Operating and Maintenance Handbook

ST22 TITATIUM SUBLIMATION PUMP CARTRIDGE

REVISION	DATE	COMMENTS	INITIALS
1	Jan 1996	Original release	MJD
2	June 2009		ECN# 3368
3	Aug 2015	VACGEN rebrand	AJL

sales@vacgen.com **www.vacgen.com** **+44 (0) 1424 856 333**

WARRANTY

1. Subject to fair wear and tear and the due, observance of any installation user, storage, operating or maintenance instructions the Seller undertakes to replace or, at its option repair free of charge to the purchaser, any goods which the purchaser can establish are defective by reason of defective workmanship or materials which are returned to the Seller, carriage paid, within 12 months of the date of dispatch by the Seller. In the event, however, that the Seller supplies spare parts either direct, or that are fitted or installed or replaced by the Sellers' service center such spare parts will be subject to a warranty period of six months only.
2. The Purchaser cannot return any product for warranty repair without the prior approval of VACGEN and the issue of a Goods Return Number (GRN). This shall be obtained by contacting the service center at VACGEN. All returned products must be accompanied by a completed Declaration of Contamination form. Customers must, in the first instance, contact the local selling agent.
3. We reserve the right to decline to service equipment, we consider is in any way hazardous until a clearance or safety certificate, in a form satisfactory to VACGEN, has been completed and returned by the customer.

REPAIR

The following additional terms and conditions apply in the event that the customer elects to use the services of VACGEN workshop on a chargeable basis.

1. At its own cost the customer shall dispatch the equipment to the workshop, carriage paid, suitably packaged, protected and insured, bearing, a Goods Return Number (GRN)and a completed Declaration of Contamination certificate obtained from VACGEN in advance of shipment.
2. During the period that the equipment is on VACGEN premises, VACGEN will insure the equipment against all risks.
3. Vacuum Generator will provide an acknowledgement of the receipt together with an estimate of the repair charges. Such estimates are carried out on a visual basis and are therefore intended as a guide only. Formal fixed price repair quotations are available and involve the disassembly of the equipment to determine the full extent of
the work necessary to restore the equipment to an acceptable standard. In the event that the customer chooses not to proceed with the repair VACGEN will make a charge to cover this examination effort.

Note:
The above are extracts from VACGEN Conditions of sale. Complete copies can be obtained from: VACGEN, Maunsell Road, Castleham Industrial Estate St. Leonards on Sea, East Sussex, TN38 9NN, United Kingdom.

sales@vacgen.com www.vacgen.com +44 (0) 1424 856 333

1.0 Introduction

The type ST22 sublimation pump cartridge replaces all previous VACGEN sublimation pump cartridges (type STI, ST2A and ST3), which are now obsolete. This design incorporates three 2.0mm diameter TiMo alloy hairpin style filaments. It is available with a standard insertion depth of 203mm (8"); non-standard depths from 120mm up to 400mm can be supplied to special order.

The cartridge is manufactured principally from high quality stainless steel with alumina insulated feedthroughs, mounted on an 70mm OD flange. The conductors have a generous cross section to carry the current required by the three 2.0mm diameter hairpin filaments, and terminate in replaceable alumina insulation bushes and filament clamps.

2.0 Specification for the ST22

Construction	Welded stainless steel, Alumina insulator, TiMo alloy filaments
Filaments	Three 2.0mm diameter TiMo Alloy wire hairpin
Operating Pressure	10^{-1} to 10^{-11} mbar
Operating Temperature	- 196 to 250^{o}C
Bakeout Temperature	350^{o}C maximum
Mounting Flange	70mm OD
Maximum Evaporation Rate	10mgm per minute
Usable Titanium	0.6gm maximum per filament
Maximum Current Setting	52 Amps (degas current)
Normal Initial Setting	48 Amps

3.0 Installation

The cartridge may be mounted at any attitude. However, when mounted horizontally or at an inclination it is necessary to ensure that the marking "TOP" on the flange is uppermost.

Care should be taken to ensure that the connections to the filament terminals, marked 1, 2 and 3, correspond to those on the filament selector switch of the controllers it is important that the filaments are used in the correct sequence normally 1, then 2 and then 3. The reason for this is to minimize the possibility of a short circuit occurring between filaments due to the fact that the filaments tend to sag slightly during operation. This makes it necessary to use the lowest filament first and the uppermost filament last (see figure 1).

Warning: The connections between the ST22 pump cartridge power lead should be regularly inspected. In particular, it is important to avoid loose or oxidized contacts to the pump feedthroughs, these can act as points of high resistance and cause the feedthroughs to overheat and the pump to perform poorly. In extreme cases this resistance heating of the feedthroughs can result in damage to the feedthrough, and vacuum failure.

4.0 Pumping with a TSP

sales@vacgen.com www.vacgen.com +44 (0) 1424 856 333

4.1 Pumping Speed

The pumping speed attainable is dependent on four factors, namely-.-

1 The rate at which titanium is being sublimated.
2 The area of the condensing surface.
3 The temperature of the condensing surface.
4 The conductance between the condensing surface and the source of the gas being pumped

At pressures above 10^{-6}mbar the pumping speed is almost entirely dependent on 1, since the titanium film becomes saturated almost as soon as it is formed. As the pressure is reduced the other factors become progressively become more important. Inert gases are not absorbed by titanium and must therefore be removed by other means. The pumping speeds attainable for various gases by a titanium film are listed in table 1 below.

Gas	Condenser	Temperature
	Room	Liquid Nitrogen
	293k (+20^{o}C)	77k (-196^{o}C)
H_2	3	10
H_20	3	14
CO	9	11
N_2	4	20
O_2	2	6
CO_2	8	9
CH_4	0	0
Inert	0	0

Table 1 - Pumping Speeds in ls^{-1} cm^{-2} of condensing surface for different gases of different temperatures

4.2 Degassing

Before Initial use it is desirable to degas, or condition all 3 filaments. This may be done in one or two stages, according to preference and to the nature of the pumping system. With an ion pumped system it may be desirable to initially outgas the filaments at or towards the end of, the rough pumping stage, to avoid trapping the initial outgassing load in the ion pump. At a later stage, the filaments should be outgassed again, into the ion pump (usually at the end of the bakeout cycle whilst the system is still hot). With a diffusion or turbomolecular pumped system the first stage degassing is normally omitted, since these pumps do not trap gases within the system.

sales@vacgen.com www.vacgen.com +44 (0) 1424 856 333

4.2.1 Degassing Procedure

1 Check that the filament current control is at the minimum setting.

2 Select filament number

3 Set the controller to manual mode, or set the timer to give a long on period (e.g. 5minutes),

4 Gradually increase the filament current to 52 amperes. At the same time ensure that the system pressure does not exceed:

10^{-1} mbar when degassing into the roughing pump, or around

10^{-4} mbar when degassing into a diffusion or turbomolecular-pumped system, or

10^{-5} mbar into an ion-pumped system.

When the pressures returns to, or close to, its original level, ("This may this may take a few minutes depending on the available pumping speed), reduce the filament current to a minimum, switch to Filament 2 and repeat step 4 above. Do the same for Filament 3.

On completion return the filament selector switch to position 1, this is the filament that will be used first.

It is important to do this to ensure that the filaments are used in the correct sequence.

4.2.2 Checking the 'on-time' Setting

Before using the sublimation pump in the cyclic or automatic mode, it is advisable to check the 'On-Time' timer setting on the controller (refer to the operating instructions for the controller). The recommended "On Time" is 1-2 minutes.

4.3 Normal Operation

Note: This section is intended for guidance only. Each vacuum system and pump installation will be different. The operator must determine the appropriate operating conditions for using the ST22 with their vacuum system.

1 Ensure that the surface onto which the titanium is to be sublimed is being cooled, by either air, water or liquid nitrogen. Pumping performance will be limited by outgassing if the surface onto which the titanium condenses is heated by the operation of the filament.

2 Check that filament 1 is selected.

3 For pressure greater than $1x10^{-6}$mbar the pump can be run continuously if required (see section 4.1 above).

Note: Care should be taken that the pump is not run continually for excessive periods of time. Continuous operating periods of greater than 3 minutes are not recommended. The need to continually run the pump may indicate a vacuum leak, particularly if the system pressure is seen to fall whilst operating the pump, and then to rise back to the previous level shortly ever the Pump filament is turned off.

4 Check that the current control is at its minimum setting.

5 Switch on the power to the filament and gradually raise the current to 48 amps maximum, for normal operation, or to 52 amps if the maximum possible titanium evaporation rate is required.

It will be noted that the current will initially fall back slowly due to the increase in the resistance of the heavy current cables and conductors caused by heating. During this time the current control may be progressively reset to return the current to the level required. However, no further adjustments should be attempted, especially if operating at the maximum level of 52A, once this adjustment has been made.

The current control should remain untouched for the life of the filament (unless venting the system requires that the ST22 filaments are degassed again - see section 4.2.1 above). This method of operation is convenient as it ensures a fairly uniform (although gradually reducing) rate of evaporation (known as constant voltage operation).

6 Once the system pressure falls below 10^{-6} mbar the controller should be switched to cyclic or automatic operation. The recommended ON time is 1 minute, and the OFF time is determined according to the pressure in the system. The recommended OFF times for an average UHV system are given below in table 2. These times may need to be varied to meet the requirements of a particular vacuum system.

Pressure /Mbar	Off Cycle time
10^{-7}	6 to 1 0 minutes
10^{-9}	60 to 90 minutes
10^{-11}	l0 to 20 hours
> 10^{-6}	On Continuously
10^{-8}	20 to 30 minutes
10^{-10}	5 to 10 hours

Table 2 - Suggested Off cycle times at different pressures

The above times may need to be varied to meet the requirements of a particular vacuum system.

When changing from continuous operation to cyclic, or automatic operation, it will be observed that as the heavy current conductors cool the current taken by the filament may rise momentarily beyond the required level on switch-on, and then fall back during the ON period, to the level selected during continuous running. Normally this is perfectly satisfactory and it should not be necessary to re-adjust the current level. The figures in the table above refer to a filament that is in a new condition, i.e one that has not been run continuously for more than 15-20 minutes.

The normal filament life, under constant voltage operation is from 8 to 12 hours, dependent on the current setting.

When the first filament is exhausted, it is usually possible to switch directly to filament number 2 without the need to adjust the current setting. However it is a good idea to slightly reduce the current setting prior to switching to the new filament and to finally adjust the current to the required level towards the end of the On period. Again, as mentioned previously, this applies only in the case of a filament in a new condition.

Note: It is important to use the filaments only in the recommended sequence i.e. 1, 2 then 3, especially if the cartridge is mounted horizontally. This minimises the chances of a short circuit between filaments due to the fact that the filaments tend to sag slightly during operation.

5.0 Maintenance

The only maintenance required apart from replacing the filaments, is the periodic removal of excess titanium from the filament clamps, conductor ends, insulating bushes and the insulator support plate. Reference to figure 1 will indicate the location of these parts.

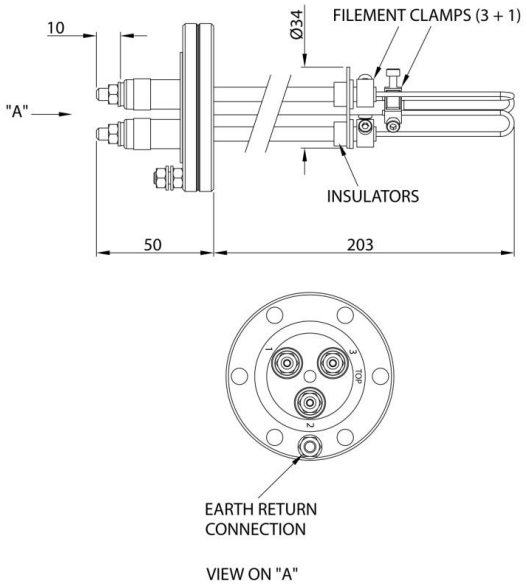

Figure 1 - Details of the construction of the ST22

Warning: The connections between the ST22 pump cartridge and the power load should be regularly inspected. In particular, it is important to avoid loose or oxidized contacts to the pump feedthroughs, these can act as a point of high resistance and cause the feedthroughs to overheat and the pump to perform poorly. In extreme cases this resistance heating of the feedthroughs can result in damage to the feedthrough and vacuum failure.

5.1 Replacing the Filaments

It is essential to apply 2 or 3 drops of a vacuum compatible solvent or degreasant (such as trichloroethylene, ethanol or acetone to the threads of each filament clamping screw (six in all), BEFORE any attempt is made to undo the screw. Failure to do this is likely to cause the seizure of the screw in the filament clamp. This will result in damage to the screw and the clamp, both of which will have to be replaced (see section 6). To aid the penetration of the "lubricant" it is a good idea to initially rotate the screw a small amount in both directions i.e. anticlockwise then clockwise, after which the screw can be easily removed, or partially removed. Unless the clamps are to be removed for cleaning (see section 5.2), it is only necessary to undo the screws sufficiently to enable the used filaments to be removed.

When replacing the filaments it is important that they are orientated only as shown in figure 2. Having inserted the filaments, position the triangular clamp approximately 1mm below the end of the central support rod. Set the ends of the filaments level with, or slightly projecting below, the underside of the triangular clamp. Evenly tighten the three screws in the triangular clamp, and then the screws in each of the three collars. The screws should be checked once again to ensure that they are all firmly tightened.

5.2 Removal of Excess Titanium

Periodically it is desirable to remove the titanium that has accumulated on the clamps, insulation bushes, conductor ends etc. This is usually done at the same time as filament replacement, however, It may not be necessary to clean off the titanium every time the filaments are replaced. Completely

remove the screws from the clamps, as described above, and remove the four clamps. It is suggested that a suitable (clean) wire brush be used to remove the titanium film from the ends of the four conductors and from the insulator support plate.

When this has been done, remove the 3 insulators and examine them. If they are very heavily coated with material that is not readily removed, they should be replaced. Details of standard replacement parts for the ST22 pump cartridge are given in section 6.

After cleaning, the metal parts should be wiped over with a lint-free cloth and suitable solvent, and left to dry. The components should be reassembled (see section 5); new filaments should always be used after any procedure which requires disassembling the pump cartridge.

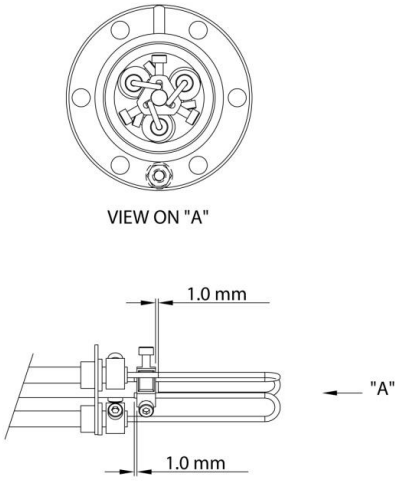

Figure 2 - Diagram showing the correct orientation of the filaments

6.0 Accessories

Order Code	Description
ZST22	ST22 Sublimation Pump Cartridge
ZST22F	Replacement Filaments for ST22
ZST22FC	Replacement Filament Clamps for ST22
ZST22IB	Replacement Insulator Bushes for ST22
ZST22CS	Replacement Screws for ST22 Filament Clamps
ZSPS8	Titanium Sublimation Pump Power Supply
ZSPS8LI	Non-bakeable Pump Lead, 4 Filament plus Earth, 5m

Note: Pump leads of non-standard length, and bakeable leads, are also available - contact VACGEN for further details

sales@vacgen.com www.vacgen.com +44 (0) 1424 856 333

sales@vacgen.com www.vacgen.com +44 (0) 1424 856 333

Service and Repair Form

Declaration of Contamination of Equipment and Components

Serving and repairs will only be carried out if the conditions for Servicing and Repair are complied with in full, according to the VACGEN Ltd. Conditions of Sale. A summary of these requirements are included on the inside front cover of the Operating Instructions. The manufacturer will refuse to accept any equipment without a signed declaration attached to the OUTSIDE of the packaging. This declaration can only be completed and signed by authorized and qualified staff.

1 Description of Equipment and Components

Equipment Type……Model Number……
Serial Number…… Your Reference Number……

2 Reasons for return……
……
……
……
……
……

3 Condition of Equipment

YES ( ) NO ( ) Toxic?
YES ( ) NO ( ) Explosive?
YES ( ) NO ( ) Radioactive?
YES ( ) NO ( ) Corrosive?
YES ( ) NO ( ) Biological Hazard?
YES ( ) NO ( ) Other Harmful Substances?

Equipment and Components that have been contaminated, WILL NOT be accepted without written evidence of decontamination.

5 Contamination Materials

List all the substances, gases and by-products that may have come in contact with the equipment, giving trade name, manufacture, chemicals names or symbols.
Please note that any of these listed, must be completely removed, so it is safe to handle and weld, without giving off health threatening gases. Please enter details below and/or attach data sheets
……
……
……

6 Legally Binding Declaration

I hereby declare that the information supplied on this form is complete and accurate.
There by stating that the goods offer no risk to health or safety
Organisation…… Name……
Country…… Job Title……
Post/ZIP code…… Telephone……
Email……
Signature…… Date……

Return goods to: Address at top
Phone: (0) 1424 851291 Fax (0) 1424 851489 (Form VGF33)