

Minifor

Laboratory fermentor

LAMBDA 



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Description of the MINIFOR fermentor

The Minifor was developed as a result of the need to construct a small laboratory fermentor for volumes from 0.1 to 1l. Based on long personal practical experience of fermentations we wanted to create a fermentor, which was easy to use and with the capacity to measure and control all the important parameters of the biological culture. The fermentor had to take up minimum space on the bench but with good access to all parts. Several fermentors should when placed side by side be suitable for the optimisation of the parameters of growth of culture or optimisation of biotransformations etc. Each fermentor should be able to work independently or be connected to a PC for advanced regulation and extensive data treatment.

To keep the cost of the MINIFOR fermentor low without compromising quality several new ideas and innovations have been introduced:

- Instead of a fermentor flask with a stainless steel cover, which is expensive, we use whole glass vessels with threaded fittings. They have been used for many years in cell culture and are proved to maintain perfect sterility.
- Instead of a traditional propeller agitator, which requires an expensive motor and magnetic coupling, we have introduced a new vibration mixer. An electromagnet and an inexpensive membrane which can perfectly assure sterility and produce an efficient mixing without formation of a vortex (no baffles are needed). At the same time this type of mixing is more gentle on cells and produces less foam.
- The culture is heated by heat radiation produced in a parabolic radiator with a gold reflector placed under the fermentation vessel. The heat is adsorbed gently in the culture in a similar way to the sun heating water. There is no overheating of the culture, as is usually the case when a heater is placed in the medium and expensive double wall vessels with thermostatic baths are eliminated. At the same time pipes and cables disappear making the fermentor less complex.
- As far as possible expensive pieces of equipment have been replaced by new high performance plastics.
- By using modern microprocessors it has been possible to position all the electronics in the front part of the instrument this makes the fermentor unbelievably compact and eliminates the casing tower usual in other products. Despite its small size six parameters are measured and controlled in the basic configuration of the Minifor.

Technical description:

Basic unit:

The main feature of the Minifor is that all the electronics, power supply, IR heater, air valve, mass flow meter, cables and tubing are positioned in one base unit, which is used as a support for a fermentation vessel and all other necessary equipment. The platform arrangement of the base unit makes all parts of the fermentor clearly visible and easily accessible from all sides despite base dimensions of only 22x40cm (approx. an A4 sheet of paper).

Up to five 250 ml reagent bottles in magnetic holders can be placed behind the fermentor vessel and up to 4 pumps can be placed on adjustable holders mounted on bars at the rear part of the base unit. The sockets are located on the rear side of the base unit thus removing cables from the work area.

Measurement and regulation:

The control panel consists of an LDC display and control buttons. All parameters (temperature, pH, pO₂, air flow rate, agitation and one free selectable parameter (for ex. pCO₂, optical density, antifoam etc.) are visible at a glance on a large LDC back light display (4 x 40 digits). The controls are simple and logical. On most parameters the limits of low or/and high alarm can be set. After alarm activation an acoustic signal is heard, an indication appears on the display and an electric signal appears on the rear side connector of the fermentor. Each fermentor can be operated in an autonomous way or can be coupled to a PC (over RS 485) using a special fermentation program (SIAM). This allows almost unlimited possibilities for control and data treatment (up to 12 fermentors in parallel).

Fermentation vessel:

The standard fermentation vessel has a total volume of 1 litre (other volumes can be delivered on request). The vessels are made of high quality Pyrex glass with one large threaded central opening for the fixation of the membrane and vibromixer and 6 to 8 threaded side necks for the fixation of different sensors, air outlet, sample withdrawal, inoculation etc. Two adjustable holders hold the vessel in position. The vessel is sterilised in an autoclave.

Agitation:

Instead of a traditional propeller agitator a new vibromixer is used in the Minifor. A strong electromagnet moves one or several perforated discs up and down. The major advantage is an efficient mixing and aeration of the culture medium together with very efficient separation of the inside of the vessel from the outside by a low cost silicone membrane. No vortex is built up and baffles are eliminated. This type of agitation is also gentler on the cells and foaming is reduced. The frequency of vibration is controlled by a microprocessor and can be varied through a broad range. The input of air is made through several capillaries fixed under the lowest disc.

Temperature control:

A new-patented IR radiator with a gilded parabolic reflector is used to warm the culture broth. The heat radiation (100W) is concentrated on the bottom of the vessel where it is adsorbed by the medium in a similar way to the sun heating water. There is no overheating of the culture common with heaters placed directly in the medium. Thanks to the low heat capacity of the IR source, overshooting of the temperature is reduced and the temperature can be controlled more precisely. The temperature sensor is placed directly in the pH sensor and is used at the same time for an automatic correction of pH and pO₂ electrodes.

pH measurement and control:

The pH is measured by a combined, sterilisable pH electrode with incorporated temperature sensor. Thanks to a new multiple plug Variopin it can be sterilised without any protection. The two-point calibration of the electrode is semiautomatic. The addition of acid or base is controlled by a micro-processor. The flow rate of pumps PRECIFLOW, MULTIFLOW or HIFLOW is varied between 0 to 100 %, which makes the pH control smoother than with the common ON/OFF switching of pumps with fixed speed. The unique PUMP FLOW INTEGRATOR (option) when coupled to the pump enables monitoring of the pump's activity during the process. This yields precise kinetic data concerning the culture state and activity.

pO₂ measurement and regulation:

A sterilisable Clark-type electrode measures the concentration of dissolved oxygen with a special reinforced membrane giving fast response times. The microprocessor performs a semiautomatic two-point calibration with automatic temperature control. The regulation of dissolved oxygen is obtained by a variation of the flow rate of air.

Air input:

The flow rate can be set from 0 to 5 l/min. in 0.1 steps. A precise mass-flow meter is used. This measurement is independent of the pressure and temperature variation of the air. Commonly used floating ball capillaries give inaccurate readings in this case. A proportional air valve using memory metals adjusts the flow rate.

Air output:

Used air is filtered by a PTFE filter. If necessary an optional condenser can be used to remove water vapour from the stream. The condenser based on a Peletier cell uses no cooling water.

Inoculation and sampling ports:

Inoculation, addition of acid or base and sample removal is made through four stainless steel capillaries equipped with Luer-Lock adapters.

Sterilisation:

The fermentation vessel is sterilized as usual in an autoclave after disconnection of the cables from the electrodes and electromagnet.

Dimensions:

A lot of effort was made to make the Minifor as small and as compact as possible. The platform arrangement of the fermentor makes control and access to all parts easy from all sides. The distance between the reagent bottles, pumps placed above them and the fermentor vessel is the shortest possible.

Pumps:

Up to four pumps PRECIFLOW, MULTIFLOW or HIFLOW can be placed on holders fixed on two bars at the rear of the fermentor. They are connected by a single cable to the sockets on the rear side of the fermentor. Since the pumps are not bound to the fermentor they can be used for other applications elsewhere in the laboratory (for ex. for chromatography etc.). This can present a considerable economy for the user.

Technical parameters:

Minifor is controlled by two microprocessors.

<i>Power:</i>	<i>Mains 190–245 V AC/50–60Hz CE conform (other voltages on request)</i>
<i>Dimensions:</i>	<i>22 x 40 x 38 cm (WxDxH)</i>
<i>Display:</i>	<i>LDC 4 x 40 digits with backlight</i>
<i>Fermentor vessel:</i>	<i>Pyrex glass with 5 to 8 side necks 0.25 and 1 l, (other volumes on request)</i>
<i>Temperature control:</i>	<i>special radiation heat source with gilded reflector 100 W,</i>
<i>Regulation:</i>	<i>from 5°C over RT to 70°C</i>
<i>Measurement:</i>	<i>from 0 to 99.9°C in 0.1°C steps</i>
<i>Precision:</i>	<i>+/- 0.2°C (0 to 60°C)</i>
<i>Sensor:</i>	<i>Pt 100 incorporated in the pH sensor,</i>
<i>pH control</i>	<i>sterilisable pH electrode pH 0–13, with automatic temperature correction, Variopin connector, two-point semiautomatic calibration</i>
<i>Resolution:</i>	<i>0.01 pH unit</i>
<i>Precision:</i>	<i>+/- 0.02 pH unit</i>
<i>pO2 control:</i>	<i>sterilisable Clark type oxygen sensor with fast response and reinforced Teflon membrane, measurement and regulation through regulation of airflow rate,</i>
<i>Range:</i>	<i>0 to 10 mg oxygen/ l, in 0.1 mg/l steps</i>
<i>Air flow:</i>	<i>0 to 5 l/min. in 0.1 l/min. steps, mass flow meter, linearity +/- 3%, reproducibility +/- 0.5%</i>
<i>Control:</i>	<i>proportional valve using memory metals</i>
<i>Supplied air pressure:</i>	<i>between 0,05 – 0,2 MPa</i>
<i>Agitation:</i>	<i>40 W Vibromixer 0 to 20 Hz with 1 or more stirring discs</i> <i>Sterility similar to magnetic coupling</i>
<i>Selectable parameter:</i>	<i>an additional parameter can be controlled by the instrument (foaming control, pCO2, optical density, conductivity, etc.)</i>
<i>Sampling ports:</i>	<i>up to four needles with Luer-Lock fittings can be used for sampling and addition of correction solutions</i>
<i>Pumps:</i>	<i>up to 4 independent pumps with speed variation from 0 to 100 % can be used with Minifor (PRECIFLOW, MULTIFLOW or HiFLOW)</i>
<i>Working temperature:</i>	<i>0 – 40 °C</i>
<i>Working relative humidity:</i>	<i>0 – 90 %</i>
<i>Weight:</i>	<i>7.5 kg</i>
<i>PC control:</i>	<i>complete PC control and data treatment using SIAM fermentation soft ware</i>

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