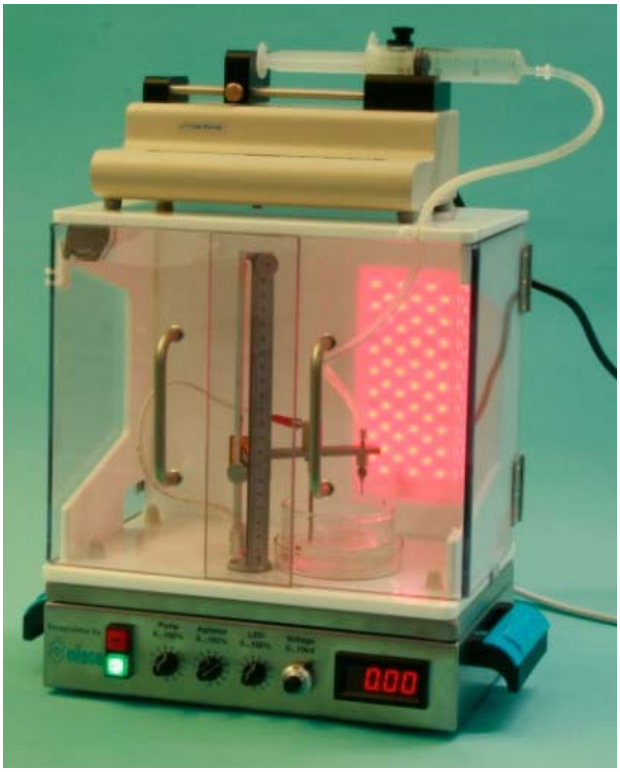
Technical Specification

OFF-LIN-1103 Rev.0

Encapsulation Unit Variation V1



Content

1. Introduction

The **VARV1 Unit** with its sophisticated multipurpose design and the flexible modular expandability has been tailored to the process developer's requirements. The modular approach in the design allows to change the unit repeatedly according to the changing requirements and to combine components delivered by us with equipment and devices already available in your laboratory. Thus, for example, you can use your own syringe pump. You can start with a minimal, unsterile system and procure the additional items later. This allows you to spend your equipment expenses according to your actual needs. While for the determination of the physical parameters of a given encapsulation process (e.g. flow rate, voltage and distance between the nozzle and the liquid level) or for non-sterile encapsulation processes, the open version might be suitable, for a sterile process (e.g. production of beads for clinical applications) the use of a closed unit might be indicated. An open unit ensures you fast access to the beads, minimising time required for the determination of the optimal process parameters. Of course we like to deliver you also a complete sterile unit from the beginning or a unit which can be run in an opened (non-sterile) or closed (sterility guaranteed) set-up. In this case, you take advantage for the better-packaged price in comparison with the price for the various modules.

The **VARV1 Units** are configured according to the customer's requirement and have to pass an extensive test program before being shipped. When the unit arrives at your place, you can – after unpacking and a short installation procedure (e.g. removing the transportation security devices, connecting the electrical power) – start working with the unit. Upon request, our engineer is ready to assist you during these first steps at your site and introduces at the same time your stuff into operation and maintenance of the unit.

Naturally, we assist you also after the successful start-up and commissioning in order to ensure a long-term operation. With the unit, we deliver drawings with the required spare parts and the order numbers. An extensive stock allows us to deliver most spares right away. An efficient network of our qualified suppliers ensures that we can also deliver those parts in a relative short period of time, which we do not have on stock.

As an engineering-oriented company, we would like to discuss your specific problems and wishes. It is our challenge to design and offer you solutions, tailored to your particular problem. Should you need support in maintaining the unit or other type of consultation, our qualified employees like to assist you also at your site.

Based on the long-term contact with the customers, who actually work with our units, we can gain precious information to improve and further develop our products. It will allow us to meet your future requirements.

The described **VARV1** system for producing microbeads works on the principle of „electrostatic technology“ (the electrostatic force pulls mono-sized drops from a needle tip into the hardening solution). All parts in contact with the product can be autoclaved. The list of used materials and the detailed customer documentation ease the validation of your processes.

The fundamentals on which the encapsulation unit is based shall now be shortly described.

2. Fundamentals and Principle of the Encapsulation Unit

The encapsulation unit is best suited for the generation of microbeads using matrices, where gelling is based on interfacial coacervation (e.g. alginate, carrageenan and the like). Which of these, or any other matrix might suit your specific needs, depends on what you want to encapsulate (e.g. proteins or bacteria), what properties the beads should have (physical strength, permeability, edibility, and so on) and which regulations and guidelines you have to follow (Hygienic Guidelines for Food, FDA, etc.).

The **VARV1 Unit** is designed for research uses production of smaller quantities spherical alginate beads ranging in size from around 200 to 1000µm.

The unit has a single static nozzle which is electrically connected to earth. A electrode tips into the hardening solution in a way that a electrostatic field between the nozzle tip and the hardening solution occurs. A pump (e.g. a syringe pump) produces a steady flow through the dripping nozzle. The electrostatic forces pull the drops from the nozzle into the hardening solution. The generated drops are quite slow, so it can be observed with our eyes. The bead sizes are somewhere between 200 to 2,400µm. The deviations between the applications depend on the density and the surface tension the matrix. Roughly, you can estimate that the smallest achievable drop diameter is 1.5 to 2 times larger than the used nozzle diameter. The average productivity per nozzle is 10 ml per hour, whereas this can significantly differ in function of the nozzle diameter and the flow rate, the voltage and the distance between the nozzle and the surface of the hardening solution. These factors determine the size of the bead you generate (within the physical limitations given by the properties of the liquid to be dropletised). Such a physical limitation is the pressure drop, which can unrealistically increase with a small nozzle diameter and high viscosity. As a conclusion, the size of the beads you want to generate greatly influences the productivity per nozzle.

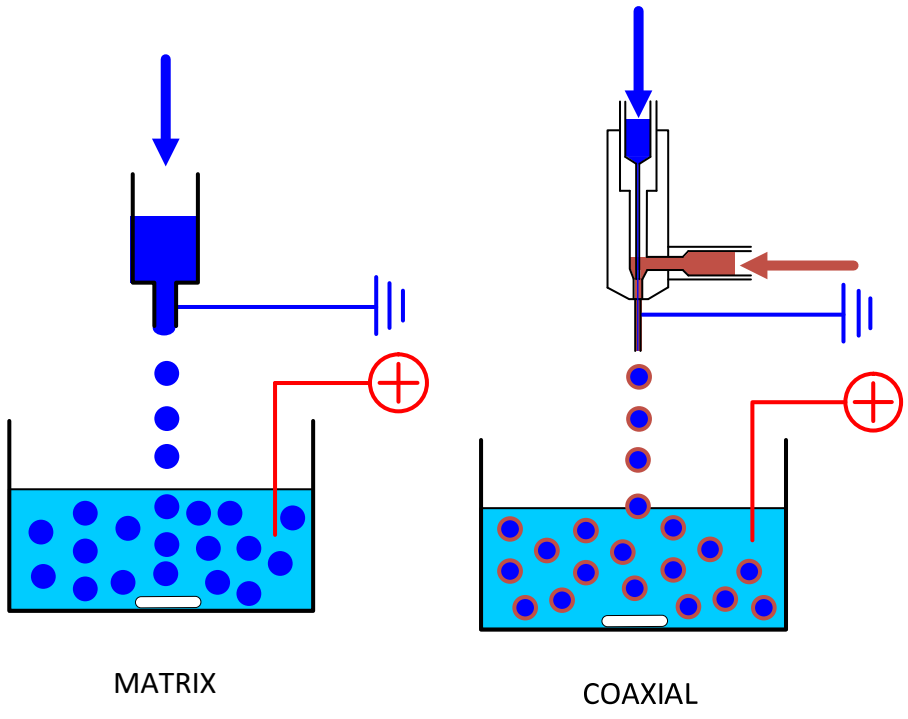
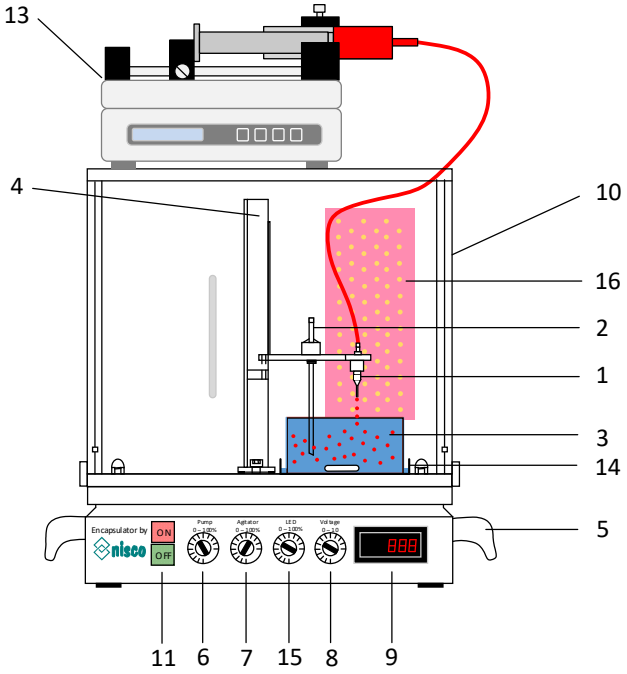


Fig. 2.1: Principle of the electrostatic bead generator

3. Layout of the Unit

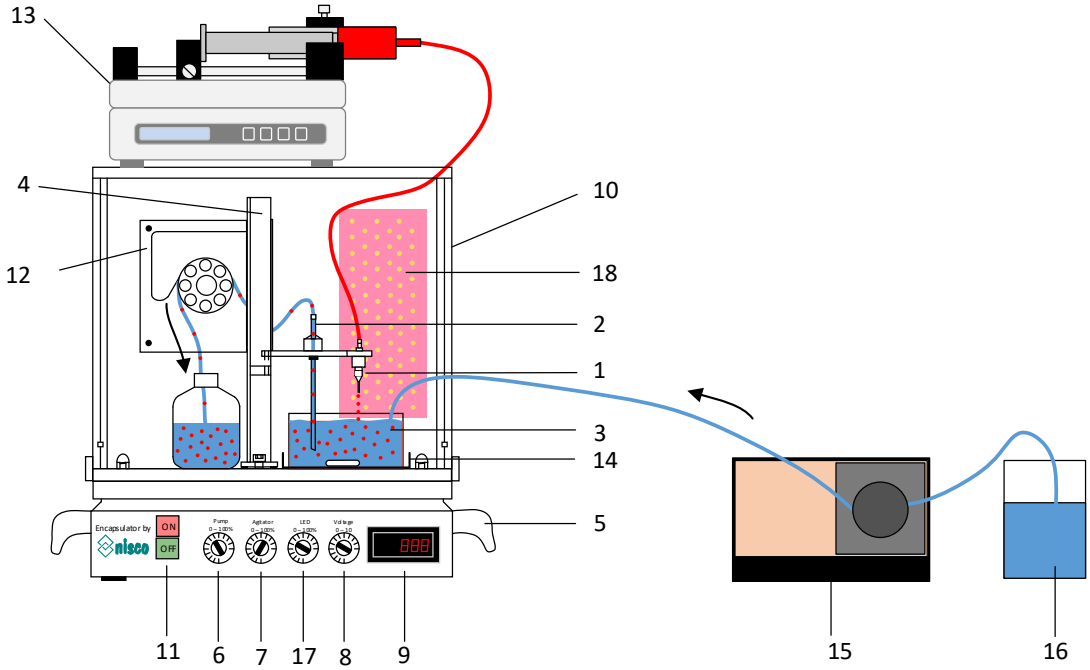
3.1 Unit with Syringe Pump - 60ml - Single Nozzle - without $CaCl_2$ Pump



Legend:

1.	Exchangeable nozzle
2.	Electrode
3.	Magnetic agitator with beaker
4.	Nozzle holder with autoclavable arm (height adjustable)
5.	Handle to carry the unit
6.	Potentiometer for optional peristaltic pump (adjustable 0..100%)
7.	Potentiometer for agitator speed (adjustable 0..100%)
8.	Potentiometer for voltage on electrode (adjustable 0..10kV)
9.	Indication of voltage
10.	Housing with doors and support for syringe pump
11.	High-voltage switch ON/OFF (red → ON, green → OFF)
12.	Not applicable
13.	Syringe pump (option)
14.	Petri dish
15.	Potentiometer for LED, adjustable 0..100%
16.	LED light

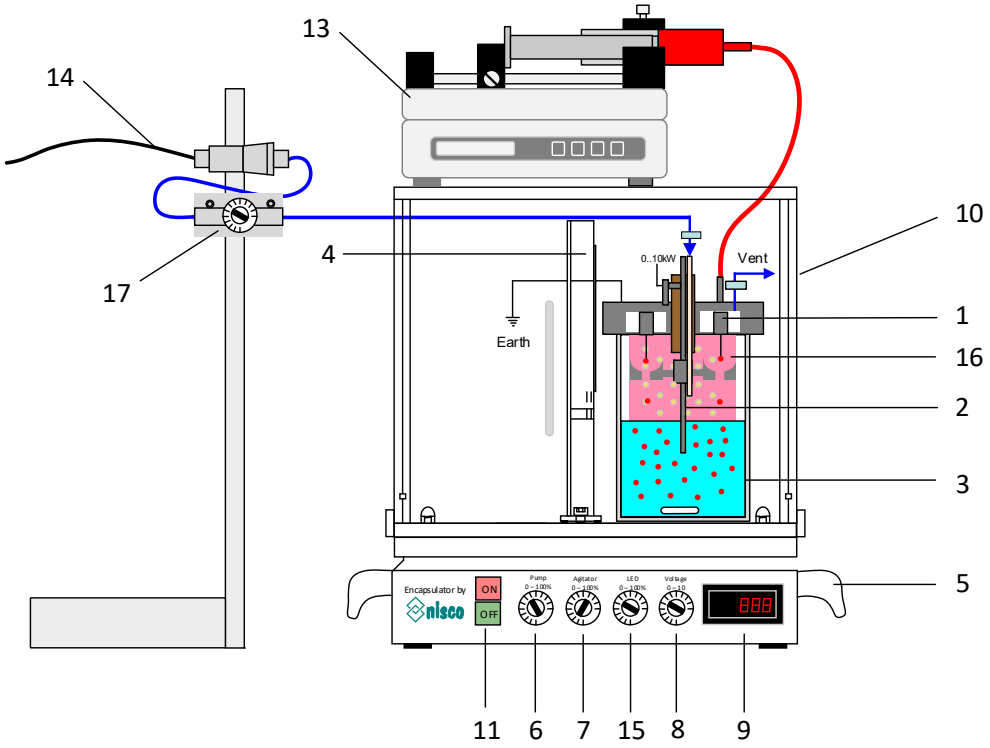
3.2 Unit with Syringe Pump - 60ml - Single Nozzle - with $CaCl_2$ Pump



Legend:

1.	Exchangeable nozzle
2.	Electrode / combined with dip tube
3.	Magnetic agitator with beaker
4.	Nozzle holder with autoclavable arm (height adjustable)
5.	Handle to carry the unit
6.	Potentiometer for optional peristaltic pump (adjustable 0..100%)
7.	Potentiometer for agitator speed (adjustable 0..100%)
8.	Potentiometer for voltage on electrode (adjustable 0..10kV)
9.	Indication of voltage
10.	Housing with doors and support for syringe pump
11.	High-voltage switch ON/OFF (red → ON, green → OFF)
12.	Peristaltic pump for removing hardening solution (not in Nisco's scope of supply)
13.	Syringe pump (option)
14.	Petri dish
15.	Peristaltic pump – customer side
16.	Fresh hardening solution
17.	Potentiometer for LED, adjustable 0..100%
18.	LED light

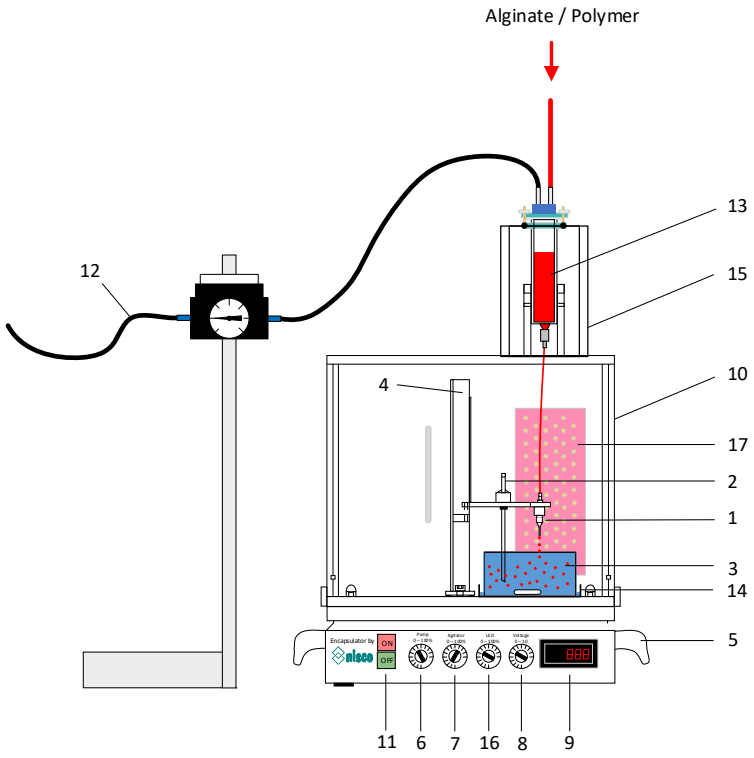
3.3 Unit with Syringe Pump - 60ml - Autoclavable Vessel (option)



Legend:

1.	Exchangeable nozzle (max. 3 nozzle)
2.	Electrode (optional combined with dip tube)
3.	Autoclavable vessel with magnetic agitator
4.	Holder for autoclavable arm (not used for the configuration)
5.	Handle to carry the unit
6.	Potentiometer for optional peristaltic pump (adjustable 0..100%)
7.	Potentiometer for agitator speed (adjustable 0..100%)
8.	Potentiometer for voltage on electrode (adjustable 0..10kV)
9.	Indication of voltage
10.	Housing with doors and support for syringe pump
11.	High-voltage switch ON/OFF (red → ON, green → OFF)
12.	Not applicable
13.	Syringe pump (option)
14.	Air Supply (max. 4 to 10barg)
15.	Potentiometer for LED, adjustable 0..100%
16.	LED light
17.	Pressure reducing unit with needle valve

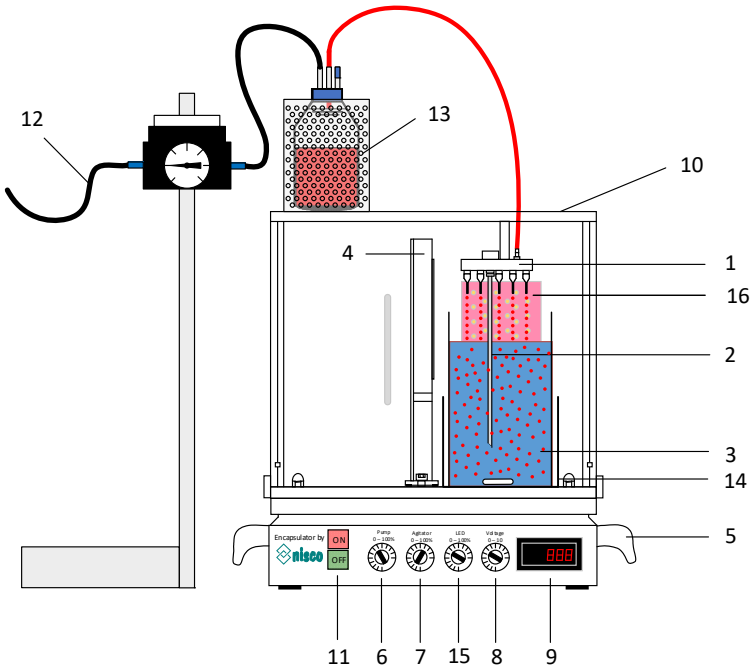
3.4 Unit with Pressurised Glass Syringe with Protection (option)



Legend:

1.	Exchangeable nozzle
2.	Electrode
3.	Magnetic agitator with beaker
4.	Nozzle holder with autoclavable arm (height adjustable)
5.	Handle to carry the unit
6.	Potentiometer for optional peristaltic pump (adjustable 0..100%)
7.	Potentiometer for agitator speed (adjustable 0..100%)
8.	Potentiometer for voltage on electrode (adjustable 0..10kV)
9.	Indication of voltage
10.	Housing with doors
11.	High-voltage switch ON/OFF (red → ON, green → OFF)
12.	Air supply to the glass syringe (max. 1.5bar)
13.	Glass syringe
14.	Petri dish
15.	Splinter shield
16.	Potentiometer for LED, adjustable 0..100%
17.	LED light

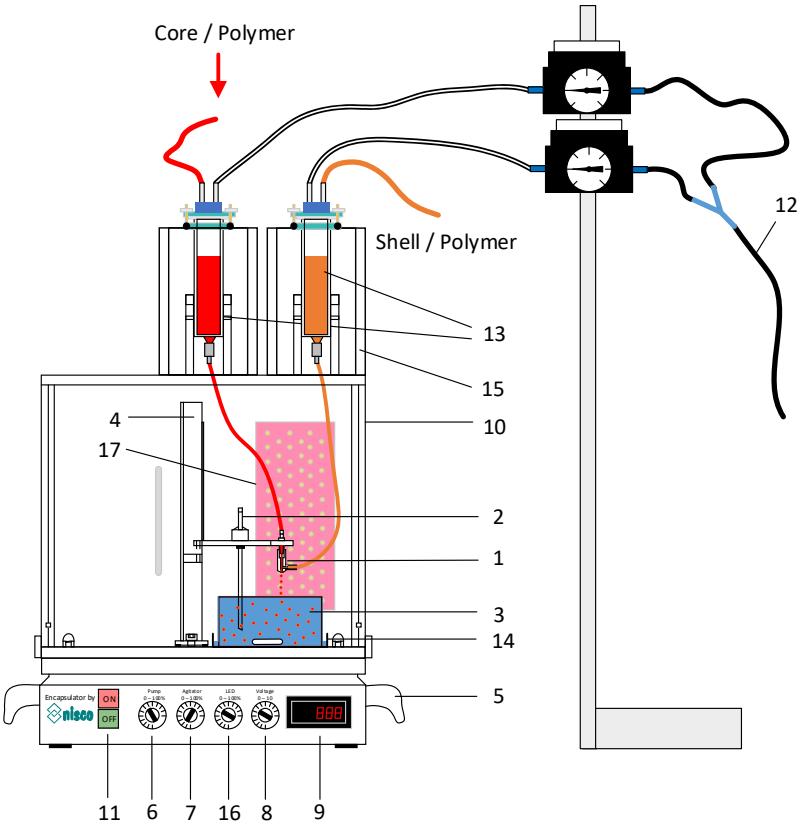
3.5 Unit with Pressurised Flask (with 10 nozzle head) (option)



Legend:

1.	Head with 10 nozzle
2.	Electrode
3.	Magnetic agitator with beaker
4.	Nozzle holder with autoclavable arm (height adjustable)
5.	Handle to carry the unit
6.	Potentiometer for optional peristaltic pump (adjustable 0..100%)
7.	Potentiometer for agitator speed (adjustable 0..100%)
8.	Potentiometer for voltage on electrode (adjustable 0..10kV)
9.	Indication of voltage
10.	Housing with doors
11.	High-voltage switch ON/OFF (red → ON, green → OFF)
12.	Air supply to the flask (max. 1.5barg)
13.	Addition system with pressurised flask (100ml or 250ml)
14.	Stainless container
15.	Potentiometer for LED, adjustable 0..100%
16.	LED light

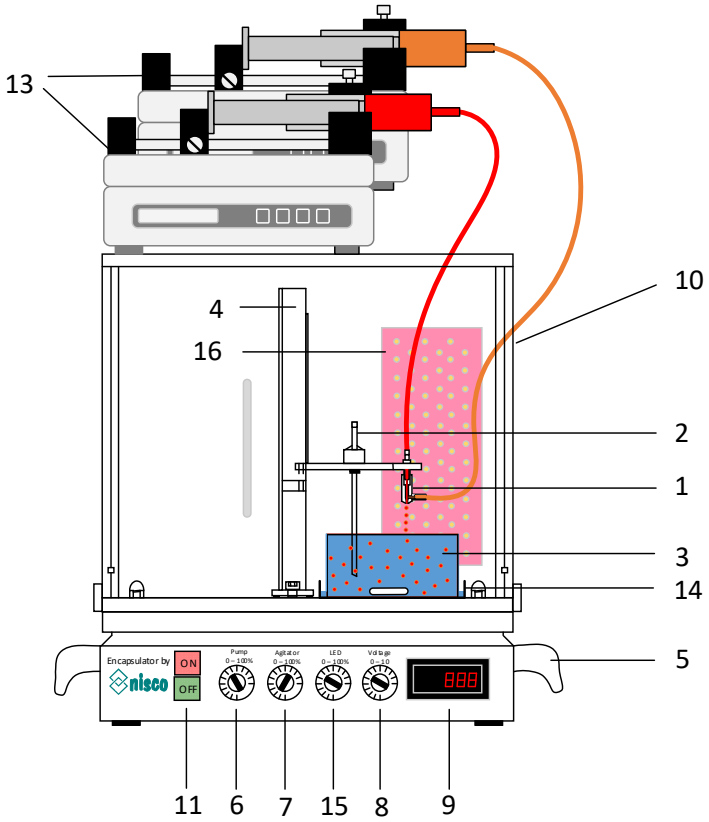
3.6 Unit with Two Pressurised Glass Syringes - Coaxial nozzle (option)



Legend:

1.	Exchangeable nozzle
2.	Electrode
3.	Magnetic agitator with beaker
4.	Nozzle holder with autoclavable arm (height adjustable)
5.	Handle to carry the unit
6.	Potentiometer for optional peristaltic pump (adjustable 0..100%)
7.	Potentiometer for agitator speed (adjustable 0..100%)
8.	Potentiometer for voltage on electrode (adjustable 0..10kV)
9.	Indication of voltage
10.	Housing with doors
11.	High-voltage switch ON/OFF (red → ON, green → OFF)
12.	Air supply to the glass syringes (max. 1.5bar)
13.	Addition system with two glass syringes
14.	Petri dish
15.	Splinter shield
16.	Potentiometer for LED, adjustable 0..100%
17.	LED light

3.7 Unit with Two Syringe Pumps - Coaxial nozzle (option)



Legend:

1.	Exchangeable nozzle
2.	Electrode
3.	Magnetic agitator with beaker
4.	Nozzle holder with autoclavable arm (height adjustable)
5.	Handle to carry the unit
6.	Potentiometer for optional peristaltic pump (adjustable 0..100%)
7.	Potentiometer for agitator speed (adjustable 0..100%)
8.	Potentiometer for voltage on electrode (adjustable 0..10kV)
9.	Indication of voltage
10.	Housing with doors
11.	High-voltage switch ON/OFF (red → ON, green → OFF)
12.	Not applicable
13.	Addition system with two syringe pumps (option)
14.	Petri dish
15.	Potentiometer for LED, adjustable 0..100%
16.	LED light

4 Mechanical Design of the Unit

4.1 Feeding System

4.1.1 Single-Syringe Infusion Pump

Part No. 74900-00

The Cole-Parmer Single-Syringe Infusion Pump is a simple, accurate cost effective syringe pump designed to hold glass or plastic syringes, of any make, from 10 microliter to 60 millilitre.

Setup and operation of this pump is extremely simple. A menu, displayed on an alphanumeric LCD "prompts" the operator to make the necessary selections using the keypad for choice of features and numerical entries.

Fig 4.1.1: Cole-Parmer Single-Syringe Infusion Pump

Suitable Applications

The pump is suitable for producing a steady flow with most fluids at ambient temperature. It is designed for a batch size up to 60 ml. The unit is suitable to run sterile batches, for example, for living cells, when using sterile syringes and tubing.

The pump is not recommended for fluids containing fast sedimentary particles.

***Advantage**:* The pump is designed for applications with low flow rate, has a robust construction and long period of use.

Nisco Applications

The pump is used for VARJ1, VARJ30 and VARV1 units.

Pump Specifications

Flow rate range:	0.1µl/hr (10µl syringe) to 426 ml/hr (60 ml syringe)
Syringe size:	10 microliter to 60 millilitre
Accuracy:	+/-0.5%
Linear force average:	9 kg (20lbs)

Voltage operating range:	US model 110-120V~, 50/60 Hz
	CE model 200-240V~, 50/60 Hz
Weight:	4.5 lb (2 Kg)
Dimensions:	9x6x5 inch (23x15.25x13 cm)

Environmental Conditions

Operating temperature range:	4°C to 40°C (40°F to 104°F)
Humidity:	20% - 80%RH, non-condensing

4.1.2 Pressurised Feeding System with Glass Syringe or Flask (option)

The pressure feeding system consists of the pressure reducing station and the glass syringe (60ml) or flask (100ml, 250ml)

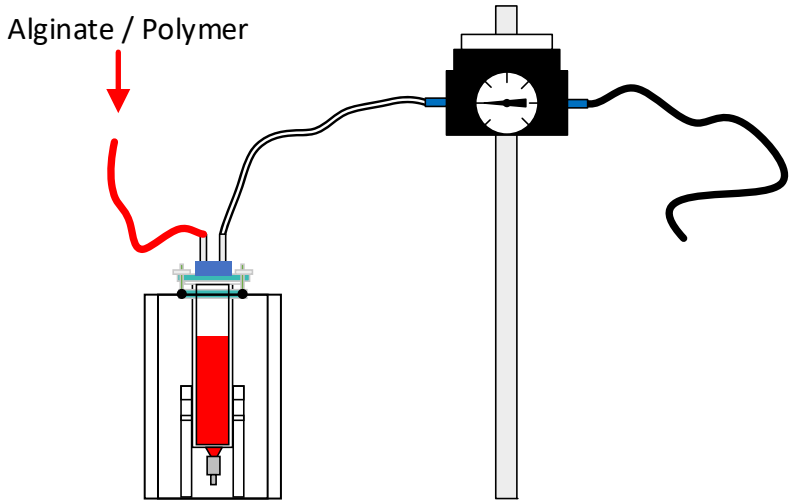


Fig 4.1.2.1: Pressurised glass syringe with protection

Pressure reducing station with manometer

In most laboratories, the gas supply is conducted through a central distribution system (line, taps) or through gas steel cylinders on a pressure level of 10barg or higher.

The supplied pressure reducing station with manometer is limited to 1.5barg for security reasons (glass syringe or flask).

The pressure reducing station consists of the following parts:

Pos.	Description	Note
1	Pressure reducing station with manometer	Part N° PE-01327
2	Connectors	Part N° PE 00758
3	Adaptation piece	Part N° D 01235
4	Laboratory support (Option)	
5	Holding clamp	Part N° PE-00253

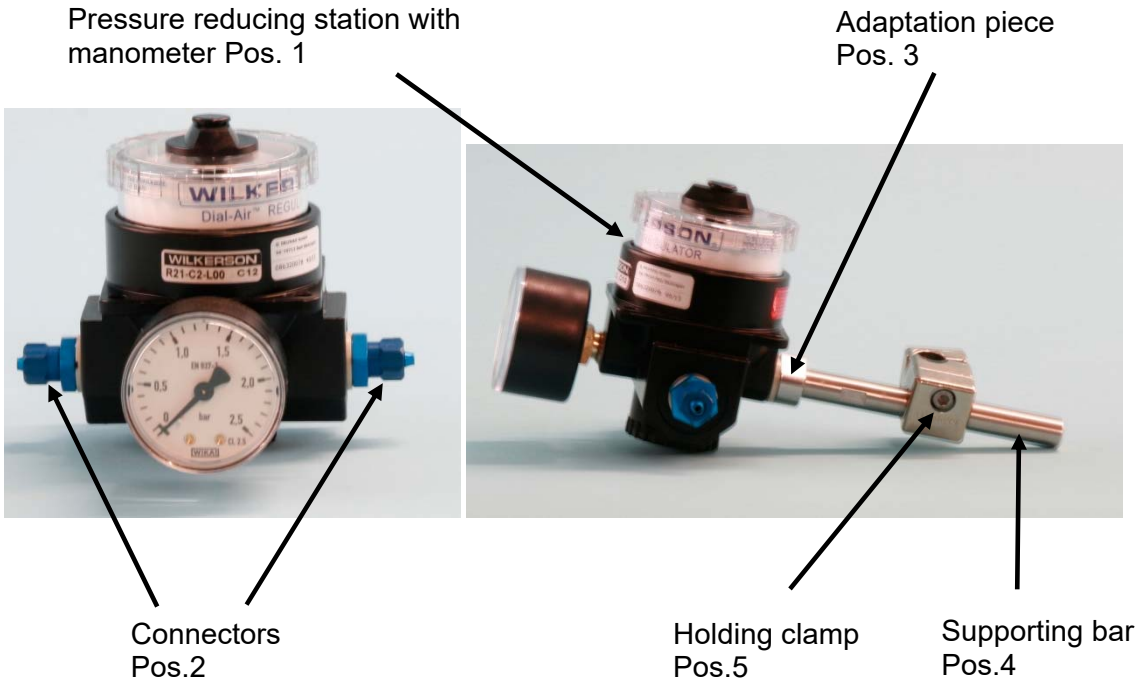


Fig 4.1.2.2: Pressure reducing station

Specification:

Flow capacity:	117SCFM (55dm³/s)
Adjusting range pressure:	0 to 40PSIG (0 to 2.8bar)
Maximum supply pressure:	300PSIG (20.7barg)
Operating temperature:	32° to 150°F (0° to 65.5°C)

Material of construction:

Body:	Zinc
Bonnet:	Zinc / Brass
Piston:	Acetal
Seals:	Nitrile
Springs:	Steel
Valve assembly:	Brass / Nitrile / Acetal

Glass syringe

Working pressure range:	-1 to 1.5barg
Max. working temperature:	125°C for sterilisation
Material:	Borosilicate glass 3.3

Flask (100ml)

Flask (100ml) with three nozzles on the head: one for the vent, one for the transfer with a dip tube and one for the filling.

Working pressure range:	-1 to 1.5barg
Max. working temperature:	140°C
Material:	Duran borosilicate glass 3.3

Certificate for the pressure resistance:

Acc. DIN ISO 1595, confirmed with GS-Sign (TUEV ID: 0000020716)

Flask connections:

Three female Luer-Lock connections (one for the filling, one for the transfer with a dip tube and one for the vent).

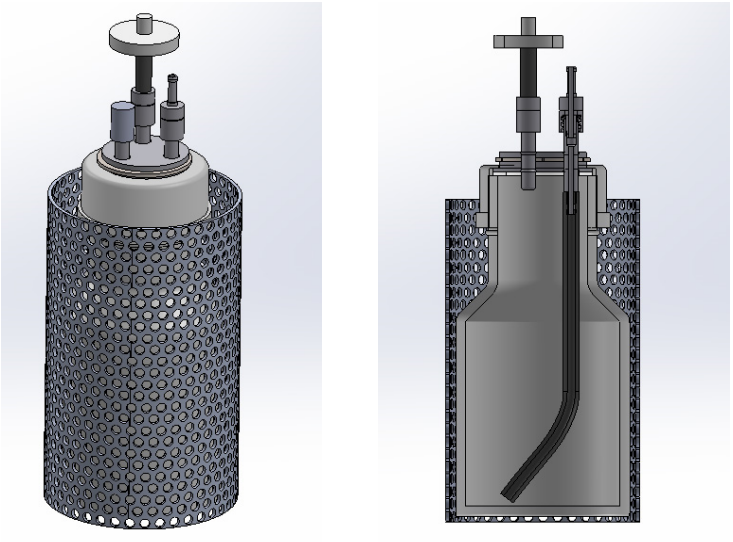


Fig. 4.1.2.3: Standard flask connections

Safety basket for the flask

When working with pressure a safety basket made of stainless steel 1.4301 is of advantage. If the glass has a crevice or if the pressure is too high (for example, it can happen, if it is connected to the wrong pressure or if the pressure reducing station is defective), the glass can burst.

In order to protect the operator and the other staff in the lab always put the flask into the basket when working under pressure.

Fig. 4.1.2.4: Safety basket

4.2 Design of the Unit

It is a table top unit standing on a stainless steel control cabinet with two handles which ease to carry the unit around. The four potentiometers for pump speed, agitation speed, LED light intensity and for the applied voltage are well accessible from the front of the unit. The indication of the voltage is always active when the unit is switched on. Besides of the actually reading the current voltage, you can also see whether the unit is switched ON or OFF.

On top of the control cabinet is a housing with transparent doors mounted. The doors are interlocked with the voltage. If the voltage is on, it will be automatically switched out when you open the doors and will not be reactivated before the doors are firmly closed again. The doors are fixed in the closed position by a special mechanical device, in order that the position is stable also when small vibrations occur. The side walls of the housing are cut in the middle of the housing to ease access with your hands. You can put your syringe pump on top of the housing in order to minimise the distance between the nozzle and the syringe.

On the bottom of the housing, the nozzle holder with the height adjustable arm is fixed. The arm can be fixed in any position by loosening the screw and by shifting it up or down before fixing it again. You do not need a tool. A scale helps you to adjust the arm on a reproducible height. On the arm there is the electrode and the nozzle holder with the hose fitting. The nozzles are exchangeable on the nozzle holder and fixed with a standard Luer-Lock connection. The arm with the electrode and the nozzle holder including the attached nozzle are removable for autoclaving if you work with living cells.

On the bottom you have a mark where the in-built agitator is positioned. It is the point where you have to position your small glass container for the hardening solution. The electrode has to dip into the liquid. On the side of the electrode there is a hole. Thus you can use it as a dip tube to remove hardening solution during your batch. For this purpose the optional peristaltic pump is available. For safety reasons it is positioned within the housing. The connection to the control cabinet on the back of the unit as well as the blind plate on the back wall is scope of supply. You can buy the pump at any time. You just have to fix it instead of the blind plate and connect it with its cable to the foreseen plug of the control cabinet. The high voltage is superimposed on the electrode by connecting the foreseen high voltage cable to electrode.

The arm and with it the nozzle are connected to earth.

The unit is made of the following materials:

Control cabinet:	1.4435 or equivalent
Nozzle holder and electrode:	1.4301 (1.4404 on request)
Support for the nozzle:	1.4301
Other plastic parts:	Polyamide 6.6
Housing:	Acrylic glass (white) / PET glass (transparent doors)
Flat gaskets:	EPDM or Silicone depending on the application
Hoses:	Silicone

For maintenance purpose, the control cabinet is accessible by removing the upper part of the unit (the plastic housing). The housing is fixed with two screws. Remove the four female connections and then you can open the control cabinet.

4.2.1 Unit with Syringe Pump (up to 60 ml - Cole-Parmer KSD100)

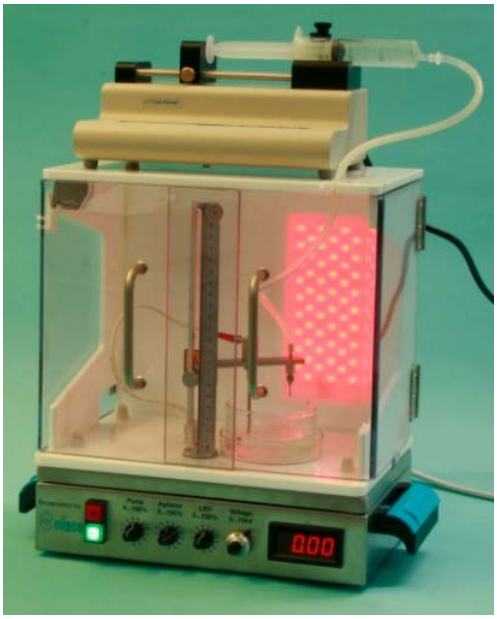


Fig 4.2.1.1: Front view of the VARV1 unit

4.2.2 Control Cabinet

Fig. 4.2.2.1: Front view of the VARV1 control cabinet

Fig. 4.2.2.2: Back view of the VARV1 control cabinet

Technical Data

Power supply:

110 to 240 Volt, 50 to 60 Hz, automatically adjusting by a standard PC cable.

Output voltage:

0 - 10kV

Technical data of agitator:

12V DC with control electronics nominal electrical power 7W.

Technical data of LED light:

LED Power supply in control cabinet.

Illumination density can be adjusted with the potentiometer 0..100%

In the housing above the control cabinet the LED stripes 21VDC are mounted in parallel rows.
Between the LED stripes and the user there is a special transparent plate for better visibility of the process.

4.3 Options

4.3.1 Additional Arm

A-00831 (A 00380)

An additional arm allows the user to continue his work during the time the other nozzle is in the process of being cleaned or autoclaved (sterilised).

For those customers who work without exchanging calcium solution, we use electrodes without holes as standard; they are easier to clean.

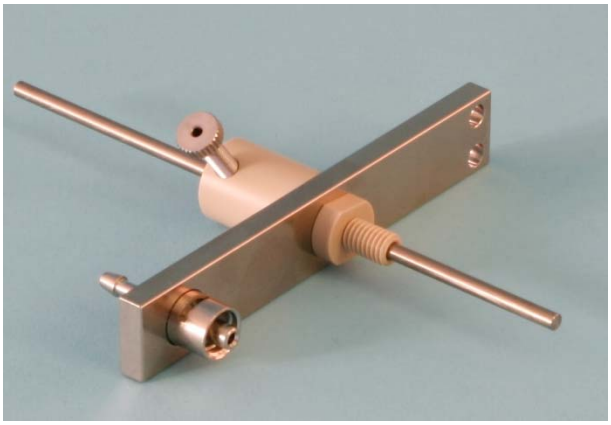


Fig. 4.3.1.1: Additional arm with standard electrode

The original electrodes with holes, dip tubes for exchanging the hardening solution, are still available as an option (see next picture).

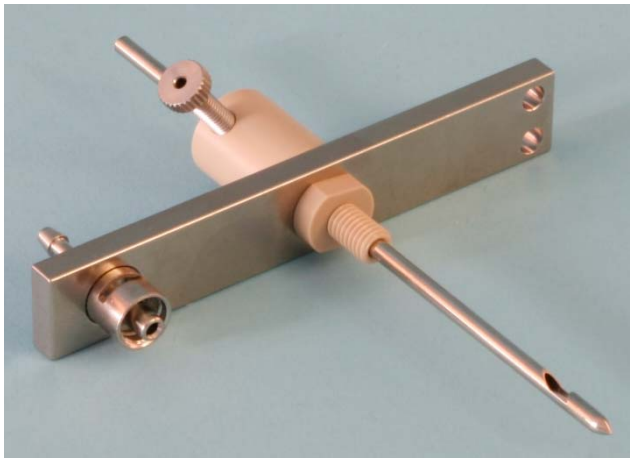


Fig. 4.3.1.2: Additional arm with electrode as dip tube

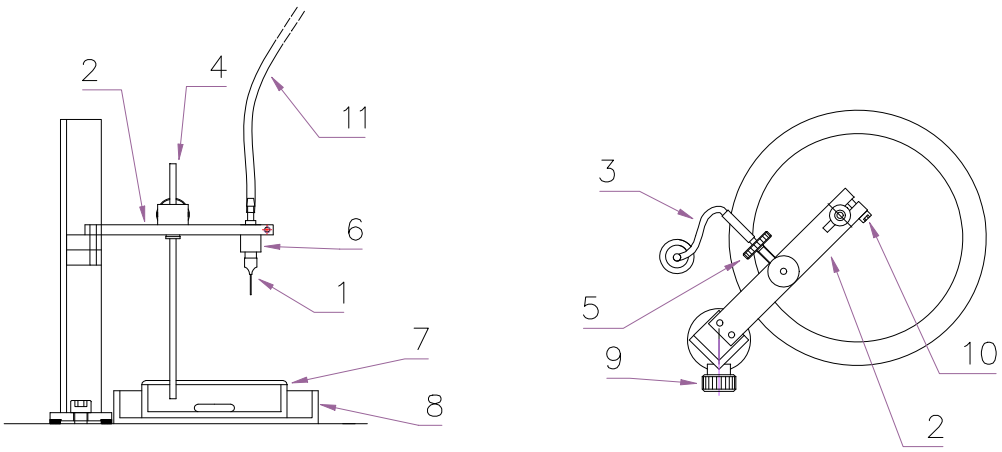


Fig. 4.3.1.3: Schematic drawing of additional arm

Legend:

1.	Nozzle
2.	Arm
3.	Electrode cable
4.	Electrode
5.	Knurled screw
6.	Nozzle holder
7.	Basin – diameter 80mm
8.	Basin – diameter 100mm
9.	Knurled screw
10.	Screw
11.	Hose

4.3.2 Electrostatic Accelerator

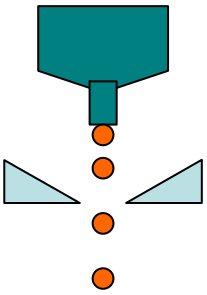
The new method is based on the use of the electrode, especially on its form.

The ring electrode is installed between the nozzles and the hardening solution. The beads fall through the centre of the electrode.

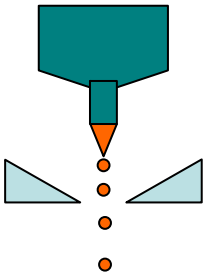
The following factors influence the bead size:

- Size of needle;
- Distance between the needle and electrode; and
- Voltage rate

Two Different Types of Drop Generating



Low electrostatic field
with standard nozzle holder



High electrostatic field
with conical jetting electrostatic accelerator resulting in small beads

Advantage of electrostatic generator compared to the standard nozzle holder:

1. The bead size is independent from the level of the hardening solution.
2. With conical jetting the bead become essentially smaller than with conventional technology.

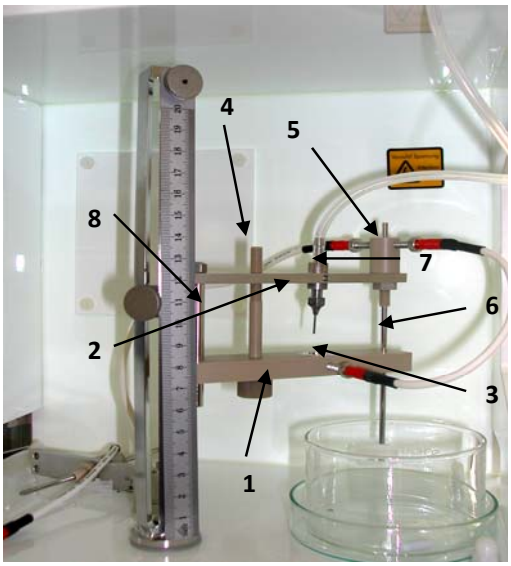


Fig. 4.3.2.1: Encapsulation unit with Nisco's electrostatic accelerator

Legend and Material:

1.	Lower holder (PEEK)	5.	Isolator (PEEK)
2.	Upper holder (1.4301, stainless steel)	6.	Electrode bar (1.4435)
3.	Orifice scoped electrode (1.4435) (concave focus orifice)	7.	Adapter (stainless steel)
4.	Height adjustment screw	8.	Guiding bar (1.4301, stainless steel)

Note:

- Cables must be removed before autoclaving the device.
- Both types of drop generation can also be used in combination with coaxial nozzles available from Nisco.

Fig. 4.3.2.2: Encapsulation unit with LED light and electrostatic accelerator

4.3.3 Head with 10 Nozzles

10 nozzles can be mounted on the autoclavable head to increase productivity of the unit. The head is mounted on a support.

Fig. 4.3.3.1: Encapsulation unit VARV1 with 10 nozzles head

All materials can be supplied with material certificates:

Stainless steel parts:	1.4435 or equivalent
Electrode:	Titanium
Isolation parts:	PEEK
Nozzles:	1.4435 or equivalent
Gaskets:	EPDM or silicone depending on application
Glass cylinder:	Borosilicate
O-Rings:	EPDM or silicone depending on application
Hoses:	Silicone or polypropylene

4.3.4 Sterile Autoclavable Container

Sterile container is designed for encapsulation with max. three nozzles at the same time. It is the ideal tool if you have to produce beads on high level pharmaceutical or medical standard. It is delivered with the required material certificates to ease the validation of your process.

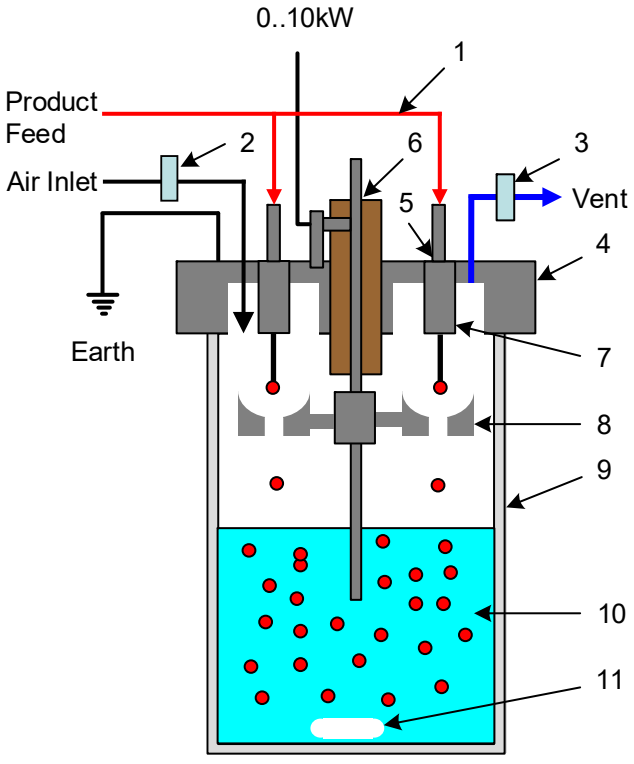


Fig. 4.3.4.1: Sterile autoclavable container

Legend:

1.	Product feed to max. 3 nozzles two blinds are supplied if you want to work with one nozzle only.	7.	Nozzle standard or special nozzles as per Nisco's Standard
2.	Air inlet to decrease humidity (to prevent short circuit) with 0.2µm filter	8.	Electrode to compensate the increasing surface of the hardening solution
3.	Vent to decrease humidity (to prevent short circuit) with 0.2µm filter	9.	Autoclavable Glass vessel (process is visible from outside)
4.	Clamp cover on earth	10.	Hardening solution with the beads
5.	Hose connection for nozzle	11.	Agitation element for stirring
6.	Electrode on high voltage with isolation		

Aeration:

When you are producing drops in a closed container with a watery solution, the humidity within the container is gradually increased, which after a while will lead to sparkling and short circuit. To overcome the problem we recommend supplying the container with dry air. The air inlet and the air outlet filter can be equipped with a standard autoclavable sterile filter 0.2µm. Two sample filters are scope of supply.

Process Information:

The Nisco electrostatic accelerator allows the size of the beads to be independent from the level of the hardening solution. (The hardening solution level will gradually rise by adding polymer drops).

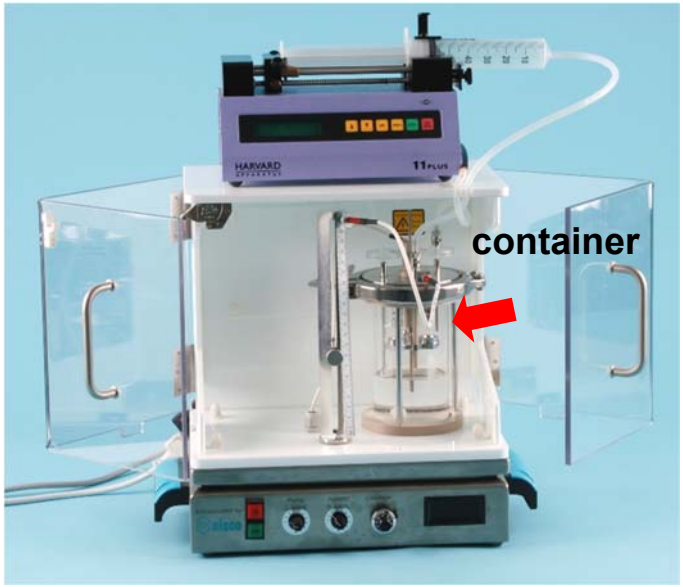


Fig. 4.3.4.2: Encapsulation unit VARV1 with sterile autoclavable container

Materials in contact with product

All materials are supplied with material certificates:

Stainless steel parts:	1.4435 or equivalent
Electrode:	Titanium
Isolation parts:	PEEK
Nozzles:	1.4435 or equivalent
Gaskets:	EPDM or silicone depending on application
Glass cylinder:	Borosilicate
O-Rings:	EPDM or silicone depending on application
Hoses:	Silicone or polypropylene

Materials without contact to product

Stainless steel parts: 1.4301 or equivalent

4.3.5 Peristaltic Pump to Exchange Hardening Solution with the Beads

A-00202

Our encapsulation unit VARV1 can optionally be delivered with this specially developed peristaltic pump, which fits onto the inner back-wall of the housing. You can connect the plug onto the designated connection at the control cabinet. The speed is adjustable with the potentiometer for the peristaltic pump.

The pump can be ordered together with a new unit, or it can be ordered and mounted at a later stage, as and when required.

Technical data:

Power:	7W
Motor voltage:	24V DC
Gear box:	1:100
Speed controller:	Built-in in control cabinet
Designed pumping rate:	max. 19ml/min
Max. counter pressure:	1.5bar
Silicone hoses:	ID 0.19 … 2.79

Fig. 4.3.5.1: Encapsulation VARV1 with peristaltic pump to exchange hardening solution

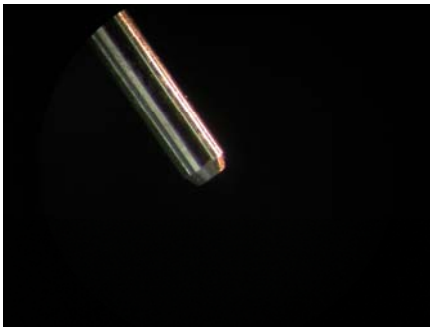
4.4 Nozzles

4.4.1 Nozzles with Flat Cut Nozzle Tip (body chromium plated)

OD [mm]	ID [mm]
0.20	0.09
0.25	0.12
0.35	0.17
0.50	0.25
0.70	0.40
0.80	0.50
0.90	0.60
1.10	0.70
1.20	0.80
1.30	0.90
1.50	1.00
1.60	1.10
1.70	1.20
1.80	1.30
2.00	1.50
2.40	1.80
2.60	2.00

4.4.2 Nozzles with Conical Polished Nozzle Tip

OD [mm]	ID [mm]
0.20	0.09
0.25	0.12
0.35	0.17
0.50	0.25
0.50	0.30
0.70	0.40
0.80	0.50
0.90	0.60
1.10	0.70



Advantages of the conical nozzle tip: :

- smaller drops with given diameter
- better bead quality
- less “small side beads”

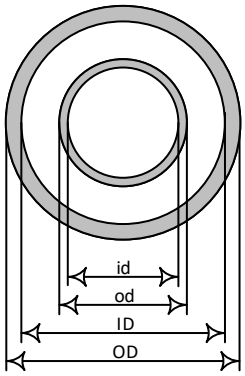
Material quality (for both types of nozzle tips):

Body: brass chromium plated / Tube: stainless steel 1.4301

Option:

Body: stainless steel 1.4435 / Tube: stainless steel 1.4301

4.4.3 Coaxial nozzles (size is given in mm)



Coaxial tube for two types of medium

Inner nozzle	Outer nozzle	Size of Coaxial Channel
od/id [mm]	OD/ID [mm]	s = (ID-od) / 2 [mm]
0.2 / 0.09	0.6 / 0.4	0.1
0.25 / 0.11	0.7 / 0.45	0.1
0.3 / 0.15	0.8 / 0.50	0.1
0.4 / 0.2	0.9 / 0.6	0.1
0.5 / 0.25	1.0 / 0.75	0.125
0.6 / 0.35	1.1 / 0.8	0.1

Material quality:

Body: stainless steel 1.4435 / Tubes: stainless steel 1.4301

5 Operating Manual

2 pieces of operating manuals in English with and pdf on data stick are included in the scope of supply.

6 Set of Small Items

Depending on the scope of supply small components and consumables are delivered, so that the customer can start to work immediately!

7 Set of Spare Parts

One set of fuses.

Normally there is no need for spares during the first year of operation.

The consumables like hoses and nozzles are NOT INCLUDED!

8 Appendix

Conversion Table (mm / Gauge)

Gauge	Ø mm
6G	5.0000
7G	4.5000
8G	4.0000
10G	3.5000
11G	3.0000
12G	2.8000
13G	2.4000
14G	2.00/2.10
15G	1.8000
16G	1.6000
17G	1.40/1.50
18G	1.20/1.30
19G	1.00/1.10
20G	0.9000
21G	0.8000
22G	0.7000
23G	0.6000
24G	0.5500
25G	0.5000
26G	0.4500
27G	0.4000
28G	0.3500
30G	0.3150
31G	0.2946
32G	0.2743
33G	0.2540
34G	0.2337
35G	0.2134
36G	0.1930
37G	0.1727
38G	0.1524
39G	0.1321
40G	0.1219
41G	0.1118
42G	0.1016
43G	0.0914
44G	0.0813
45G	0.0711
46G	0.0610
47G	0.0508
48G	0.0406
49G	0.0305
50G	0.0254