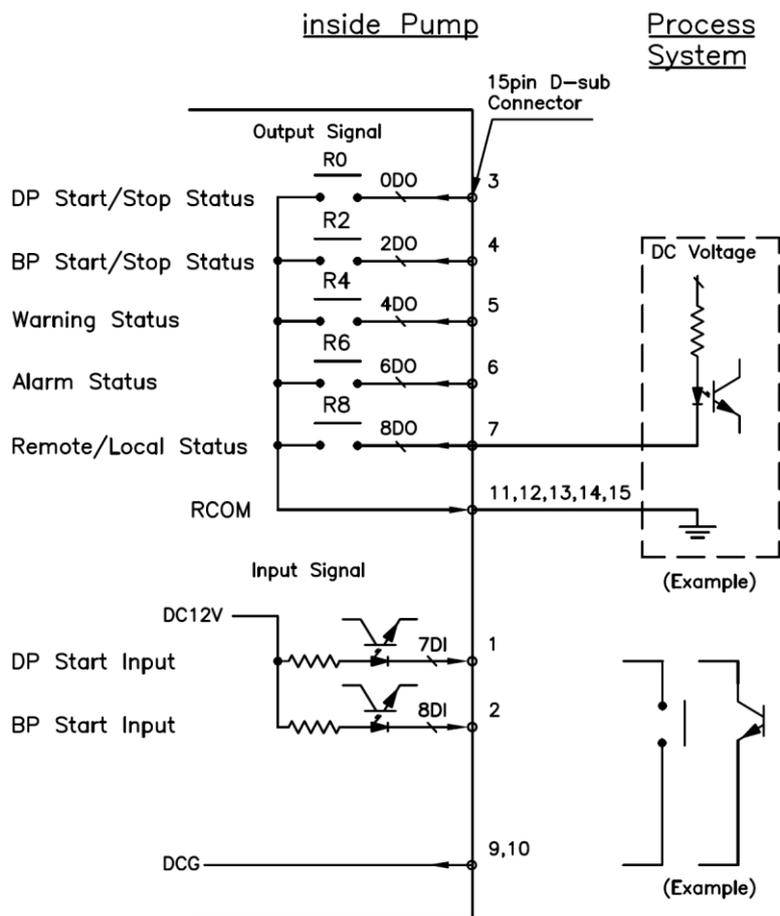


Figure 3.6 Sequence diagram for remote control



Note: The contact rating of the output R0~R8 is 5A 250VAC/30VDC.

Figure 3.7 Control signal wiring for remote control

Table 3.3 Pin Assignment for SEMI Interface Port

Pin No.	Purpose	Sign in electrical box	I/O	Signal type
1	DP start input	7DI	IN	Closed(DP will start)
2	BP start input	8DI	IN	Closed(BP will start)
3	DP start/stop status	0DO	OUT	Closed(when DP starts)
4	BP start/stop status	2DO	OUT	Closed(when BP starts)
5	Warning status	4DO	OUT	Closed(when warning)
6	Alarm status	6DO	OUT	Closed(when Alarm)
7	Remote/Local status	8DO	OUT	Closed(when remote mode)
8	Reserved	-	-	-
9	DP start input	DCG	IN	
10	BP start input	DCG	IN	
11	DP start/stop status	RCOM	OUT	
12	BP start/stop status	RCOM	OUT	
13	Warning status	RCOM	OUT	
14	Alarm status	RCOM	OUT	
15	Remote/Local status	RCOM	OUT	

Note 1: The output signals are dry-contacts. The contact rating is 5A 250VAC/30VDC.

Note 2: The control mode of the pump must be in the SEMI mode. Please check the setting in the LCD controller.

Note 3: If the Pins 1 and 9 are closed, the DP will start, otherwise DP will stop.

Note 4: Refer to Fig. 3.6. When the setting "Booster Autostart" in the LCD controller is disable, the Pins 2 and 10 can control BP to start or stop. The delay time T is the sum of the waiting time for the vacuum switch inside the pump actuated and the setting "Booster Start Delay Time".

Note 5: If the setting "Booster Autostart" is enabled, BP will start automatically when DP is running and after the delay time T.

4. Operation

4.1 LCD Control Panel

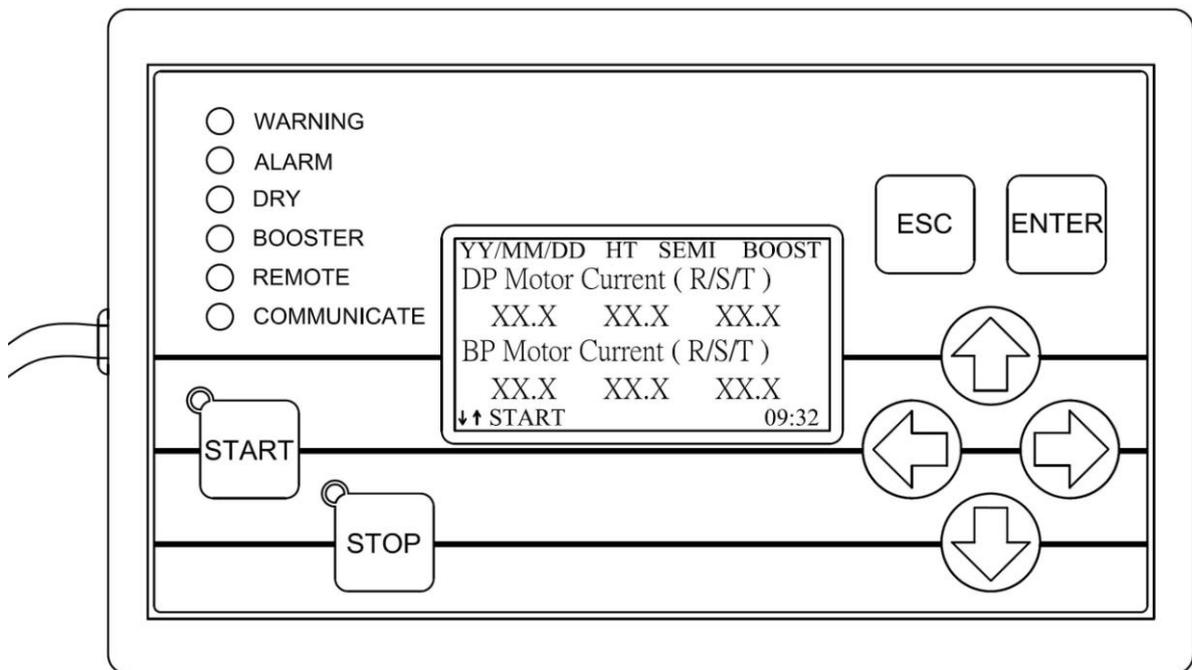


Figure 4.1 LCD Control Panel

[LED definitions] (The lights in the left side of the panel)

WARNING (Orange)	flashing upon warning
ALARM (Red)	flashing upon alarm
DRY (Green)	lighted up upon DP running
BOOSTER (Green)	lighted up upon BP running
REMOTE (Red)	lighted up upon REMOTE mode
COMMUNICATE (Green)	flashing upon communicating

[Button functions]

START (Green)	Start the pump, and the light will be on after pump gets started.
STOP (Red)	Stop the pump, and the light will be on after pump gets stopped.
ESC	Escape to the previous item, and reset the warning and alarm.
ENTER	Confirm the selection or setting.

Up, Down, Left, and Right	Changing the selected item, and increase or decrease the settings.
---------------------------	--

[LCD Display Items Definitions]

YY/MM/DD	Year/ Month/ Day
HT	The N2 gas Heater is equipped and in function.
SEMI	The pump is in the remote control mode.
BOOST	While the pump was stop, it means BP will get started automatically after the pressure is lower than the setting. While the pump was running, the “BOOST” lighted up means that BP is already started, and “BOOST” blinking means that BP is in the starting progress.
↓ ↑ START	For reference, indicate the buttons that could be operated by the user.
09:32	Current time, 24-hour format

4.2 Control Panel Operating Introduction (See Fig.4.2)

The pump control function could be divided into four layers. The first layer indicates the status of the pump including pump currents, motor temperature, casing temperature, water flow, N2 mass flow, exhaust pressure, etc. The second layer could check the warning, alarm records and the lasting hours before maintenance of every major component. The UP and DOWN key could be used to scroll the display to show more information.

The third layer “12.1 User Setup” provides user to change the system setting which includes language setting at “12.1.1”, settings for BP at “12.1.3, 12.1.4, 12.1.5”, settings for N2 flow meter at “12.1.6, 12.1.7”, settings for connecting with PC at “12.1.10, 12.1.11, 12.1.12”, setting for temperature unit at “12.1.15” and setting for pressure unit at “12.1.16”, etc.

The third layer “12.2 DRYTEK Setup” provides some factory settings, and is not open to the user. If there are any special requests, please contact DRYTEK.

4.3 Start / Stop the Pump

4.3.1 Before Starting

Please proceed with the following items before connecting the vacuum pump with the power cable.

- (1) Check if the vacuum pump is in its position, and the adjustment feet are fixed or not.
- (2) Turn on the cooling water flow, and check piping for water leaks.
- (3) Check that the pressure regulator on the front panel is closed, i.e. the pressure adjustment knob is fully counterclockwise. Turn on N2 gas supply. Adjust the pressure slowly to 0.05 MPa, then lock the knob. The manometer might be damaged while the N2 supply pressure is too large.
- (4) Check the exhaust piping. If there is any valve closed on the exhaust piping, please open it.



CAUTION!

If any valve on the exhaust piping is closed, the pump will be shut down because of overloading.

- (5) Check if the inlet port of the pump and the vacuum system are connected properly.
- (6) Check that the voltage of the power supply is correct; turn on power; release the emergency stop button. An alarm message will appear if the phase sequence of the main power is not correct. Please change any two wires in the power cable.
- (7) See the LCD controller. Check if the water flow is suitable, the minimum required value is 3 l/min.



CAUTION!

If the water flow is too low, the temperatures of the pump body and the motor will rise, and may cause rotor contact and other problems.

- (8) See the LCD controller. Adjust the flow regulator in the N2 piping, and let the flow is suitable.



CAUTION!

If the N2 flow is too low, it will cause oil backstream, pump corrosiveness and byproducts.

- (9) If there is any other abnormal message on the LCD controller, please refer to chapter 5 and solve it. Then press ESC to clear the warning or alarm message before the pump could be started

4.3.2 Start or Stop Pump



WARNING!

In order to prevent a scald accident, it is strictly forbidden to touch the pump body, the exhaust piping and the hot N2 piping before they are cold down completely.

Keep the pump body and the exhaust piping away from contact with personnel and flammable substances.

Keep cool the pump with the cooling water for at least ten minutes; after that, stop to supply the cooling water.



CAUTION!

In order to prevent any corrosive gases or byproducts inside the pump, do not stop the pump until after at least 30 minutes after stopping the flow of process gases.

In order to prevent any residual process gas inside the pump, purge with N2 gas for at least one hour after the pump stops

[LOCAL] Mode Operation

When the setting “12.1.2 control mode” is LOCAL, press the START key to start the pump and the STOP key to stop the pump. If the setting “12.1.5 Booster Autostart” is Enable, the BP will start automatically after the delay time. The delay time is the sum of the waiting time for the vacuum switch inside the pump actuated and the setting “Booster Start Delay Time”. If the setting “12.1.5 Booster Autostart” is Disable, BP will not start.

The DRY LED on the control panel will light after that DP gets started; the BOOSTER LED will light after that BP gets started.

[SEMI] Mode Operation

When the setting “12.1.2 control mode” is SEMI, the REMOTE LED will light, and the user could control the pump via external signals. In this situation, START and STOP keys have no function.

When the Pins 1, 9 in the SEMI port are closed, DP will start. If the setting “Booster

Autostart” is enabled, the user just need to control DP, and therewith BP will start automatically after some time. When the setting “Booster Autostart” is disable, the Pins 2 and 10 can control BP to start or stop.

The DRY LED on the control panel will light after that DP gets started; the BOOSTER LED will light after that BP gets started.

4.4 N2 Gas Heater (Optional)

When the setting “12.1.8 heater temperature” is less than 10°C, the gas heater is disabled. If the setting value is over 10°C, then, the heating function is enabled. The gas heater is protected by two ways. First, if the temperature of the heater is higher than the setting value “12.2.1.8 Heater Temp. High”, the heater is turned off. Second, if the N2 flow is lower than the setting value “12.2.1.7 Heater N2 Mass Flow Low”, the heater is turned off.

When the heater function is active and the pump gets started, the gas heater will be in action, otherwise the heater will stop heating. When warning messages “W19 Heater Temp. High”, “W20 Heater Error” or “W08 Heater N2 Flow Low” occur, the gas heater stop heating, but the pump will not stop. When the gas heater is heating, the LCD will display “HT”

The suitable N2 flow for the heater is 30~60slm. If the N2 flow is too low, the heater body will be overheating and may be burned out. The maximum setting temperature is 80°C

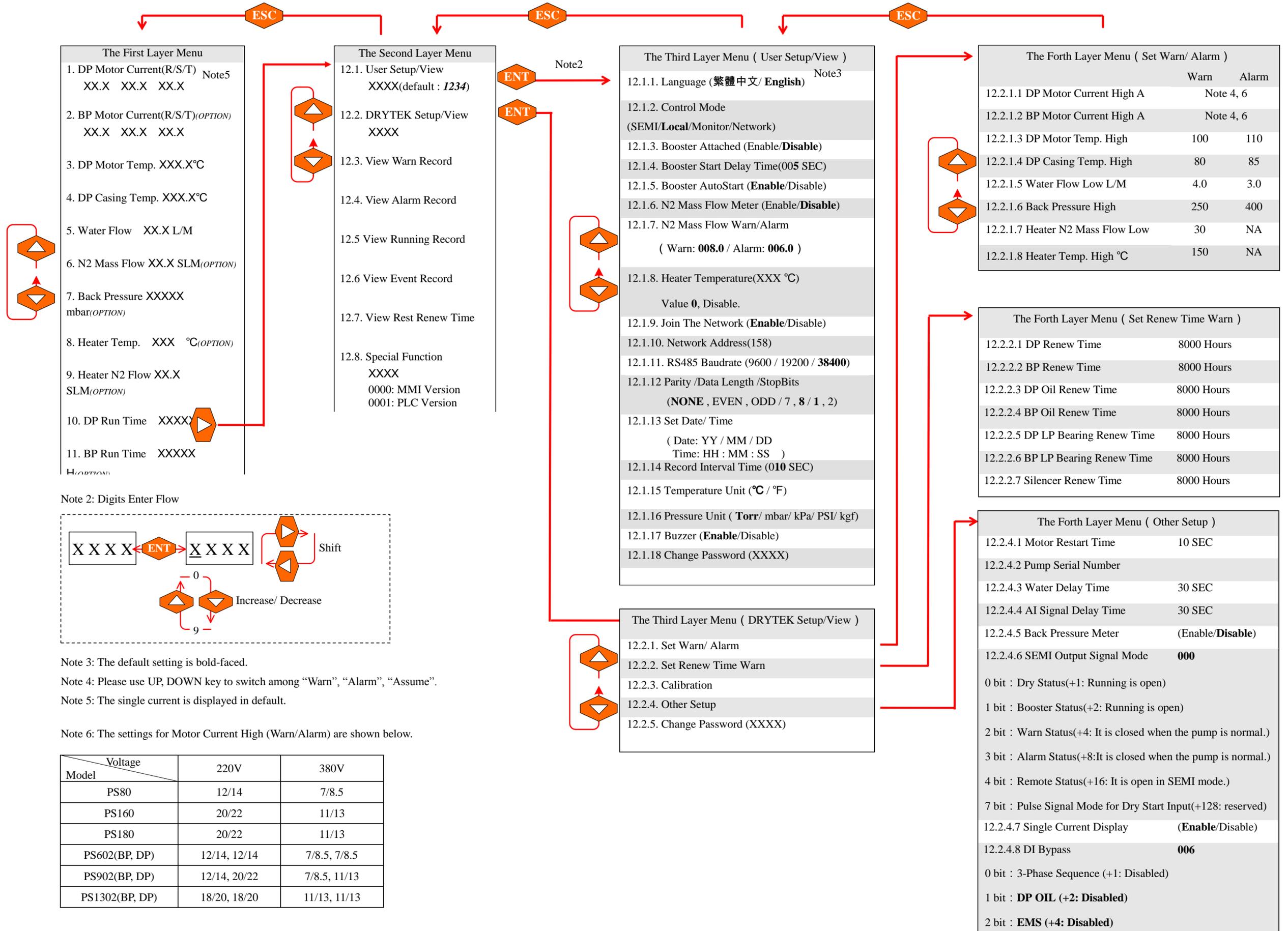


Fig. 4.2 Control Panel Operating Flowchart

5. Trouble Shooting

Message Code	Problem	Cause	Action
W01(A01) DP Current High	DP motor current is too high.	Exhaust pressure rises	Check exhaust piping and silencer
		Pump with noise, and rotors are in contact.	Replace or overhaul pump
		Power supply failure	Check power supply
W02(A02) BP Current High	BP motor current is too high.	Pump start pressure is too high	Check vacuum pressure switch setting
		Pump with noise, and rotors are in contact.	Replace or overhaul pump
		Power supply failure	Check power supply
W03(A03) DP Motor Temp. Hi	DP motor temperature is too high.	Insufficient cooling	Check water flow and temperature
		Motor failure	Replace the motor
W04(A04) DP Casing Temp. Hi	DP casing temperature is too high.	Insufficient cooling	Check water flow and temperature
		Insufficient coolant in the water jacket	Refill the coolant
		Byproduct is clogged	Replace or overhaul pump
W05(A05) N2 Mass Flow Low	The N2 mass flow is too low.	N2 piping is clogged	Replace N2 piping
		Pressure regulator setting is low	Increase pressure setting
		N2 piping leaks	Replace N2 piping
		The mass flow meter is abnormal	Replace mass flow meter
		Flow regulator setting low	Increase dilution flow
W06(A06) Water Flow Low	Water flow is too low	Water piping leaks	Check the fittings
		Differential pressure is too small	Check the inlet and outlet pressure of water piping
		Water piping is clogged	Clean or replace piping
		Outlet/inlet is reverse.	Connect correctly
		Flow meter failure	Replace flow meter
W07(A07) Back Pressure High	The exhaust pressure is too high.	Pump silencer is clogged	Check the silencer
		Exhaust piping is closed.	Check exhaust piping
W08 Heater N2 Flow Low	The N2 mass flow is too low.	N2 piping is clogged	Replace N2 piping
		Pressure regulator setting is low	Increase pressure setting
		N2 piping leaks	Replace N2 piping
		The mass flow meter is abnormal	Replace mass flow meter
W09 DP Renew Time		DP needs to be maintained.	Check the setting. Overhaul the DP.
W10 BP Renew Time	.	BP needs to be maintained.	Check the setting. Overhaul the BP.
W11 DP Oil Renew Time		DP lubricating oil need to be replaced.	Check the setting. Replace the lubricating oil in DP.
W12 BP Oil Renew Time		BP lubricating oil need to be replaced.	Check the setting. Replace the lubricating oil in BP.
W13 DP Bearing Renew		DP's Bearings need to be maintained.	Check the setting. Replace bearings in DP.

W14 BP Bearing Renew		BP's Bearings need to be maintained.	Check the setting. Replace bearings in BP.
W15 Silencer Renew		The silencer needs to maintain.	Check the setting. Maintain the silencer.
W16 Back Temp. Low (option)	The exhaust temperature of DP is too low.	The hot N2 flow is insufficient	Increase N2 flow.
		The hot N2 temperature is low.	Increase the heater temperature setting.
W18 Comm. Error	The communication between LCD and PLC is abnormal.	The PLC is failed.	Replace the PLC in electrical box.
		The LCD is failed.	Replace LCD controller.
W19 Heater Temp. High	The gas heater temperature is too high.	Heater controller is failed.	Replace the controller.
		The thermal couple in heater is abnormal.	Replace the gas heater. Check the connector of the gas heater.
W20 Heater Error	The heater controller is failed.	Heater controller is failed.	Replace the controller.

A18 Power Phase Error	The power source has some problem.	The phase sequence of voltage is incorrect.	Wire R/S/T correctly
		The power source is out-of-phase.	Check the wiring and power supply
A19 DP Motor Overload	The DP current rises. (thermal relay trip ¹)	Exhaust pressure rises	Check the exhaust piping and silencer
		Byproduct or object clog	Replace or overhaul pump
		Rotors are in contact.	Replace or overhaul pump
A20 BP Motor Overload	The BP current rises. (thermal relay trip)	Operating pressure is too high	Check vacuum pressure switch setting ²
		Byproduct or object clog	Replace or overhaul pump
		Rotors are in contact.	Replace or overhaul pump
A21 Water Oil level Low	The coolant or the oil level is too low	The coolant level in the expansion vessel is low.	Refill the coolant in the expansion vessel and in the water jacket.
		Oil level in DP gear box is low.	Refill the lubricating Oil.
A22 Water Leakage	Water leaks.	Tube fitting loose	Tighten fittings
		Coolant leaks	Check the expansion vessel

Note 1: The manual reset button of Thermal Relay Trip

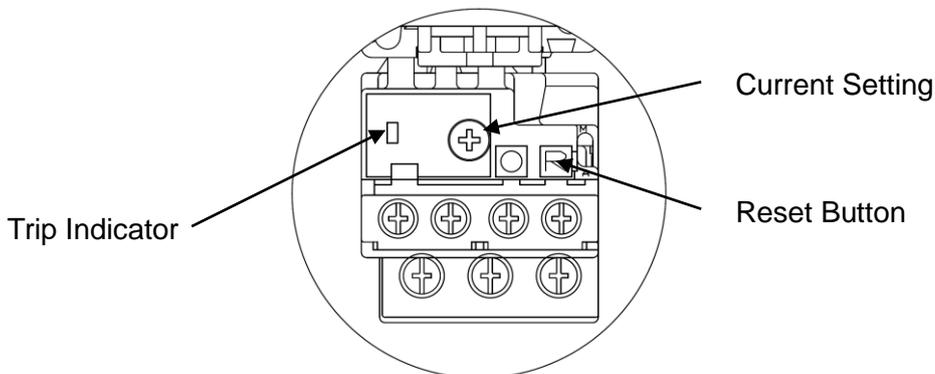


Figure 5.1 Thermal relay features

Note 2: Vacuum Pressure Switch



CAUTION!

Please adjust the vacuum pressure witch by DRYTEK authorized technicians. DRYTEK will not be responsible for any damage of the vacuum pump or vacuum system if the vacuum pressure switch was operated by an unauthorized personal.

The PS902, PS1302, PS1802 consists of DP and BP. The pressure switch is located at the inlet of the BP. The procedure to start the pumps is as follows below.

- (a) The controller starts the DP.
- (b) The vacuum pressure switch will actuate when the inlet pressure of the BP is lower than the setting on the pressure switch.
(The pump is in LOCAL mode.)
- (c) The controller will start the BP for some delay time.
- (d) When the inlet pressure of the BP is higher than the pressure setting during operating, the BP will stop. Then, the procedure goes to (b) and check the pressure switch again.

The suitable working pressure for the BP is under about 10torr. When the working pressure is too high, the BP will take high current which causes an overloading error. If user wants to change the pressure setting, please contact the DRYTEK service engineer for this issue.

Please refer to Fig. 5.2. When the pressure is lower than the setting, the SW1 LED will be turned on. User can check if the BP is in active pressure by the SW1 LED.

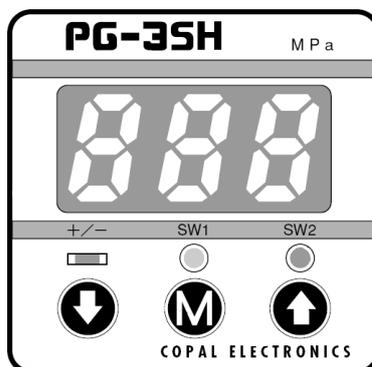


Figure 5.2 Vacuum pressure switches

6. Maintenance

6.1 Notes



WARNING!

Follow the safety notes listed below. Improper operation may cause dangerous accidents and serious injuries.

1. Any maintenance work must be performed by the qualified personnel. The personnel must be familiar with the safety rules related to the pump, and can use the suitable tools to dismantle and clean the contaminated parts.
2. In order to prevent any danger, don't move or disassemble the pump before it has stopped completely; switch off the power supply to the pump before you start maintenance.
3. The pump casing, the exhaust piping and the heating piping are extremely hot during operation and remain hot for some time after stopping. Keep the personnel and flammable substances away from the hot area.
4. Purge the pump with sufficient N₂ gas, at least one hour, before removing and cleaning the vacuum lines and exhaust piping.
5. Don't reuse any o-ring. Be careful to cleaning all flange surfaces and check they are undamaged. Check for gas leaks after installing and maintaining the piping.
6. Disposal of process byproducts, lubricating oil, vacuum grease and other wastes must be in strict accord with all local and national environmental and safety regulations.
7. Do not touch or inhale the thermal breakdown products of fluorinated materials which may be present if the pump has been overheated to 260°C and above. These breakdown products are very dangerous. Fluorinated materials in the pump may include oils, greases and seals. The pump may have overheated if it was misused, if it malfunctioned or if it was in a fire.

6.2 Dismantle/Assemble Pump Plates

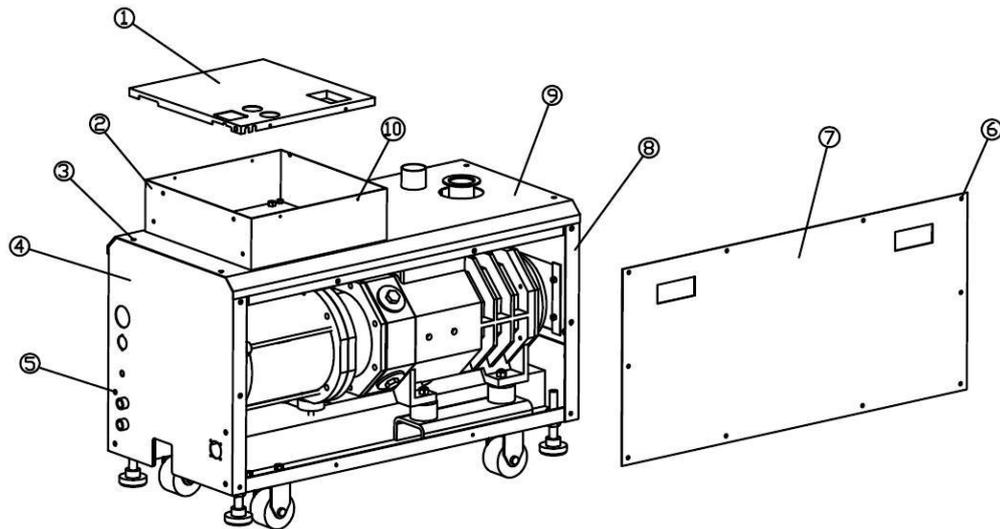


Figure 6.1 Dismantle/ Assemble pump plates

- | | |
|------------------------------|------------------------------|
| 1. Electrical box top Cover | 6. Hex Socket Cap Screw (M6) |
| 2. Electrical box | 7. Side Plate |
| 3. Hex Socket Cap Screw (M6) | 8. Rear Plate |
| 4. Front Plate | 9. Top Plate |
| 5. Hex Socket Cap Screw (M6) | 10. Cross Head Screw (M4) |

6.3 Lubricating Oil



WARNING!

There might be toxic process gas and material inside the gear box, please be careful to avoid the contact with your eyes or skin.



CAUTION!

The lubricating oil should be used according to DRYTEK's suggestion. DRYTEK will not be responsible for any damage of the vacuum pump or vacuum system

**CAUTION!**

Do not start filling oil until the pump interior reaches atmospheric pressure. During pump operation, the chamber containing the oil is under vacuum. Removing the oil fill plug while the pump is running will damage the pump.

The waste oil must be disposed by the professional and qualified waste disposal dealer.

The lubricating oil for the vacuum pump is Fluorinated lubricant oil. Another kind of oil can not be used or replaced; otherwise, it will cause a major damage of the vacuum pump. When replacing the oil, the used oil inside the pump must be drained out completely; otherwise, it will reduce the lifetime of the new oil. The procedures to replace the oil are listed as follows.

1. Dismantle the oil fill plug at the oil inlet hole.
2. Dismantle the drain plug at the oil outlet hole; purge all the used oil out of the oil box, or making use of a proper pump to draw out the used oil.
3. Replace all the O-rings. Check all plugs are tightened. The O-rings can be found from DRYTEK PM kit package.
4. Use DRYTEK authorized vacuum oil and re-supply the oil to a proper level.

6.4 Piping Connector

A regular leakage check should be performed over all the connecting parts of the piping. It should be included of checking any crack on the hoses. Washers, O-rings and hoses should be replaced according their condition. All parts should be tightened again or re-sealing if necessary.

6.5 Pump Inlet Flange

Dismantle the pump inlet flange regularly for cleaning the dirt on the mesh and change with a new O-ring.

6.6 N2 Pressure and Flow Regulator

Check and test regularly that the function of the N2 pressure regulator and the N2 flow regulator are normal. When the pump is running, supply the N2 gas and regulate the flow to check the N2 mass flow works in normal condition.

6.7 Cooling Water Piping

After operating for a period of time, the cooling water piping might encounter the problem of a poor cooling effect because of the dirt adhering to the piping. It will cause the pump casing temperature to rise. A regular cleaning job is necessary, and the clean frequency is dependent on the quality of the water. The cooling tower and the filter should also be cleaned often. If the piping has already been adhered with the dirt, the piping should be cleaned with a cleaner or be replaced.

6.8 Coolant Level

Check the coolant level in the expansion vessel regularly. If the coolant is insufficient, re-supply it and keep the level between FULL and LOW.

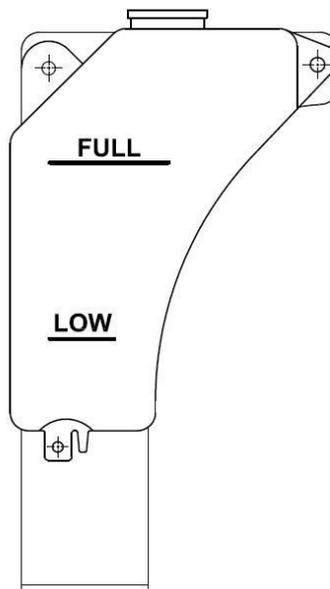


Figure 6.2 Expansion Vessel

6.9 Maintenance Plan

The plan shown as below details the maintenance operations we recommend to maintain the pump in normal operation. To perform the maintenance periodically and effectively will keep the pump in a normal working condition, and will not suffer with the loss causing from the breakdown and failure of the pump. The frequency of the maintenance is dependent on your process. In clean processes, you can decrease the frequency of the maintenance; in harsh processes, you may have to increase the frequency of the maintenance.

Table 6.1 Maintenance plan

Item	Content	Weekly	500 h	1500 h	4000 h	8000 h	Remark
			Monthly	Every Season	Half a Year	Every Year	
LCD controller	Check if there is any abnormal message.	○					
Motor temperature	Check if it is warning.	○					
Casing temperature	Check if it is warning.	○					
Motor current	Check if it is warning.	○					
Cooling Water flow	Check if it is warning.	○					
Coolant level in the Expansion vessel	Check / Re-supply		○				
Lubricating oil level and color	Check / Re-supply		○				
Lubricating oil	Replace oil				●	●	
Cold trap (Optional)	Clean	○					
Piping connector	Check		○				
Cooling water piping	Clean			○		○	
Emergency Switch	Function test					○	
N2 pressure regulator	Function test					○	
Pump inlet flange	Check / Clean					○	
Silencer	Check / Clean				○	○	
N2 flow regulator	Check / Clean					○	
Vacuum pump bearings	Check / Replace				○	●	
Vacuum pump piston ring	Check / Replace					●	

○ Adjust, Check, Clean

● Replace

7. Appendix

7.1 Inspection Record Table

Date	DP/BP Running Hours	Check Items	Personnel
		DP Current: _____ / _____ / _____ A BP Current: _____ / _____ / _____ A DP Motor Temperature: _____ °C DP Casing Temperature: _____ °C Water Flow: _____ L/min. N2 Mass Flow: _____ L/min. Pump Inlet Pressure: _____ Torr	
		DP Current: _____ / _____ / _____ A BP Current: _____ / _____ / _____ A DP Motor Temperature: _____ °C DP Casing Temperature: _____ °C Water Flow: _____ L/min. N2 Mass Flow: _____ L/min. Pump Inlet Pressure: _____ Torr	
		DP Current: _____ / _____ / _____ A BP Current: _____ / _____ / _____ A DP Motor Temperature: _____ °C DP Casing Temperature: _____ °C Water Flow: _____ L/min. N2 Mass Flow: _____ L/min. Pump Inlet Pressure: _____ Torr	
		DP Current: _____ / _____ / _____ A BP Current: _____ / _____ / _____ A DP Motor Temperature: _____ °C DP Casing Temperature: _____ °C Water Flow: _____ L/min. N2 Mass Flow: _____ L/min. Pump Inlet Pressure: _____ Torr	

7.2 Return of pump - Declaration

Section 1: Customer Information				
Company Name		Date of Delivery		
Department		Contact Person		
Telephone Number		E-mail		
Section 2: Pump Information				
Model		Power Source		
Serial Number		MFG Date		
3. Process Information				
(process name, process material...)				
	Substance	Chemical symbol	Precautions required	Action required after contacting with human
1				
2				
3				
4				
5				
4. Reason for return (symptoms of malfunction, warning or alarm message...):				
5. Accessories				
<input type="checkbox"/> Inlet Flange	<input type="checkbox"/> Outlet Flange	<input type="checkbox"/> Silencer	<input type="checkbox"/> Quick-connect coupler	
<input type="checkbox"/> Power cable				