



SD-06 SPRAY DRYER

ASSEMBLY & OPERATING INSTRUCTIONS

- 1) **Introduction**
- 2) **Safety / COSHH**
- 3) **General Safety Rules**
- 4) **Components Included**
- 5) **Packing List**
- 6) **Connection to Electrical Supply**
- 7) **Assembly and Preparation**
- 8) **Controls**
- 9) **Jet Spray Assembly**
- 10) **Operation**
- 11) **General Advice and Useful Hints**
- 12) **Optional Accessories**
- 13) **Maintenance, Replacement and Spare Parts**

**Last Revision : Dec 2003
F:\SprayDrying\SD06 Manual revision 4**

1) **INTRODUCTION**

The Lab-Plant SD-06 Laboratory Scale Spray Dryer is the result of more than 30 years of continuous development.

The SD-06 has been designed primarily for simplicity and ease of use, rapid assembly and disassembly for cleaning, minimal maintenance, efficiency of operation and reproducibility of previous conditions.

2) SAFETY IN THE USE OF EQUIPMENT SUPPLIED BY LAB-PLANT UK LTD

Before proceeding to install, commission or operate the equipment supplied you should be aware of potential hazards so that they may be avoided.

Although designed for safe operation, any equipment may involve processes or procedures, which are potentially hazardous. The major potential hazards associated with this particular equipment are listed below.

- INJURY THROUGH MISUSE
- INJURY FROM ELECTRIC SHOCK
- RISK OF INFECTION THROUGH LACK OF CLEANLINESS

Accidents can be avoided provided that equipment is regularly maintained and operators are aware of potential hazards. A list of general safety rules is included in this manual. This list is intended to be for guidance only.

The COSHH Regulations (1988) - The Control of Substances Hazardous to Health

The COSHH regulations impose a duty on employers to protect employees and others from substances used at work which may be hazardous to health. The regulations require that you assess all operations which are liable to expose any person to hazardous solids, liquids, dusts, vapours, gases or micro-organisms. You are also required to introduce suitable procedures for handling these substances and to keep appropriate records.

The equipment supplied by Lab-Plant UK Ltd may involve the use of substances which can be hazardous (for example, cleaning fluids used for maintenance or chemicals used for particular applications) and it is essential that a person in authority is responsible for implementing COSHH regulations.

Part of these regulations is to ensure that the relevant Health and Safety Data Sheets are available for all hazardous substances used in the laboratory. Any person using a hazardous substance must be informed of the following:

- Physical Data about the substances
- Any hazard from fire or explosion
- Any hazard to health
- Appropriate First Aid treatment
- Any hazard from reaction with other substances
- How to clean/dispose of spillage
- Appropriate protective measures
- Appropriate storage and handling

Although these regulations may not be applicable in your country, it is strongly recommended that a similar approach is adopted for the protection of staff operating the equipment. Local regulations must also be considered.

3) GENERAL SAFETY RULES

- a) Before attempting to install, commission or operate equipment the manufacturers instructions should be understood and implemented.
- b) It is dangerous to misuse equipment or ignore instructions, regulations or warnings.
- c) Do not exceed specified maximum operating conditions (e.g. temperature, pressure, speed etc.).

INSTALLATION

- a) Use lifting tackle where possible to install heavy equipment.
- b) Care should be exercised to avoid damage to the equipment during handling and unpacking.
- c) Ensure that all services are compatible with the equipment and that independent isolators are always provided and labelled. Use reliable connections in all instances, do not improvise.
- d) Ensure that all equipment is earthed and connected to an electrical supply at the correct voltage. The electrical supply must incorporate an Earth Leakage Circuit Breaker (ELCB) or Residual Current Circuit Breaker (RCCB) to protect the operator from electric shock in the event of misuse or accident.
- e) Potential hazards should always be the first consideration when deciding on a suitable location for equipment. Leave sufficient space around equipment.

COMMISSIONING

- 1) Ensure that equipment is commissioned and checked by a competent member of staff.

4) COMPONENTS INCLUDED

The SD-06 is supplied complete and ready for operation without any extra equipment normally being required. Options are available such as alternative jet nozzle spray assembly sizes, exhaust wet scrubber, floor stand, protective screen, large main chamber, etc. The unit comprises:

<u>Main Unit.</u>	Including control panel, inlet air filter, top chamber, peristaltic pump, with motor and controller, outlets from compressors to jet de-blocker and jet nozzle, cyclone support arm and exhaust stack.
<u>Spray Assembly</u>	Main chamber, chamber/cyclone tube, collection bottle and bottom collection tube.
<u>Other Items</u>	All necessary silicone pump tubing, exhaust tubing, connectors, clamps and PTFE gaskets.

5) PACKING LIST

The apparatus should be carefully unpacked and the components checked against the Delivery Note.

Any omissions or breakages should be notified to Lab-Plant UK Ltd within three days of receipt.

<u>PART NUMBER</u>	<u>DESCRIPTION</u>	<u>QTY</u>
SD-06	Main SD-06 unit	1
SDS2018	Main Chamber	1
SDS2022	Cyclone	1
SDS2006	Sample Collection Bottle 500ml	1
SDS2010	Waste Collection Tube	1
SDS2011	SVL Screw Connectors	2
SDS2012	PTFE Gaskets	2
SDS0021	Clamp for Chamber/Cyclone/Tube	2
SDS2046	Jet Assembly with 0.5 mm jet	1
SDS2023	PTFE Transition Piece	1
SDS2031	Silicone Tube 4.8mm bore x 1.6mm wall	2.0 m
SDS2022	Exhaust Tube	1.7 m
	Nylon Tube 4mm \varnothing (fitted to unit)	1.0 m
	Nylon Tube 6mm \varnothing (fitted to unit)	1.0 m

The above comprises the unit SD-06. Any accessories or spares ordered will be additional to the above.

6) CONNECTION TO ELECTRICAL SUPPLY

The Lab-Plant SD-06 Spray Dryer is supplied for 220/240V, 50/60Hz operation.

A 110/120V primary 240V secondary step down transformer is supplied for 110V operation.

The power requirement for the 240V unit is 13 amp and for the 110V unit is 30 amps.

****IMPORTANT****

The mains cable is connected as follows:

Brown = Live
Blue = Neutral
Green/Yellow = Earth

The SD-06 must always be connected to suitable earthing.

7) **ASSEMBLY AND PREPARATION**

*FITTING SD-06 TO STAND**

If the SD-06 is to be fitted onto the optional stand it is better to do this before fitting any other items.

1. Lay the SD-06 face down on the floor with some protection to prevent damage to the front face of the top section.
2. Remove the three screw in feet from the base of the SD-06.
3. Position the stand next to the SD-06 base and using the three screws provided screw the stand firmly to the base of the SD-06. It is better to fit all three screws before tightening up with a suitable Allen Key (not provided).
4. Fit the three “screw in feet” into the stand, screw the feet fully in to give maximum stability.
5. Using two people stand the unit upright, adjust the feet if necessary to ensure vertical alignment.

* the stand is available as an optional accessory

FITTING GLASSWARE.

- a) The main chamber fits into the U shaped clamp on the left hand side of the unit, slacken the two black knobs and slide the main chamber in towards the central control panel. Lightly tighten the two black knobs, with the 90° outlet of the main chamber passing below the control panel.
- b) The cyclone fits directly into the exhaust stack to the right of the control panel. Loosen the knurled cap on the end of the exhaust stack. Enter the top of the cyclone into the cap, push the cyclone upwards. There will be some resistance as the glass tube slides up through a rubber seal.
Rotate the cyclone 90° to pass the inlet flange over the black nylon support arm. Move the cyclone down allowing the inlet flange to rest on the support arm.
- c) The white PTFE transition tube fits between the outlet flange of the main chamber and the inlet flange of the cyclone. Using the two clamps fasten the main chamber, transition tube and cyclone together, tighten clamps finger tight only.
- d) Finally position glassware and tighten knurled ring on the exhaust stack and the two black knobs holding the main chamber.

FITTING JET NOZZLE.

The jet nozzle assembly fits into the top of the unit and is fastened in by a threaded ring.

Align the liquid inlet and compressed air inlet as required.

Fit the white nylon tube into the push-fitting mid way down the jet assembly and the blue nylon tube into the push in fitting at the top of the assembly .

The silicone tube for the liquid sample is fitted to the grooved inlet. The remaining tube is fitted through the pump and the open end placed into the sample.

EXHAUST TUBING

Fit the 50 mm diameter flexible exhaust tube supplied over the exhaust outlet (P) and direct to atmosphere or existing extraction system.

THE SD-06 IS NOW READY FOR USE. SWITCH ON THE POWER AND PROCEED.

8) CONTROLS

The green indicator (E) on the lower left hand side of the control panel, when illuminated indicates that the SD-06 is connected to the electrical supply.

The on-off (I-0) switch (F) on the lower right hand side is used to turn the electrical power to the SD-06 on & off.

All other control settings and start/stop are effected by means of the microprocessor controller (O).

Study the two diagrams, screen functions & screen details carefully. Familiarise and practise moving from screen to screen and changing values (see next pages)

Notes.

- 1) You can only change values on the screen displayed
- 2) Values can be changed on the following screens :-
 - a) SET TEMPERATURE. (0-250)
next
 - b) SET FAN (0-50)
next
 - c) SET PUMP (0-50)
next
 - d) SET DEBLOCKER (Slow. Medium. Fast)
- 3) The above screens will only allow values within the above range.
- 4) Pressing ESC (escape) during data input will restore the original value.
- 5) Start & Pump buttons only operate on the Start – Up screen.
- 6) The start button is used in the set De-Blocker screen, to change the De-Blocker from Slow to Medium or Fast.
- 7) The next button is active on all screens and is used to select the next screen.
- 8) The Stop button is active in ALL screens and will immediately stop the pump and jet De-Blocker. After 20 seconds delay the fan and compressor will also stop.
- 9) When the SD-06 is stopped, using the Stop button, all settings are retained.
- 10) When the Start buttons on the Start Up screen is pressed the fan and compressor will start immediately. The heat does not switch on for 10 seconds.

Remote Control and Data Logging

The SD-06 unit can be remotely controlled by means of a computer and leads via a RS232/485 link (found on the reverse of the unit) allowing the process to be controlled and monitored (in real time) from a PC. During a monitored run the process conditions can be printed out to give a hard copy record. 2 versions of the software are available from Lab-Plant UK Ltd - the 'full' version for unlimited use and the 'limited' version which allows up to 20 x 1 hour sessions. A set of leads and a RS 232/485 converter is required, these can also be obtained from Lab-Plant UK Ltd.

9) JET SPRAY ASSEMBLY

The stainless steel spray assembly is a double fluid nozzle where the inner nozzle develops the liquid jet and the outer the compressed air jet. The compressed air atomises the liquid as it emerges from the jet to form the required fine spray.

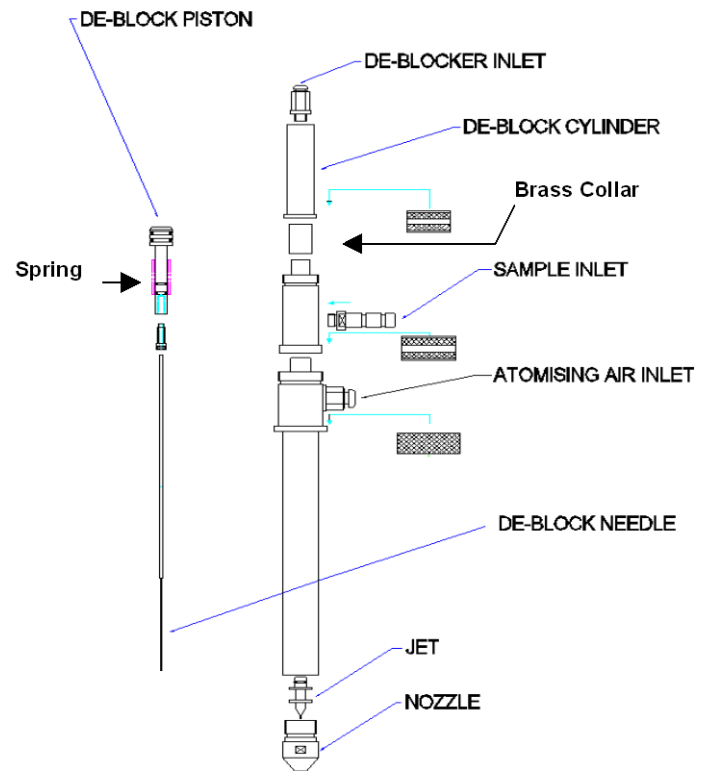
The jet and outer nozzle can be unscrewed from the main assembly for cleaning as required.

Always be careful not to damage the inner jet nozzle (which is only 0.5mm \varnothing thin wall stainless steel) as any slight misalignment will affect the efficiency of the spray.

The jet assembly is easy to disassemble by unscrewing the knurled rings.

Instructions for testing the jet spray assembly outside the main chamber

Before fitting the jet into the top chamber it is useful to operate it outside, with water, to see the actual spray formation. First connect the silicon tubing to the pump head by the following procedure.



De-blocker inlet (A)
Sample Inlet (B)
Atomising air inlet (C)

Open the hinged plastic cover of the pump and leaving sufficient tube to connect to the jet when it is in the top chamber, insert the tube rotate pump head by hand, until positioned under the pump rollers.

Open the white plastic clips which retain the tube in position, insert the tube fully and release the clips. The tube should now be regularly compressed by the pump rotors. Fit one end of the tube to the sample inlet (B).

Using the larger 6mm diameter white nylon tube emerging from the top left side of the unit connect the free end into the atomising air inlet (C) on the jet assembly. This is the main compressed air feed line to the jet nozzle.

Then connect the small diameter blue tube into the de-blocker inlet (A). This is the compressed air supply for the jet de-blocking system. There is no possibility of connecting these tubes incorrectly as the connectors are of different sizes. To release these tubes simply push in the black outer ring on the connector and pull the tube out.

Connect to mains electric and the green 'Mains' indicator (E) will illuminate. Switch on the 'ON' SWITCH (F) adjacent to the mains indicator lamp. Select start up screen, press green start button to start fan and compressor. Press next to go to temperature screen and using enter and arrow keys change set temperature to 10°C this will prevent the heater from coming on. Press next 4 times to return to the Start – Up screen in readiness to start the pump.

When the three tubes are connected to the jet assembly place the open end of the silicone tube into a beaker of clean water and switch on the pump. Increase the speed by increasing the value of "pump setting" and watch the water travel through the tube.

When the water reaches the jet assembly it will emerge from the jet nozzle in a fine spray mist.

Note: Switching on the pump also activates the jet de-blocking system. This can be set to slow, med or fast as required, using the SET DE-BLOCKER screen.

Set pump speed by increasing (or decreasing) value in the pump setting screen.

The information indicates pump speed on a nominal 50 scale. For appropriate flow rates in ml/hr please see the chart on Note II.

The compressed air pressure setting is factory set to a maximum pressure of 3 bar, however running pressure is a function of jet nozzle size and will only approach this value with the 0.5mm nozzle.

Note that the maximum air pressure available is considerably reduced when larger jet diameters are used so that, for example, if using the 1mm jet the maximum compressor pressure available may be as low as 0.6 bar. This is normally sufficient for the larger jets.

When you have become familiar with the operation of the jet system look closely at the jet nozzle to see the fine jet de-blocking needle in operation. The frequency of the de-blocking action is controlled by the 'De-blocker' screen. If de-blocking is not required simply remove the small diameter (4mm) nylon tube from the top of the jet assembly and from the outlet at the top left of the main unit. The internal de-blocker controls will continue to operate but will not affect the jet

Now place the jet assembly in the top chamber and secure with the knurled collar.

THE SD-06 UNIT IS READY FOR OPERATION.

10) OPERATION

Select the product you wish to spray dry but always start and end the process by using clean or distilled water.

Place the pump tube in the water.

Switch on the mains switch on the SD-06 and then switch on the fan, compressor and the heater using the appropriate screen and green 'START' button.

Note: The heater will not operate unless the blower is running. There is a delay on start up before the heater switches on.

Using the screen on FAN SETTINGS increase to maximum (50).

When the airflow is at maximum setting, use the SET TEMP screen to set the temperature required.

The actual inlet temperature and outlet temperature is displayed at all times on the set temp screen.

A fixed over temperature protection cut out is fitted and will actuate at approximately 300°C (if actuated allow to cool down and re-start), allow inlet temperature to stabilise before setting pump and deblocker and starting.

Using the 0.5mm jet maximum backpressure is approximately 2.8 bar and this reduces when larger diameter jets are used.

THEN SET THE PUMP TO A SLOW RATE E.G. 5 OR 10.

Allow a small amount of water to be pumped into the silicone tube to clean the tube and the jet and then transfer the tube to the sample. When the sample reaches the jet the Spray Drying Operation should commence and dried powder should be observed spiralling down the cyclone into the collection bottle.

Once spray drying has commenced varying the parameters of temperature, airflow and pump speed, may be tried to improve the process.

11) **GENERAL ADVICE AND USEFUL HINTS**

- 1) Always start a trial with a low to medium inlet temperature (150-180°C), maximum air-flow, and a slow pump rate. Observe the bottom of the main chamber for wetting and either reduce the pumping rate or increase the temperature if the product is not completely drying. The optimum pumping/temperature rates are achieved when no wet spotting of the product is observed (this assumes water as the solvent).
- 2) If the sample is a liquid with solids in suspension it may be necessary to keep it continually agitated with a magnetic or overhead stirrer. Heavy suspensions are best pumped from the sample container when it is positioned on the side shelf as this shelf, the pump and the jet are all at a similar height. If the sample is pumped from the bench top the product may separate as it is being pumped upwards in the silicone tube.
- 3) Most spray drying processes lose fines in the exhaust. The amount lost usually depends on air flow and particle weight. The air flow can be reduced using the screen controls. The particle size/weight can often be increased by using a larger jet size.
- 4) At the commencement of a run allow the main chamber a few minutes to heat up. The inlet temperature may show the required setting but the glassware and main chamber will be quite cool for a few minutes. (Wait until inlet temperature has stabilised).
- 5) If the sprayed sample is light coloured it may be more easily observed by placing a dark card behind the cyclone.
- 6) The ideal flow path through the cyclone should be a continuous spiral. If product accumulates on the cyclone wall try alterations to the air flow or the compressor jet pressure or the jet size.
- 7) Only change one parameter at a time e.g. temperature, air flow etc.
- 8) Some samples may require pre-heating before spraying.
- 9) In rare instances the use of a suitably supported separating/dropping funnel positioned as near as possible to the jet assembly has been found to be effective rather than using the pump. This gravity feed method is effective where e.g. abrasive ceramics may cause the pump tube to wear exceptionally quickly.
- 10) Peristaltic pumping always creates a pulsing liquid flow. If this is a problem the pulsing effect can be reduced by connecting a small glass expansion bulb in the tube between the pump and the jet.
- 11) Generally the most efficient drying is achieved using the highest temperatures compatible with the product but temperatures as low as ambient may be used with e.g. non aqueous solvents.

SD-06 Laboratory Scale Spray Dryer Pump Flow Rates with silicon tubing 4.8 mm id x 1.6 mm wall thickness.

Pump Speed	Liquid Flow Rate (+/- 10 %)
50 RPM	2115 ml/hour
45 RPM	1895 ml/hour
40 RPM	1665 ml/hour
35 RPM	1500 ml/hour
30 RPM	1305 ml/hour
25 RPM	1090 ml/hour
20 RPM	900 ml/hour
15 RPM	695 ml/hour
10 RPM	485 ml/hour
5 RPM	280 ml/hour

SD-06 Drying Air Speed

Controller Setting	Air Speed at Exhaust
10	2.7 m/s
20	3.0 m/s
30	3.5 m/s
40	3.9 m/s
50	4.3 m/s

Measured with digital anemometer at exhaust

12) OPTIONAL ACCESSORIES

- 1) 0.5mm jet is supplied as standard. 1.0mm and 2.0mm jets are optional.
- 2) Amber stained glassware is available for products which are light sensitive.
- 3) An exhaust air wet scrubber unit.
- 4) Magnetic stirrer hotplate MR 3001 for maintaining liquids in suspension and for heating. The optional side tray is designed to accept this stirrer.
- 5) Magnetic hotplate MR 3000 when heating is not required.
- 6) Integral floor stand to give optimum working height when standard bench space is not available.
- 7) Large main chamber - 800 mm long. Gives added spray drying efficiency but must be used with optional floor stand. Supplied with a connection tube between the cyclone and the stainless steel exhaust assembly.
- 8) Full operational software for remote operation and data logging.

13A) MAINTENANCE

Regular maintenance of any equipment ensures maximum trouble-free life.

Customers are recommended to carry out simple maintenance at regular intervals – the most basic of which is to keep the equipment clean! No matter how regularly your equipment is in use always find time to thoroughly clean it.

Periodically vacuuming of the rear air filter and replacement every 12 months will prolong performance.

Annual service and maintenance contracts are available in the UK

13B) REPLACEMENT CONTROLLER

Control modules for the SD-06 are designed to be exchanged, there are no serviceable parts.

Replacement boards will be despatched on receipt of returned faulty modules

SD-06 PLC	Main P.L.C. module with software.
SD-06 PSU	Power supply unit.
SD-06 HMI	H.M.I. screen with software.
SD-06 PM	Peristaltic pump motor board.
SD-06 A1-2	Analogue unit (state unit 1 or 2).
SD-06 SC	P.R.T. signal conditioning unit.

Please contact your supplier for spare parts pricing information.

13C) ACCESSORIES AND SPARE PARTS LIST

SD-06-001	Stainless steel base support unit for floor standing operation
SD-SOFT/LIMITED	Limited Version Software (20 x 1 hour sessions for one SD-06 unit)
SD-SOFT	Full Version Software (unlimited use for one SD-06 unit)
SD-SOFT-CC	RS485/232 Converter and Cable
SD1010	Transformer to convert operation to 100V, 50/60Hz
SD1004	0.5mm Stainless Steel Jet Nozzle Assembly (Inner Jet and Outer Nozzle)
SD1006	1.0mm Stainless Steel Jet Nozzle Assembly (Inner Jet and Outer Nozzle)
SD1008	2.0mm Stainless Steel Jet Nozzle Assembly (Inner Jet and Outer Nozzle)
SDS2032	Small Diameter Main Spray Chamber – 115mm OD x 460mm long
SDS2018	Standard Main Spray Chamber – 215mm OD x 500mm long
SDS2020	Large Main Spray Chamber – 215mm OD x 800mm long
SDS2024	Chimney Extension (required when using SDS2020)
SDS2022	Cyclone
SDS2023	PTFE Connection Tube
SDS-0021	Clamp for Chamber/Cyclone to PTFE Connection Tube
SDS2006	Sample Collection Bottle - 500ml
SDS2021	Sample Collection Bottle - 1000ml
SDS2010	Waste Collection Tube
SDS2011	SVL Double Screw Cap Adapter
SDS2012	PTFE Gasket Seal
SD-06-SPARESKIT	Recommended Spares Kit Comprises SDS2018, SDS2022, SDS2031, SDS2006, SDS2011, SDS2012 (x2), SDS2040, SDS2042, SDS2033
SDS2001	Exhaust Tube – 3.5 metre length
SDS2002	Exhaust Tube – 1.75 metre length
SDS2031	Peristaltic Pump Silicone Tube – 4.8mm ID x 1.6mm wall per metre
SDS2034	Peristaltic Pump Silicone Tube – 3.2mm ID x 1.6mm wall per metre
SDS2046	Jet Assembly Complete with any specified standard jet size required
SDS2040	Plunger De-blocking Needle Assembly for 0.5mm and 1.0mm Jets
SDS2041	Plunger De-blocking Needle Assembly for 2.0mm Jet
SDS2042	Needle
SDS2033	Pack of Assorted O Rings for Jet Assembly