

Vapourtec R2S Pumping Module User Manual

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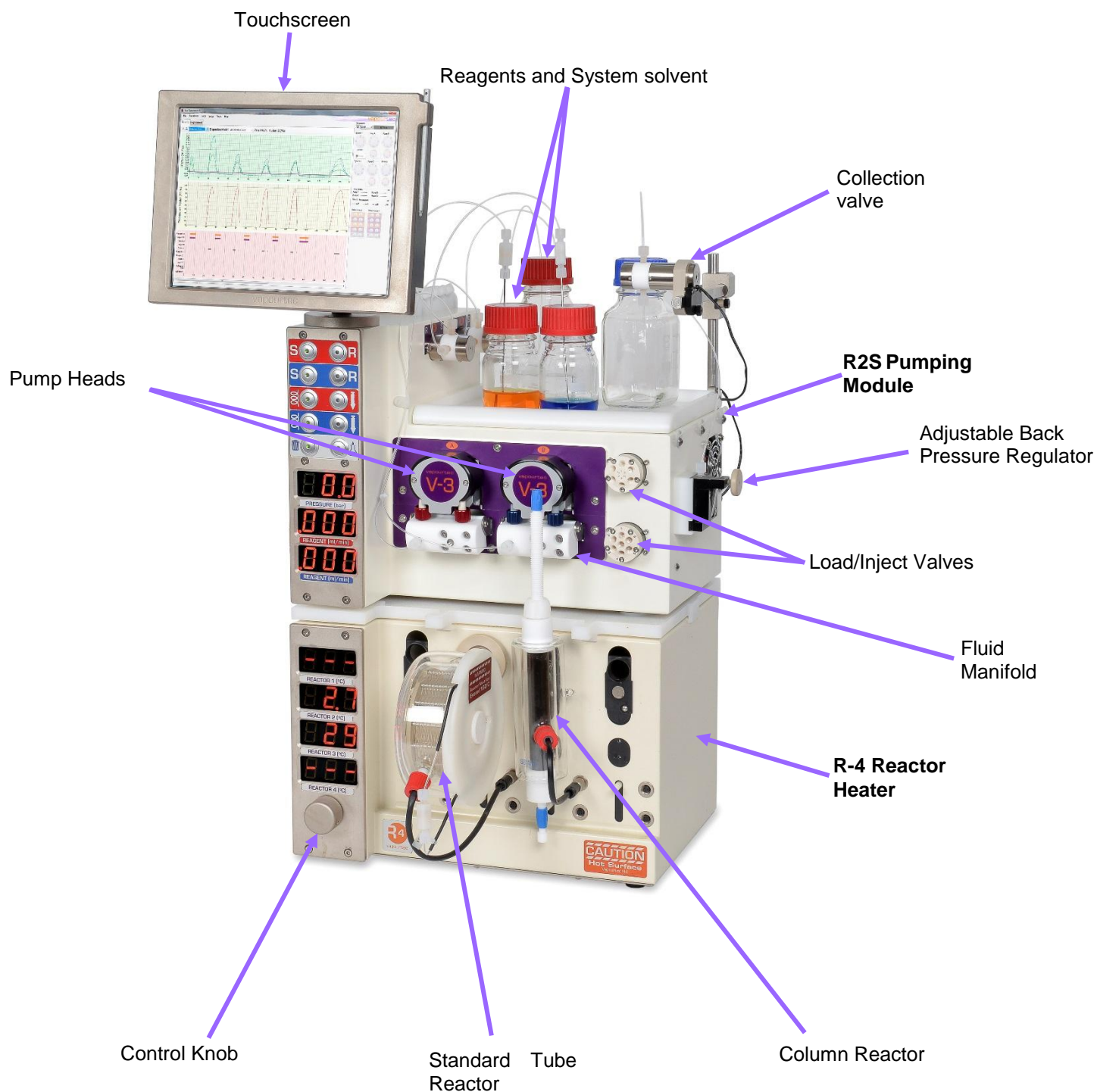
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Product Description

The Vapourtec R1xx and R2xx are pumping modules for applications in Flow Chemistry, particularly for use with the Vapourtec R-4 Reactor Heater.



The different pumping module variants are shown below.

Where more than 2 pumps are required, a second pump module can be used (either an R2S module for a total of 4 pumps or else an R1xx module for a total of 3).

In this case the original module is referred to as the “Primary” and the additional one as the “Secondary”.

Model	Number of pumps	Sample Injection Loops	Strong acid resistance
R2	2	x	x
R2 Plus	2	✓	x
R2 C	2	x	✓
R2 C Plus	2	✓	✓
R1	1	x	x
R1 Plus	1	✓	x
R1 C	1	x	✓
R1 C Plus	1	✓	✓
R2S	2	x	✓
R2S Plus	2	✓	✓

1 SAFETY INFORMATION

The symbols shown below will be used throughout this manual to draw the reader’s attention to important information.



Attention. Important notes.



Caution. Hot surfaces.



Not permitted.
Misuse may cause damage.



Isolate equipment from mains



Note.

2 INSTALLING THE PUMPING MODULE



Your Vapourtec pumping module can be installed by the User. Before the pumping module is used this manual should be read.

2.1 Unpacking



Carefully lift the pumping module out of the packaging and place on a firm surface.

2.2 Siting



For safety your pumping module must be sited within a fume cabinet or other suitably vented enclosure. If it is decided to site the pumping module in an open lab then the customer should undertake a thorough risk assessment prior to operation. The R-xx systems are designed to stand on top of the R-4 Flow Reactor Heater.



Ensure the R-2xx is standing centrally on top of the R-4 Flow Reactor Heater and that both systems are level.



Ensure the drip tray is securely installed on top of the pumping module before placing solvent bottles on top of the module. Damage may result from spillage of liquids into the pumping module or flow reactor heater. If spillage of liquids does occur, isolate the pumping module and the R-4 from the mains.



Provide a firm surface for the pumping module and check that the structure is adequate for supporting its weight or site the pumping module on top of the R-4 Reactor Heater, again, checking that the structure is adequate for supporting the weight of both units.

Leave a minimum distance of 100 mm between the rear of the pumping module or the flow reactor heater and pumping module and any solid objects. The R-4 requires this clearance to ensure adequate air flow through the equipment.



Do not block the air exhausting from the fan on the right-hand side of the pumping module. This is necessary to ensure adequate air flow through the pumping module.



If you need to move your pumping module caution should be exercised as it weighs 18 kg. To avoid damage, disconnect the pumping module from the R-4 Flow Reactor Heater and the mains power supply. Disconnect all fluid connections between the pumping module and any reactors on the R-4 Flow Reactor Heater. Remove any bottles of solvent, reagent, waste or collected products from the drip tray on top of the pumping module. Carefully lift the pumping module off the R-4 Reactor Heater. Ensure that all the glass heat exchangers are removed from the R-4 Flow Reactor Heater before moving.

2.3 Care of your pumping module



When changing solvents with significantly different properties, (e.g. from a polar solvent to a non-polar solvent) it is necessary to first change the solvent to Isopropanol (IPA). If this is not done then pumping performance may be compromised.



If the pumping module is to be left with solvent for a period of time it is advisable to leave the system with IPA.

Connecting the R2S to the R-4



1. Plug the RS232 9-pin cable into both the R-2S pumping module (connector marked "R4") and the R-4 flow reactor heater. This enables the R-4 control knob to be used to control both the R-2S and the R-4.
2. For fluid connections see Section 5 in this User Manual.



Please ensure that all fluid connections are free from leaks as damage may occur to the R2S or the R-4 from spillage into the pumping module or the flow reactor.

2.4 Connecting a second pump module



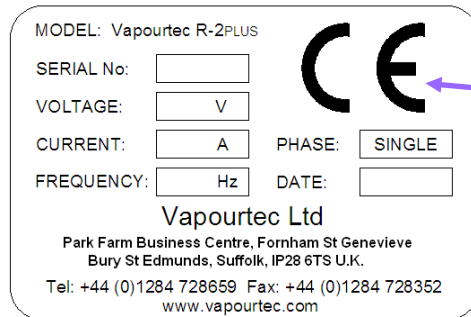
1. A system can be upgraded to 3 or 4 pumps with the addition of an R1xx or R2xx module. A special stand is also available (see right).
2. Plug the extra supplied RS232 9-pin "X-Over" cable into the "spare" socket of the Primary pumping module and the "R4" socket of the Secondary pumping module. This enables the R-4 control knob to be used to control both the R-4 and both pumping modules.



2.5 Electrical connections



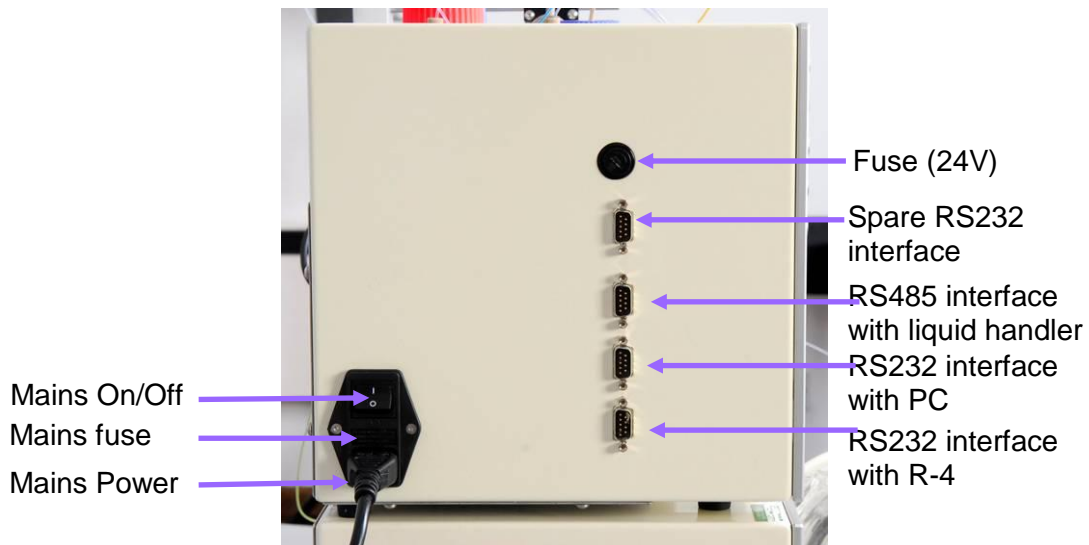
Check the rating plate located to the rear of the pumping module to ensure that the electrical supply you intend to connect to the reactor is suitable for your model of Pump Module.



Rating plate with electrical specifications



The electrical connections should be made in accordance with the picture below. For detailed specifications of the serial and switched I/O connections please see the appropriate section in this manual.



3 THE USER INTERFACE

3.1 Description of the interface



The user interface is used for manual control of the R-2S. The control knob on the R-4 can be used to switch between three modes: OFF, SET and ON and is also used to set the required temperature for each column.

The buttons on the R-2S are used to toggle between the required fluid supply to the pumps and the waste and collect ports after the reactors. The user interface is colour coded to show the flow path for each reagent stream. Please see the photographs below for more details.

Toggle between solvent (S) and reagent (R)

Toggle between load and inject on sample injection valves

Toggle between waste and collect



Control knob

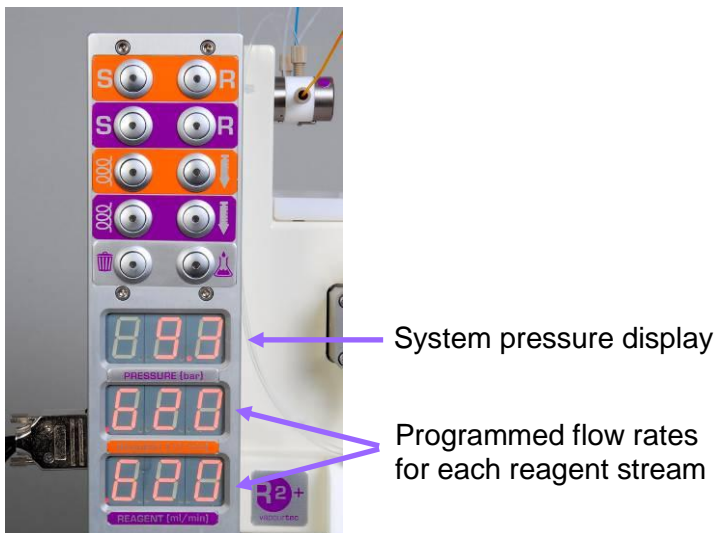
Programmed temperatures for each reactor



3.2 Display of data during pumping



During pumping the top display will show the actual pressure within the reactor. The lower two displays will show the programmed flow-rates of the two reagent streams

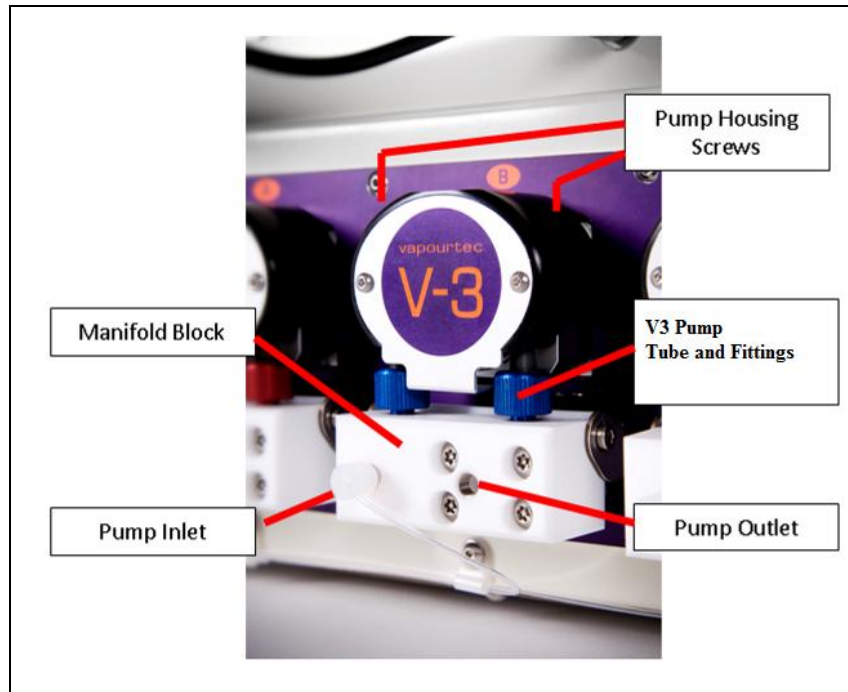


4 PUMPS

4.1 The V-3 Pump – Overview



Each R-2S system contains 2 Vapourtec V-3 pumps.



The V-3 pump is an advanced peristaltic pump.

It can self-prime (i.e. pump gas until liquid is drawn in) and is tolerant to small amounts of suspended particulates in the reagent stream.

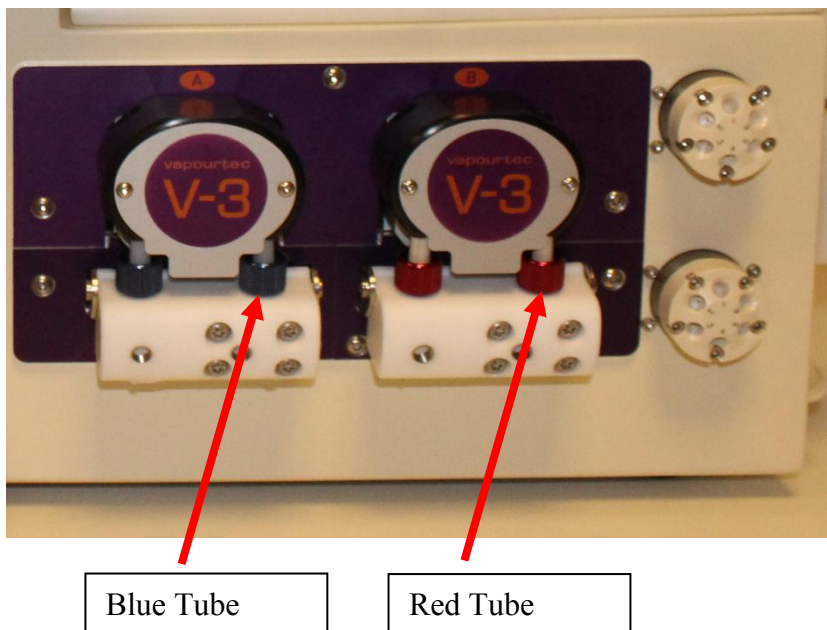


Before using the V-3 pump, read section 7.2, Chemical Compatibility of Pump Tubing, page 25.

4.2 R-2S Pump Tubing



There are two types of pump tube. (Referred to as Red and Blue).
These are easily discernible by the colour of the pump tube end fittings.



The two different tube types are compatible with different subsets of the possible range of solvents, but between the two types, most solvents can be accommodated.

See section 7.2, Chemical Compatibility of Pump Tubing, page 25 for more information



Never pump a chemical that is listed as not compatible with the fitted tube type (or not listed at all). Tube life may be drastically reduced.



The red tube costs less than the blue tube. Therefore where a solvent is compatible with either tube, it is more cost effective to use the red.

4.3 Tubing Calibration Setup

To set the correct tubing colour and tubing calibration the data is displayed on the R2S display panel and controlled via the R4 control Knob. To select the tube colour and set the calibration figure follow the steps below.

Step 1 – From the default display push in and hold the R4 control knob for 3 seconds this will change to 'SEL' then 'CAL' when CAL is displayed let go of the control knob.



R4 Control Knob Default system display SEL display CAL display

Step 2 – Pump A will display the current Tube colour turn the R4 control knob to change between 'RED' or 'BLUE' select the colour you have fitted on the pump.



Tube colour displayed (Pump A)

Step 3 – Press the R4 control knob once more the current calibration figure will appear, this can be adjusted up and down between -30 to +30 percent. Adjust this to the desired calibration figure.



Tube calibration figured displayed (Pump A)

Step 4 – Press the R4 control knob once more to move down to Pump B – Repeat steps 2 & 3 once all are selected the display will go back to the default system settings.



Tube colour displayed (Pump B)

5 OPERATION

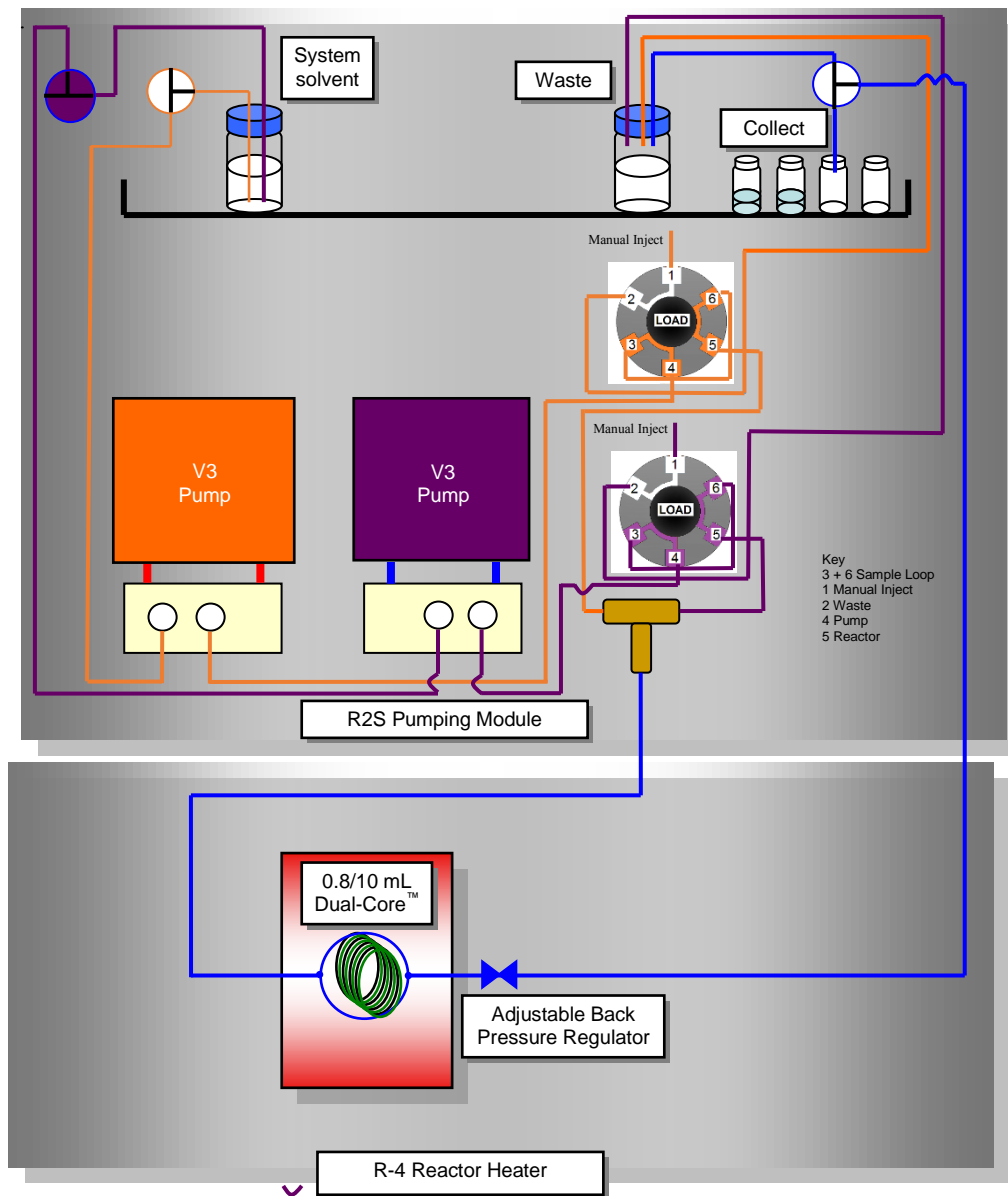
5.1 Configuring the pumping module for use with R-4 Reactor Heater

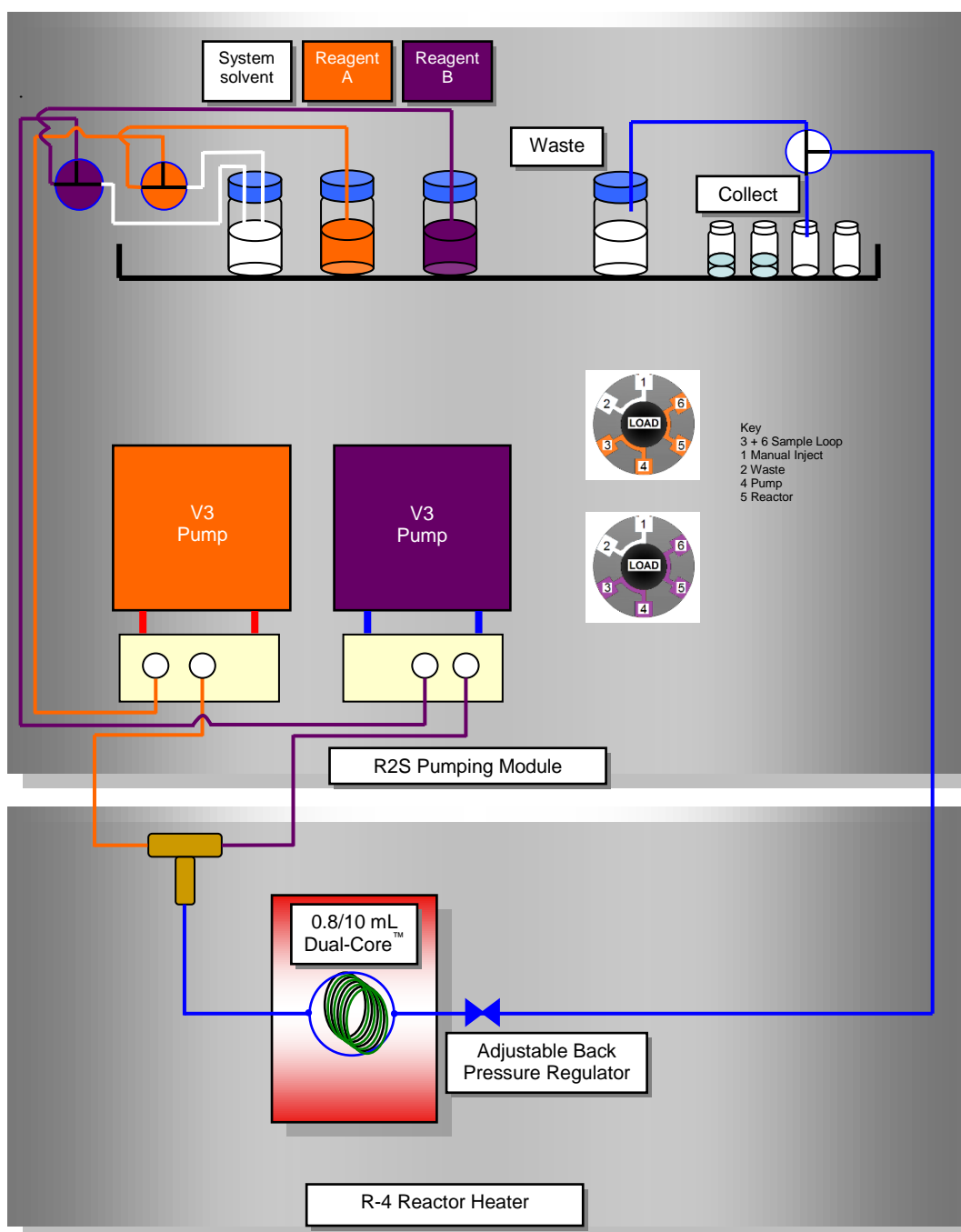


The pumping module can be integrated with your R-4 Reactor Heater. The pumping module is provided with serial data communication using RS232 protocols.

5.2 Fluid connections

Fluid connections for small-scale synthesis using injection loops





Fluid connections for large-scale synthesis.

5.3 Installing back pressure regulators



The adjustable back pressure regulator should be fitted to ensure all gases and vapour remain in solution. Connect the back pressure regulator to the outlet of the tube or column reactor. The set pressure of the back pressure regulator should be chosen to ensure vapour bubbles do not occur but that reactors are not over-pressurised. Please see the tables below for assistance with the choice of the correct back pressure regulator for your reaction.



Caution. Ensure the back pressure regulator is connected to the outlet of the reactor with the arrow pointing in the direction of flow of fluids. If this is not done there is a risk of damage to reactor columns or tubes.

Table 5.3a - Pressure to prevent vapour bubbles at 150°C

Solvent	Minimum Pressure to prevent vapourisation			
	150°C		250°C	
	Bar	psi	Bar	psi
DMSO	-	-	5.0 bar	75 psi
DMF	-	-	7.8 bar	120 psi
Toluene	2.7 bar	40 psi	16.7 bar	250 psi
Water	4.8 bar	70 psi	✘	✘
THF	8.8 bar	130 psi	✘	✘
Isopropanol	10.2 bar	150 psi	✘	✘
Chloroform	10.2 bar	150 psi	✘	✘
Ethanol	10.2 bar	150 psi	✘	✘
Methanol	12.9 bar	90 psi	✘	✘
Di-chloromethane	21.8 bar	320 psi	✘	✘

✘ = not recommended



Vapourtec recommend using a minimum back pressure regulator of 2.7 bar (40 psi) with all reactions. The R2S has a pressure limit of 10 bar

Table 5.3b – Maximum Safe Operating Pressures for Reactors in Vapourtec Flow Chemistry Systems

NB FlowCommander™ software will automatically enforce limits on known reactors

Tube reactors (all standard pressure systems)	Reactor temperature range				
	-70°C to -20°C	-20°C to 40°C	40°C to 99°C	100°C to 150°C	150°C to 250°C
PFA tube reactors (and PFA supply tubing)	40 bar (580 psi)	40 bar (580 psi)	25 bar (362 psi)	15 bar (217 psi)	Do not use
UV-150 Photochemical reactors	N/A	12 bar (174 psi)	12 bar (174 psi)	Do not use	Do not use
Stainless Steel	42 bar (609 psi)	42 bar (609 psi)	42 bar (609 psi)	42 bar (609 psi)	42 bar (609 psi)
Copper					
Hastelloy®					

Tube reactors (High Pressure, 200 bar systems)	Reactor temperature range				
	-70°C to -20°C	-20°C to 40°C	40°C to 99°C	100°C to 150°C	150°C to 250°C
PFA tube reactors (and PFA supply tubing)	40 bar (580 psi)	40 bar (580 psi)	25 bar (362 psi)	15 bar (217 psi)	Do not use
UV-150 Photochemical reactors	N/A	12 bar (174 psi)	12 bar (174 psi)	Do not use	Do not use
Stainless Steel	200 bar (2900 psi)	200 bar (2900 psi)	200 bar (2900 psi)	200 bar (2900 psi)	200 bar (2900 psi)
Hastelloy®					
Copper					

Column reactors (Used on any Vapourtec system)	Reactor temperature range				
	-40°C to -20°C	-20°C to 40°C	40°C to 99°C	100°C to 150°C	150°C to 250°C
6.6 mm Bore Columns	20 bar (290 psi), Silicone O-rings only	40 bar (580 psi)	30 bar (435 psi)	20 bar (290 psi)	Do not use
10 mm Bore Columns	20 bar (290 psi), Silicone O-rings only	30 bar (435 psi)	25 bar (362 psi)	15 bar (217 psi)	Do not use
15 mm Bore Columns	20 bar (290 psi), Silicone O-rings only	20 bar (290 psi)	15 bar (217 psi)	10 bar (145 psi)	Do not use

5.4 Priming the pumps



To prime the pumps run them with a flow rate of 3ml/min for 3 minutes. This should be adequate to remove any air. Repeat if all air is not removed. If after this air is still present check all joints for signs of a leak. Ensure both solvent and reagent connections are primed before starting your synthesis.

5.5 Setting the pumping pressure and speed



Use the display for the R-2S and R-4 to switch ALL between three modes; OFF, SET and ON. To achieve this control the following operation is required;

One push of the control knob changes all displays to read SET.

Turning the control knob clockwise changes all displays to read ON.

Turning the control knob C-Clockwise changes the displays through SET to read OFF.

The maximum pressure of the R-2S or R-2S+ can be set in the range 0 – 10 bar. The pumping speeds of each pump can be set independently in the range 0.1 – 10ml/min. The temperature of each of the 4 reactors can be set independently in the following ranges:

Position	Reactor type	Range
1	Standard PFA tube or column	Ambient to 150°C
	Cooled tube reactor	-70 °C to ambient
	Cooled column	-40 °C to ambient
2	Standard PFA tube or column	Ambient to 150°C
	High temperature tube	Ambient to 250°C
3	Standard PFA tube or column	Ambient to 150°C
	Cooled tube reactor	-70 °C to ambient
	Cooled column	-40 °C to ambient
4	Standard PFA tube or column	Ambient to 150°C
	High temperature tube	Ambient to 250°C
	Cooled tube reactor	-70 °C to ambient
	Cooled column	-40 °C to ambient



From start-up the control works as follows:

1. Turn both the R-4 and R-2S on at the mains power inlet switch. Ensure the systems are connected using the correct RS232 cable.
2. Press the control knob - all counter displays read SET.
3. Press the control knob again while SET is displayed to adjust the set point. If the pumps or heaters are on then they should remain on throughout the changing of the set point (unless a particular reactor is set to OFF) and will once again be ON after the set points are changed. If the pumps or reactor heaters were OFF before the set points were adjusted then after adjusting the set points the pumps/heaters will revert to OFF state.
4. Once the set points have been adjusted the displays will all revert to displaying the actual pressure, pumping speed and temperature.

5.6 Turning the pumps and heaters on and off



To turn the pumps off:

1. Press the control knob - all counter displays read SET.
2. Turn the control knob C-clockwise until OFF is displayed and then press.
3. Both pumps and all heaters are turned OFF while the displays on the R-4 show actual temperature and the top display on the R-2S or R-2S+ shows the actual pressure.



Caution. If at any time the control knob is pressed once but then no other action is taken the display will revert to actual temperature after 5 seconds.



Caution. Do not place anything other than the glass heat exchangers in the holes in the front of the R-4 as they may be hot.

6 INTERFACING THE R-2S FOR AUTOMATION

6.1 Overview of Serial Interface

The R-2S is equipped with two different interface options for communication between upstream processes or serial communication using RS232 protocols.

The RS-232 interface uses a 19200 Baud rate, 8 data bits, 1 stop bit and no parity for data transmission. The lead length connecting the RS-232 devices can be up to 3 m long but should be kept as short as possible to ensure reliable data transfer.

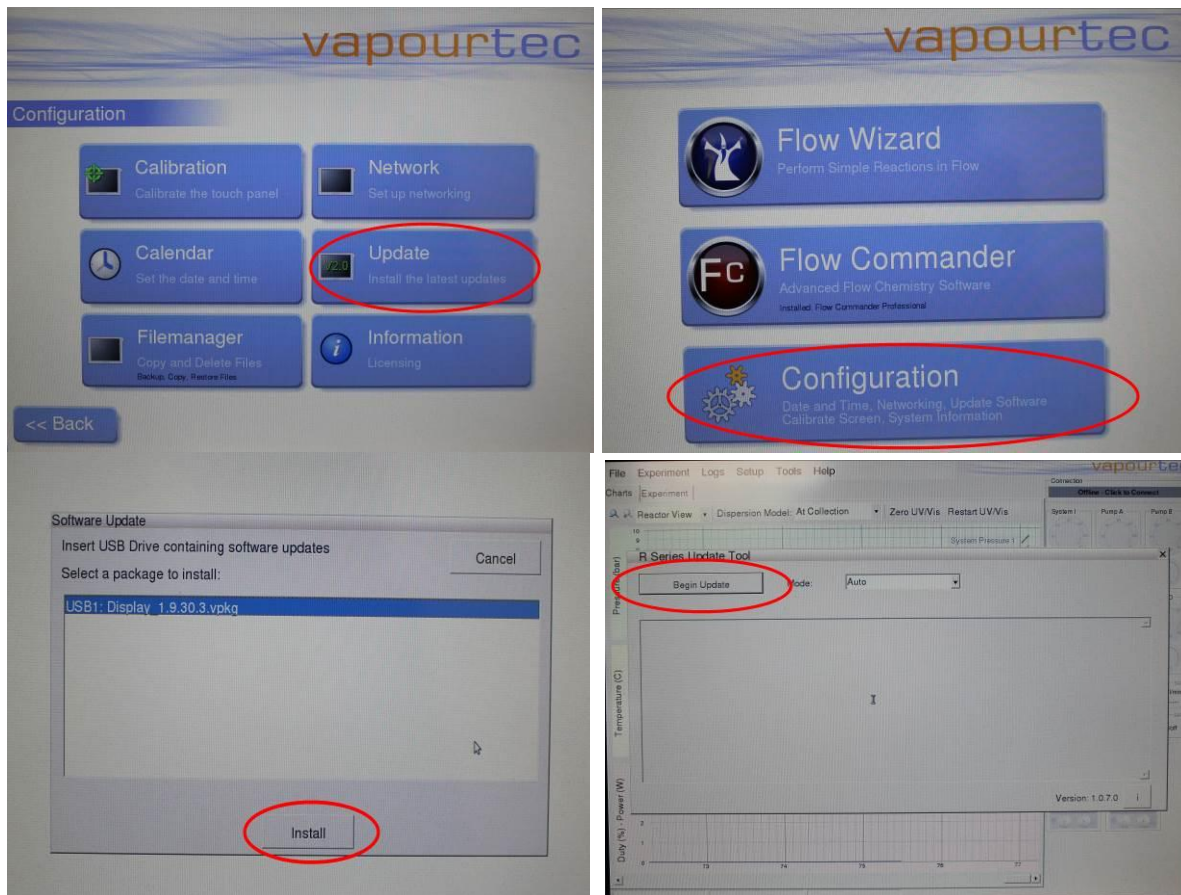
Please contact Vapourtec Ltd for details of the serial command protocol.

6.2 Command Protocol

Control of the R-2S and R-2S+ is achievable through software available from Vapourtec Ltd. Please contact Vapourtec Ltd for further information.

6.3 Software Update Procedure – R – Series – Using the touch Screen

- Step 1** The 'RSeriesUpdateTool_1_0_6.exe' file will be sent via e-mail or post on USB stick from Vapourtec.
- Step 2** Copy the *.epkg file received from Vapourtec with this guide to the ROOT of a USB memory stick.
- Step 3** Place the USB into the Touch Panel USB Port and from the start screen touch on Configuration. Then touch on 'Update' and then the software update screen will appear with the software to install. Touch on 'Install' and the update will begin and complete and the USB can be removed. See pictures below for a guide.



Step 4 With the latest software installed. Open Flow Commander and touch on 'Tools' then 'Update Firmware'. The Update Tool window will appear and touch on 'Begin Update'.

The programme will start automatically. The tool will run through a series of updates and prompts, when prompted to power cycle the R-Series turn off and leave for 1 min before turning back on then start Flow Commander again and restart the Update Tool and 'Begin Update' the system will follow on to the next module if you have additional modules connected. Follow the prompts until the software update is completed.

7 USER SERVICEABLE PARTS

7.1 User replaceable parts

7.1.1 Replacing the fuse



Isolate the equipment from mains before removing ANY covers.



Remove the fuse cover onto the side panel (see picture below). For description of fuse function and specification see General Specifications.



Fuse cover

7.1.2 Replacing / Changing a Pump Tube



Changing the pump tube will require the use of a 2mm & 3 mm Allen key.



In normal lab use with compatible solvents, the pump tubing should be expected to last for 6 months or more.

When a tube's useful life has ended, or when it is necessary to switch to the other pump tube type for solvent compatibility, it is necessary to change the pump tube.

A tube that has come to the end of its life will lose its properties and the pump will no longer deliver at full rated pressure. When this is the case, it indicates that the tubing needs replacing.

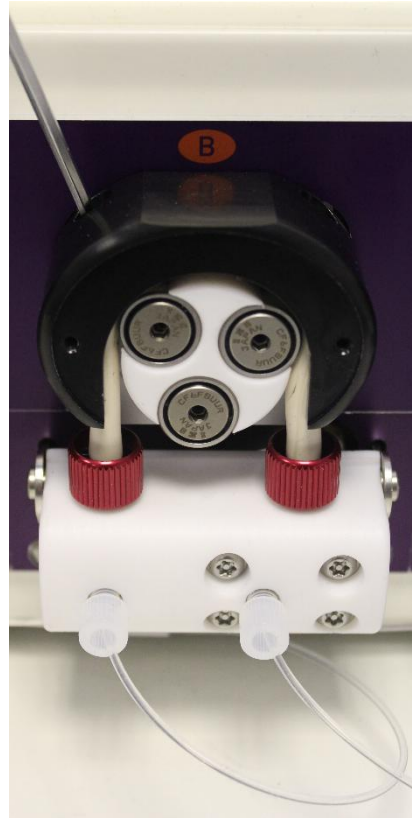
Changing the tube is straightforward.



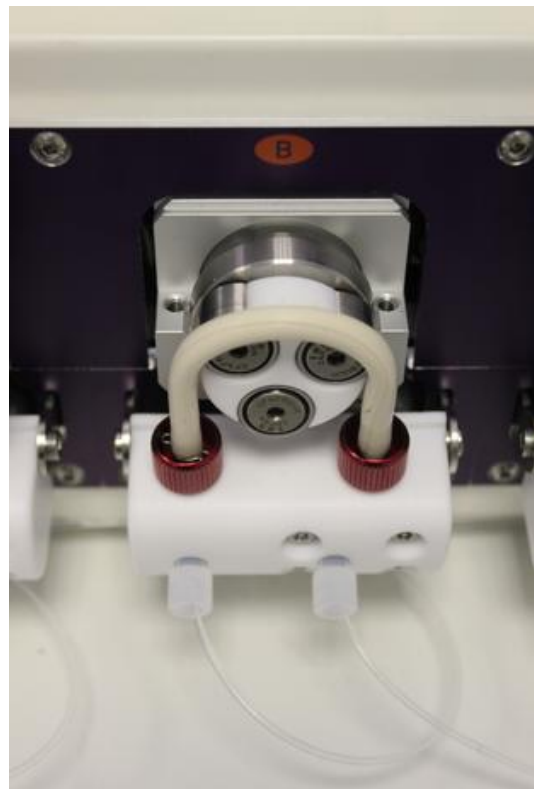
Ensure that any corrosive or toxic substances have been flushed through the pump before changing the tube.



1. Remove the front cover plate (two button head screws from the front), exposing the rotor.
2. Remove the pump housing (two cap screws from above) (see right)



3. Slide the tube off the front of the rotor (to facilitate this the white manifold may be pivoted forwards)





4. Unscrew the tube ends from the manifold and remove
5. Install new tube to the manifold, ensuring fittings are screwed in tight to prevent leaks.
6. Pivot the manifold back and slide the tube onto the rotor



7. Replace the pump housing. Ensure that the housing goes back level, by tightening both screws progressively at the same time until the housing is firmly in place. Failure to do this may result in no apparent problem but reduced life and/or pump performance.
8. Replace the front cover
9. If required, (if the fitted tube is new) follow the procedure for calibrating the new pump tube.
10. **Ensure the correct pump tube colour is selected for that pump in the settings menu. (See section 4.4) If not, the wrong calibration constants will be used.**



Never pump a chemical that is listed as not compatible with the fitted tube type (or not listed at all). Tube life may be drastically reduced. If in doubt contact Vapourtec.

See compatibility chart in section 7.2, page 24.

7.1.3 Calibrating the pump tube



Each pump on the R2S can be used with either the red or blue pump tube (see compatibility chart in section 7.2, page 24 for details of which tube to use).

The system stores settings for each tube for each pump (see Settings, section 4.4)

To calibrate a pump, follow these steps.

1. Ensure a calibration solvent is chosen that is compatible with the pump tubing
2. Ensure pump is fully flushed through with the target calibration solvent
3. Set the calibration to 0.0% in the Settings menu for that pump
4. Run the pump for 2mins at 1ml/min, collecting the output into a pre-weighed vessel.
5. Weigh the vessel again and determine the mass of the output. Based on the calibration solvent's density, determine the actual volume pumped.
6. Enter the calculated adjustment in the settings screen as a percentage. (for example, if the collected amount is 1% higher than expected, enter -1%)
7. Repeat to confirm correct calibration.

7.1.4 Changing the Moulded element in the BPR

The BPR element has wide solvent compatibility but may eventually need replacing.



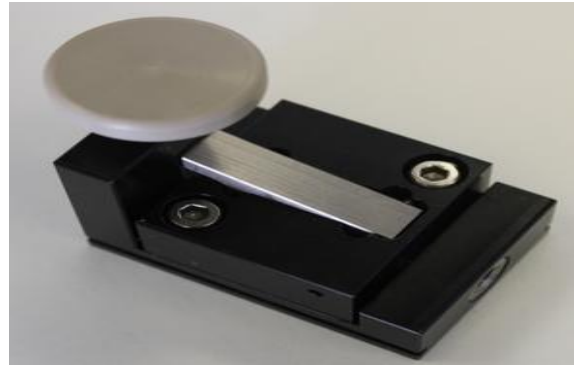
Changing the BPR element requires the use of a 3 mm Allen key.



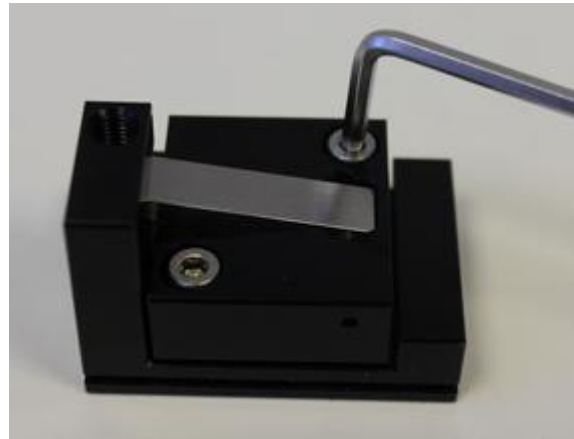
1. Ensure that any corrosive or toxic substances have been flushed through the BPR before changing the element.



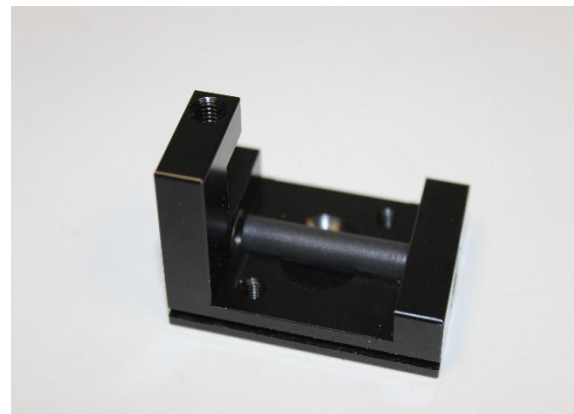
2. Disconnect all tubing from the BPR and remove it from its holder on the R2S (See right)



3. Unscrew the adjusting knob and remove the 2 x M4 socket-cap screws using a 3mm Allen-key (Figure 2). Loosen each screw one turn at a time, in turn, so that the pressure on the tube remains uniform.



4. When the 2 screws have been removed, the pressure plate can be removed to expose the BPR tubing



5. The tubing can now be removed and replaced centrally in the assembly.
6. Re-assembly of the BPR is carried out by reversing the above steps.
7. Take care to tighten the M4 screws sequentially one turn at a time to avoid un-

necessary stress on the new tubing



8. Ensure that when the tubes are reconnected to the BPR they are screwed in just tight enough to form a seal. It is not necessary to screw them overtight and the performance of the BPR will be adversely affected if you do.

7.2 Chemical Compatibility of Pump Tubing



The table below shows the chemical compatibility of the two different types of pump tube.

Where a solvent or reagent is not listed at all, please contact Vapourtec for advice. Please note also that as more testing is carried out the list of approved solvents may increase, and this manual may be out of date.

Unless specified otherwise, it is assumed that the chemical in question is to be pumped neat. Where the chemical in question constitutes only a small percentage of the solution to be pumped, contact Vapourtec for specific advice.




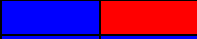
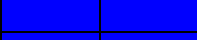
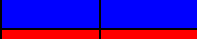
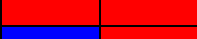
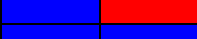
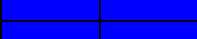
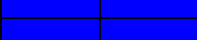
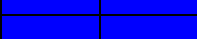
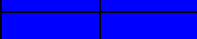
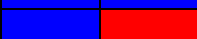
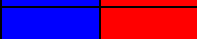

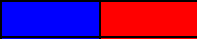
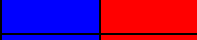
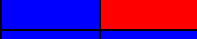
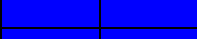
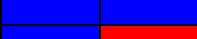
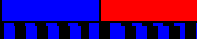
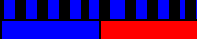
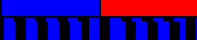
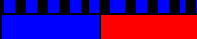
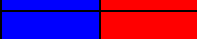
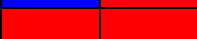

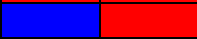
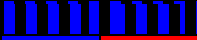
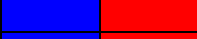
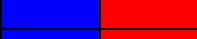


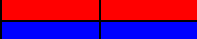
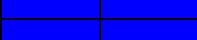
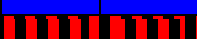





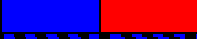
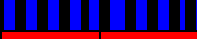
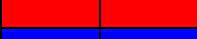
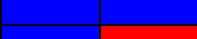
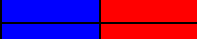
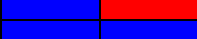


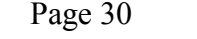

Never pump a chemical that is listed as not compatible with the fitted tube type (or not listed at all). Tube life may be drastically reduced.

If in doubt contact Vapourtec

Chemical Name	Which Tube To Use		Note
Acetaldehyde	Blue	Blue	
Acetic acid Glacial	Blue	Blue	
Acetic anhydride	Blue	Blue	
Acetone	Blue	Blue	
Acetone cyanohydrin	Blue	Blue	
Acetonitrile	Blue	Blue	
Acetyl chloride	Blue	Red	
Acetylene gas	Blue	Red	
Acrylonitrile	Blue	Blue	
Adipic acid	Blue	Red	
Alcohol	Blue	Red	
Alkyl benzene	Blue	Red	
Alkyl-arylsulphonic acid	Blue	Blue	
Alumina trihydrate	Black/White Stripes	Black/White Stripes	Do not use
Aluminum acetate	Black/White Stripes	Black/White Stripes	Do not use
Aluminum chloride	Red	Red	
Aluminum nitrate	Red	Red	
Aluminum potassium sulfate	Red	Red	
Aluminum sulfate	Red	Red	
Amines mixed	Black/White Stripes	Black/White Stripes	Reduced life
Ammonia Gas cold	Blue	Blue	
Ammonium acetate	Blue	Blue	
Ammonium bicarbonate	Blue	Blue	
Ammonium bromide	Blue	Blue	
Ammonium carbonate	Blue	Red	

Chemical Name	Which Tube To Use		Note
Ammonium chloride	Blue	Red	
Ammonium hydroxide	Blue	Blue	
Ammonium nitrate	Blue	Red	
Ammonium phosphate	Blue	Red	
Ammonium stearate	Blue	Blue	
Ammonium sulfate	Blue	Red	
Ammonium thiocyanate	Blue	Red	
Amyl acetate	Black/White Stripes	Black/White Stripes	Reduced life
Amyl alcohol	Blue	Red	
Amyl nitrate	Blue	Red	
Aniline	Blue	Red	
Aniline hydrochloride	Blue	Red	
Anti-freeze glycol based	Blue	Blue	
Aqua regia	Yellow	Yellow	
Argon gas	Blue	Red	
Arsenic acid	Blue	Red	
Barium chloride	Blue	Red	
Barium hydroxide	Blue	Red	
Barium nitrate	Blue	Red	
Benzaldehyde	Blue	Red	
Benzene	Blue	Red	
Benzenesulfonic acid	Blue	Red	
Benzochloride	Blue	Red	
Benzoic acid	Blue	Red	
Benzotrifluoride	Black/White Stripes	Black/White Stripes	Do not use
Bleach solutions	Blue	Red	
Boric acid	Blue	Red	
Boron trichloride	Red	Red	
Bromine	Red	Red	
Bromo trifluoride	Black/White Stripes	Black/White Stripes	Do not use
Bromobenzene	Red	Red	
Butadiene	Red	Red	
Butane	Red	Red	
Butyl acetate	Black/White Stripes	Black/White Stripes	Reduced life
Butyl alcohol	Blue	Red	
Butyl ether	Black/White Stripes	Black/White Stripes	Reduced life
Butylamine	Black/White Stripes	Black/White Stripes	Reduced life
Butylene	Red	Red	
Butylene glycol	Blue	Blue	
Butyllithium solution 1.6M in hexanes (BuLi)	Red	Red	
Butyric acid	Blue	Blue	
Calcium acetate	Blue	Blue	
Calcium carbonate	Blue	Red	
Calcium chlorate	Blue	Red	
Calcium cyanide	Blue	Red	
Calcium hydrogen sulfite	Blue	Blue	
Calcium hydrosulfide	Blue	Blue	
Calcium hydroxide aqueous	Blue	Red	
Calcium hypochlorite	Blue	Red	

Chemical Name	Which Tube To Use		Note
Calcium magnesium chloride	Blue	Blue	
Calcium nitrate	Blue	Red	
Calcium phosphate	Blue	Red	
Calcium sulfate aqueous	Blue	Red	
Carbamate	Blue	Red	
Carbon dioxide	Blue	Red	
Carbon disulfide	Blue	Red	
Carbon monoxide	Blue	Red	
Carbon tetrachloride	Red	Red	
Carbonic acid	Blue	Red	
Chloric acid	Blue	Red	
Chlorinated solvents	Red	Red	
Chlorine	Red	Red	
Chlorine dioxide	Red	Red	
Chloroacetic acid	Black/White Stripes	Black/White Stripes	Reduced life
Chloroacetone	Black/White Stripes	Black/White Stripes	Reduced life
Chlorobenzene	Blue	Red	
Chloroform	Red	Red	
Chlorosulfonic acid	Blue	Red	
Chromic acid	Red	Red	
Chromic oxide	Blue	Red	
Chromium potassium sulfate	Blue	Red	
Citric acid	Blue	Red	
Cod-liver oil	Blue	Red	
Copper acetate	Black/White Stripes	Black/White Stripes	Do not use
Copper ammonium acetate	Black/White Stripes	Black/White Stripes	Do not use
Copper chloride	Red	Red	
Copper cyanide	Red	Red	
Copper nitrate	Red	Red	
Copper sulfate	Red	Red	
Corn oil	Blue	Red	
Cottonseed oil	Blue	Red	
Crude oil	Blue	Red	
Cumene	Blue	Red	
Cyanogen	Blue	Red	
Cyclohexane	Red	Red	
Decahydronaphthalene	Blue	Red	
Diacetone alcohol	Blue	Red	
Diallyl phthalate	Blue	Red	
Dibromoethyl benzene	Red	Red	
Dibutyl Cellosolve adipate	Blue	Red	
Dibutyl phthalate	Blue	Red	
Dibutylamine	Black/White Stripes	Black/White Stripes	Reduced life
Dichlorobenzene	Red	Red	
Dichloromethane (DCM)	Blue	Red	
Dichlorosiloxane (DCS)	Blue	Red	
Diethanolamine	Blue	Red	
Diethyl carbonate	Blue	Red	
Diethyl phthalate	Blue	Red	

Chemical Name	Which Tube To Use	Note
Diethylamine		Reduced life
Diethylene glycol		
Diethylenetriamine		
Diisobutyl ketone		
Diisobutylaluminium hydride (DIBAL)		
Dimethyl phthalate		
Dimethyl sulfoxide (DMSO)		
Dimethyl terephthalate		
Dimethylamine		
Dimethylformamide (DMF)		
Dinitrochlorobenzene		
Diocetyl phthalate		
Diphenyl		
Epichlorohydrin		
Ethane		
Ethanethiol		
Ethanol		
Ethanolamine		
Ethyl acetate		
Ethyl alcohol		
Ethyl ether		Reduced life
Ethyl formate		
Ethylamine		Reduced life
Ethylbenzene		
Ethylene		
Ethylene dibromide		
Ethylene dichloride		
Ethylene glycol		
Ethylene oxide		Reduced life
Fatty acids		
Ferric sulfate aqueous		
Ferrous sulfate aqueous		
Fluorine gas		Reduced life
Fluosilicic acid		
Formaldehyde		
Formic acid		
Freon 11		Reduced life
Freon 113		Do not use
Freon 114		Reduced life
Freon 12		Do not use
Freon 22		Do not use
Freon 502		Do not use
Fumaric acid		
Furfural		Reduced life
Gasoline		
Glacial acetic acid		
Glucose		
Glycerol		
Glycine		

Chemical Name	Which Tube To Use		Note
Helium	Blue	Red	
Heptane	Blue	Red	
Hexyl alcohol	Blue	Red	
Hydrazine	Blue	Blue	
Hydrochloric <10% v / v	Blue	Red	
Hydrochloric acid Concentrated	Blue	Red	
Hydrocyanic acid	Blue	Red	
Hydrofluoric acid	Black/White Stripes	Black/White Stripes	Do not use
Hydrogen chloride gas dry	Blue	Blue	
Hydrogen fluoride anhydrous	Black/White Stripes	Black/White Stripes	Do not use
Hydrogen gas	Blue	Red	
Hydrogen peroxide	Blue	Red	
Hydrogen sulfide	Blue	Blue	
Hypochlorous acid	Blue	Red	
Isobutane	Blue	Red	
Isopropyl acetate	Black/White Stripes	Blue	Reduced life
Isopropyl alcohol	Blue	Red	
Isopropyl ether	Black/White Stripes	Blue	Reduced life
Kerosene	Blue	Red	
Lactic acid	Blue	Red	
Ligroin	Blue	Red	
Linoleic acid	Blue	Red	
Linseed oil	Blue	Red	
Liquefied petroleum gas	Blue	Red	
Magnesium chloride	Blue	Red	
Magnesium hydroxide	Blue	Red	
Magnesium sulfate	Blue	Red	
Maleic acid	Blue	Red	
Maleic anhydride	Blue	Blue	
Malic acid	Blue	Red	
Manganous chloride	Blue	Red	
Melamine resin	Blue	Blue	
Mercuric chloride	Blue	Red	
Mesityl oxide	Blue	Blue	
Methane	Blue	Red	
Methyl acetate	Black/White Stripes	Blue	Reduced life
Methyl alcohol (Methanol)	Blue	Red	
Methyl benzoate	Blue	Red	
Methyl bromide	Blue	Red	
Methyl chloride	Blue	Red	
Methyl ethyl ketone (MEK)	Blue	Blue	
Methyl formate	Blue	Blue	
Methyl isobutyl ketone	Black/White Stripes	Blue	Reduced life
Methyl methacrylate	Blue	Blue	
Methyl propionate	Blue	Blue	
Methyl tertiary butyl ether	Black/White Stripes	Blue	Reduced life
Methylene bromide	Black/White Stripes	Red	Reduced life
Methylene chloride	Blue	Blue	
Naphthalene	Blue	Red	

Chemical Name	Which Tube To Use		Note
Natural gas sour	Red	Red	
n-Hexane	Blue	Red	
Nickel chloride	Blue	Red	
Nickel sulfate	Blue	Red	
Nitric acid < 10%	Red	Red	
Nitric acid concentrated	Red	Red	
Nitrobenzene	Blue	Red	
Nitrogen gas	Blue	Red	
Nitromethane	Blue	Blue	
n-Methyl-2-pyrrolidone (NMP)	Blue	Blue	
Oleic acid	Blue	Red	
Oxalic acid	Blue	Red	
Oxygen gas	Blue	Red	
Ozone gas	Blue	Red	
Palm oil	Blue	Blue	
Palmitic acid	Blue	Red	
Pentane	Red	Red	
Peptide coupling reagents	Blue	Blue	
Perchloric acid	Blue	Red	
Perchloroethylene	Red	Red	
Phenol 10%	Blue	Red	
Phenylacetic acid	Blue	Red	
Phosphoric acid concentrated	Blue	Red	
Phosphoric acid diluted	Blue	Red	
Phthalic anhydride	Blue	Blue	
Picoline alpha	Blue	Blue	
Picric acid H2O solution	Blue	Blue	
Polyethylene glycol	Blue	Red	
Polypropylene slurry	Blue	Red	
Polyvinyl acetate emulsion	Blue	Blue	
Polyvinyl alcohol	Blue	Blue	
Potassium bromide	Blue	Red	
Potassium carbonate	Blue	Red	
Potassium chlorate	Blue	Red	
Potassium chloride	Blue	Red	
Potassium cyanide	Blue	Red	
Potassium dichromate	Blue	Red	
Potassium hydroxide diluted	Blue	Blue	
Potassium hydroxide concentrated	Black/White Stripes	Black/White Stripes	Reduced life
Potassium nitrate	Blue	Red	
Potassium permanganate	Blue	Red	
Potassium phosphate	Blue	Blue	
Potassium sulfate	Blue	Red	
Propane	Red	Red	
Propionic acid cold	Blue	Blue	
Propyl acetate	Black/White Stripes	Black/White Stripes	Reduced life
Propyl alcohol	Blue	Red	
Propylene	Red	Red	
Propylene oxide	Black/White Stripes	Black/White Stripes	Reduced life

Chemical Name	Which Tube To Use		Note
Pyridine	Blue	Blue	
Silver nitrate	Blue	Red	
Sodium acetate (2M)	Blue	Red	
Sodium bicarbonate	Blue	Red	
Sodium bisulfate	Blue	Red	
Sodium cyanide aqueous	Blue	Red	
Sodium dichromate	Blue	Red	
Sodium dithionite	Blue	Blue	
Sodium hydroxide < 10%	Blue	Red	
Sodium hydroxide < 50%	Red	Red	
Sodium hypochlorite < 10%	Blue	Red	
Sodium hypochlorite < 20%	Red	Red	
Sodium nitrate	Blue	Red	
Sodium peroxide	Blue	Red	
Sodium phosphate	Blue	Red	
Sodium silicate	Blue	Red	
Sodium sulfate	Blue	Red	
Sodium sulfide	Blue	Red	
Sodium sulfite	Blue	Red	
Sodium thiocyanate	Blue	Red	
Sodium thiosulfate	Blue	Red	
Stearic acid	Blue	Red	
Styrene	Blue	Blue	
Sulfur chloride	Blue	Red	
Sulfur Dioxide Dry	Blue	Red	
Sulfur dioxide Wet	Blue	Red	
Sulfur In water	Blue	Blue	
Sulfur molten	Blue	Red	
Sulfuric acid Concentrated	Red	Red	
Sulfuric acid <10% v / v	Red	Red	
Tallow	Blue	Red	
Tartaric acid aqueous	Blue	Red	
Terephthalic acid	Blue	Red	
Tetrachloroethane	Red	Red	
Tetrahydrofuran (THF)	Blue	Blue	
Thiols	Blue	Blue	
Thionyl chloride	Red	Red	
Titanium dioxide	Blue	Red	
Titanium tetrachloride	Red	Red	
Toluene	Blue	Red	
Trichloroethane	Red	Red	
Trichloroethylene	Red	Red	
Tricresyl phosphate	Blue	Red	
Triethanolamine	Blue	Blue	
Triethylamine	Black/White Stripes	Black/White Stripes	Reduced life
Trifluoroacetic acid (TFA)	Blue	Blue	
Urea	Blue	Blue	
Urea-formaldehyde resin	Blue	Blue	
Vinyl acetate	Black/White Stripes	Black/White Stripes	Reduced life

Chemical Name	Which Tube To Use		Note
Vinyl chloride	Red	Red	
Vinylidene chloride	Red	Red	
Water	Blue	Red	
Xylene	Blue	Red	
Zinc chloride	Blue	Red	
Zinc nitrate	Blue	Red	
Zinc sulfate	Blue	Blue	

TROUBLESHOOTING

Problem	Possible Cause	Solution
No display	System not plugged in and turned on Fuse (24V) needs replacing.	Check system is plugged in and turned on. Replace fuse as described in Section 7.1.1 of this user manual.
Pumps not running	Maximum pumping pressure has been exceeded (10bar) so pumps are limiting delivery.	Check maximum pumping pressure is correct and re-set if required. Turn pumps on using the control knob.
Pumps running but no solvent flow through system	System has run out of solvent Blockage in back pressure regulators. Back pressure regulator installed the wrong way round. Leak at one of the fluid connections. System not fully wetted.	Check solvent/reagent supply containers Check all back pressure regulators are free from sediment and replace if necessary. Check that the arrow on the back pressure regulator is pointing in the direction of fluid flow. Check all fluid connections are leak-free. Prime system at 3ml/min for 3 minutes.

Problem	Possible Cause	Solution
System pressure display flashing 'Lo'	<p>Low pressure due to a leak in fluid connections.</p> <p>Low pressure due to lack of system solvent/reagent.</p>	<p>Check all fluid connections are leak-free.</p> <p>Top up system solvent and/or reagents and re-start pumps.</p>
System pressure display flashing 'bAr'	System pressure has gone over pressure trip.	<p>Check system target pressure is not set too low. Check back pressure regulators are free from blockages and installed the correct way round. Check all tubing is clear of blockages. Re-start the pumps and prime if necessary.</p>
Pump display flashing 'bAr'	<p>Blockage in fluid manifold.</p> <p>Back pressure regulator connected the wrong way round and reactor pressure trip set above 10 Bar.</p> <p>Blockage in reactor.</p>	<p>Check all tubing is clear from blockages. Check back pressure regulators are free from blockages.</p> <p>Check back pressure regulator on the reactor is connect the correct way round and check the reactor pressure trip is set below 10 Bar. Re-start pumps and prime if necessary.</p> <p>Remove reactor from the system and disconnect fluid connections. Connect a syringe to the reactor and check there is a free-flow of fluid through the reactor. Replace reactor cartridge if there is no fluid flow.</p>

8 GENERAL SPECIFICATIONS

8.1 R2S, R2S+

Independent Pumps	2
Pressure Range	0 – 10 Bar
Flow rate/channel	0.100 to 10ml/min
Control interfaces: Serial	RS 232 communication standard x 2 RS485 (GSIOC)
Environmental	Operational ambient temperature range: 15 to 25 °C Operational humidity: 20 to 70% RH
Size & Weight	Width: 350 mm Height: 270 mm Depth: 280 mm Weight: 18 kg
Services	Power; 230V (+/- 10%), 50 Hz, 2A (see rating plate) Or, 110V (+/- 10%), 60 Hz, 4A (see rating plate)
Fuses	IEC socket (230 V external): 2 A, 20 mm, type T IEC socket (110 V external): 4 A, 20 mm, type T Fuse socket (24V): 6.3A, 20mm, type T
Conformity	Conforms to all applicable EEC standards, CE marked.

9 VAPOURTEC WARRANTY

9.1 Standard limited warranty

The Vapourtec Ltd standard UK warranty follows. The warranty covers parts and labour for a period of 12 months, commencing the date of invoice, for any repairs deemed resultant of a defect in materials and/or workmanship by Vapourtec Ltd. This warranty excludes wear and tear of parts considered to be 'consumable', a list of these parts is given below. Replacement of consumable parts or repairs to equipment that is not covered by this warranty will be chargeable.

Any factory approved changes or extensions to this warranty should be received in writing from Vapourtec Ltd and filed with this warranty statement. If your equipment is eligible for coverage, please review this warranty thoroughly and contact Vapourtec Service Department with any questions you may have. If your equipment is not covered by our standard warranty, or you are seeking optional or additional coverage, see sections below for service plans offered.

Consumable parts and other items not covered by the standard warranty:

- External tubing and tubing connectors
- Sample injection valve heads
- Back pressure regulators
- Red or Blue V3 pump tubes

Items COVERED by the limited warranty

- Parts and labour for a period of one (1) year from date of delivery. Any part excluding those in the list above found to defective will be either repaired or replaced at the discretion of Vapourtec Ltd, free of charge by Vapourtec Ltd.
- On site labour if repairs require that Vapourtec Ltd personnel travel to the equipment.

Items NOT COVERED by the limited warranty

- Travel time, travel expenses and mileage expended by Vapourtec Ltd personnel if repairs require on-site labour.
- Transportation of equipment for repair.
- Vapourtec Ltd cannot be held responsible for incidental or consequential damages

The above statement is a final and complete statement of the agreement between the Customer and Vapourtec Ltd. Vapourtec Ltd makes no other warranties expressed or implied, of merchantability, fitness or otherwise, with respect to the goods supplied under this agreement, which extend beyond the description of this limited warranty.

Vapourtec Ltd will have the right to inspect the equipment and determine the repairs or replacements necessary. The customer will be notified within a reasonable time of any damages incurred that are not covered by this warranty prior to initiation of such repairs.

Any customer modification of this equipment or any repairs undertaken without prior written consent of Vapourtec Ltd will render the limited warranty void.

9.2 Service contracts Europe and UK

Vapourtec recognises that by choosing Vapourtec R Series Flow Chemistry equipment you are investing both capital and resources. Our customer support program is designed to help you protect the value of your investment by prolonging the usable life of the equipment and maximising system performance & up-time in your laboratory.

For your convenience we present a range of support contracts to suit your budget and working requirements. Often our contracts provide more cost-effective cover than insurance, with faster response and no risk of refusal of cover in subsequent years.

Service and Breakdown Contract (SBC)

The SBC is a full service breakdown contract that includes preventive maintenance and all parts and labour. It is ideal for heavily trafficked or multi-user instruments in high throughput environments and guarantees peace of mind throughout the year. All service call outs and a scheduled preventive maintenance visit are included. If you do need to call in an engineer, there is no call out fee and all parts and labour are included. This is the best option for the busy laboratory where up time is at a premium.

Includes:

- One preventive maintenance visit per year
- All call-out, travelling time and labour charges *
- All parts needed for PM or Call out visits, inc. full Service Kit but excluding the items in the section below titled exclusions
- Average 48-hour response time
- Attractive discounts for multiple systems on the same site
- Access to Vapourtec on-line technical support
- Free software downloads to keep your copy of Flow Commander updated

Exclusions:

- Glassware
- Reactor and reactor components
- Replacement back pressure regulators
- Replacement pump check valves
- Replacement of sealing components for the injection valves except during the annual PM when these parts are replaced. This applies to the R2PLUS only

* Please note, clearing of blockages caused by foreign objects or precipitation of compounds will be attended but travelling time and labour charges may be charged at Vapourtec discretion.

Preventative Maintenance Contract (PMC)

Our PMC is a popular option with budget-conscious laboratories that cannot afford the inconvenience of an unscheduled stoppage. It includes a planned maintenance visit and the cost of all parts needed during that visit and labour costs. Call-outs are charged at normal rates.

Includes:

- One preventive maintenance visit per year, including cost of full Service Kit of parts, travelling time and labour
- Average 48-hour response time
- Attractive discounts for multiple systems on the same site
- Access to Vapourtec on-line technical support
- Free software downloads to keep your copy of Flow Commander updated

Discount Schedule for SBC and PMC

If you have more than one Vapourtec system included in your Service Contract you will be eligible for attractive discounts that help stretch your service budget further. The systems are assessed for discount in installation date order, so your newest systems attract the highest level of discount.

1st (oldest) system = List Price

2nd system = 15% discount

3rd system = 20% discount

4th system = 25% discount

5th system = 30% discount

All subsequent systems = 30% discount

On-site Training of your own engineers.

For multiple installations of Vapourtec equipment it may be advisable to have your own engineers or technicians trained to provide first-line service diagnostics and repairs. Please contact Vapourtec if this is of interest.

Annual Training/User support Contacts

Training/User support contracts are offered on a 12 monthly basis, and cover on site and telephone support for users with application enquiries.

These contracts are based on 12 days per annum training/user support for Vapourtec system users. Please contact Vapourtec if this is of interest.

9.3 Sample copy of EC Conformity

declaration of

EC DECLARATION OF CONFORMITY



Product	Vapourtec R-2S Pumping Module
Serial no.	

Manufacturer Address
 Vapourtec Ltd
 Park Farm Business Centre
 Fornham St Genevieve
 Bury St. Edmunds
 Suffolk, IP28 6TS

We hereby declare that the product above complies with the essential health and safety requirements of the following directives:

- MACHINERY** **Directive 2006/42/CE**
 Implemented in the UK by Supply of Machinery (Safety) Regulations 2008 (SI 2008 no. 1597).
- Low Voltage Directive (LVD)** **Directive 2014/35/EU**
 Implemented in the UK by The Electrical Equipment (Safety) Regulations 2016 (SI 2016 no. 1101).
- Electromagnetic Compatibility (EMC)** **Directive 2014/30/EU**
 Implemented in the UK by The Electromagnetic Compatibility Regulations 2016 (SI 2016 no. 1091).
- CE marking** **Directive 93/68/EEC**
 Implemented in the UK by The EMC (Amendment) Regulations (1994 no. 3080).

The product has been designed and manufactured in accordance with European standards:

EN 12100-1: 2004	Safety of Machinery: Basic concepts, general principles for design. Part 1: Basic terminology, methodology
EN 12100-2: 2004	Safety of Machinery: Basic concepts, general principles for design. Part 2: Technical principles
EN 13849-1: 2016	Safety of Machinery: Safety related parts of control system. Part 1: General principles of design
EN 60204-1: 2006	Safety of Machinery: Electrical equipment of machines. Part 1 General requirements
EN 61010-1: 2013	Safety requirements for electrical equipment for measurement, control and laboratory use Part 1: General requirements

A Technical Construction File is retained at the manufacturer's address.

Signed	
Name	
Position	
Date	

9.4 Vapourtec contact details

Address: Vapourtec Ltd
Park Farm Business Centre
Fornham St Genevieve
Bury St Edmunds
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IP28 6TS
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