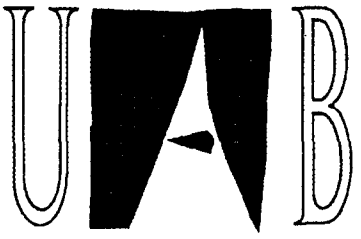

Universitat Autònoma de Barcelona

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- TECHNICAL NOTE 25.4-

Preparation of photoheterotropic compartment hardware

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INTRODUCTION

Due to the evolution in the compartment IV studies, new hardware is in preparation. The characteristics of the biomass of compartment II, a photosynthetic micro-organism, makes it a perfect candidate to reuse the hardware currently used for compartment IV. What is more the software of compartment IV now in use, will be modified to allow its implementation for compartment II. For all this it has been decided to adapt the old compartment IV hardware to be used for the studies to be done for compartment II. This technical note proposes modifications to be done in order to adapt the existing hardware for the new requirements. It is also described the initial experiments that can be done in the future, taking as a starting point the information already available and following the same trends as in compartment IV.

EVALUATION OF THE MODIFICATIONS REQUIRED FOR COMPARTMENT II HARDWARE

Due to the characteristics of the new bacteria metabolism, working conditions will be different. Considering that the first experiments will be done in photoheterotropic conditions, the following culture conditions can be expected :

-Temperature : 30 °C
-pH : 6.8
-Radiant light available ($4\pi J$) : 1-250 W/m^2 .
-Agitation : Aeration with inert gas.
-Dilution rate : up to 0.15 h^{-1}.
-pH=6.9

To allow the process to be computer controlled, it is necessary to have a measurement of the majority of those physical working conditions, as well as other measurements that will allow to follow the metabolic behaviour of the cells. According to this the measurement of the following variables is advisable :

Temperature
pH
Dissolved oxygen
Gas flow
Liquid flow
Biomass concentration on the bioreactor.
CO_2 concentration on the gas line.
Carbon source on the culture media.
Nitrogen source on the culture media.

For the measurements on the liquid phase of the culture a sampling system able to supply filtered media is necessary. During operation of the bioreactor some off-line analysis will have to be done, therefore a sampling port, with capability to maintain the axenic conditions of the bioreactor is required. Besides the measures, it can be expected that there will appear some operational problems affecting either those measurements or

culture behaviour, like biomass attachment to the bioreactor walls or biomass sensors. Those problems will have to be evaluated in real working conditions.

Process variables should be computer controlled and the values of the measured and manipulated variables have to be stored for post-experiment analysis.

Most of those systems are already available in the old hardware. In the following paragraphs the different systems will be discussed and the proposed improvements or alternatives presented as needed.

-Temperature, pH, liquid dissolved oxygen.

The present system uses conventional temperature and pH probes. Those measurement systems appear at present time, enough reliable to be used in the future. Therefore it is proposed to keep the same systems with just minor investments in maintenance tasks.

Control of the pH is done by injection of CO_2 on the gas line. This system was adequate for the Spirulina cultures due to the relationship among the carbonates consumed by the bacteria and the pH. For the new cultures it would be preferred to change this pH control system for a conventional acid/base addition system. The control can be implemented on the actual controllers, in a similar way it has been implemented on the fixed bed nitrifying bioreactor, and will require only the additional use of two peristaltic pumps (for example the Ismatec ones that are currently used for input and output liquid flow).

Although this bacteria can consume oxygen, in the near future experiments will be done in anoxygenic conditions. The presently used probe can be used as a security measurement device to ascertain that there is no net input of oxygen in the system or that the initial culture media has been degassed. However the probe is not sensitive enough to detect small amounts of oxygen (ex. 0.5 ppm) that can result from small leaks in the system. The sensor will not detect either the case where there is an input of oxygen that is being nearly completely consumed by the bacteria ; that results also in a oxygen concentration too low to be measured. The use of an inert gas (He, Ar) at a slight overpressure can avoid oxygen leaks into the bioreactor. This gas will also be used for agitation pourposes. Input culture media will have to be de-oxygenated and maintained in an inert gas atmosphere. Oxygen can also diffuse into the culture medium during its transfer from the bottle to the bioreactor if certain tubes are used (silicone tubing). Therefore the use of gas tight tubes is recommended.

-Light measurement at the centre of the bioreactor

In the actual set up there is a combination of a commercial sensor and a custom made amplifier, together with a light ball collector also built on purpose. In the next phase the bioreactor will operate with a correlation among the incident light on the bioreactor wall and the power supplied to the lamps. This correlation will be tested before the beginning of the bioreactor operation in the new conditions. Therefore there is no need of this light sensor for the control purposes. Therefore the light sensor can be removed from the set up or maintained in it as a security device to detect a failure in the illumination system.

-Liquid flow measurement. Pumping systems.

At this time there is no direct measurement of the liquid flow in the bioreactor. Pumping of liquids in and out of the bioreactor is done by means of peristaltic pumps. This pumps are calibrated at the beginning of the experiment. However as time passes tubing lines are deformed and the pressure drop up on the sterility filters increases. That forces at daily manual measurements of the flow. Moreover when the new flows are substantially different from the previous ones, calibration coefficients have often to be modified. In case of a leak on the liquid line, the flow changes, but there is no possibility for the computer control to enforce security measures up on this fact, because the change of flow is not noticed. Consequences can be catastrophic for the cultures specially on the occasions (for example : at night, weekends,...) when the operators are not present to take appropriate actions. For this reasons it is highly desirable to improve the liquid handling system.

From the different types of pumps available, two alternatives have been selected. Diaphragm metering pumps and gear pumps have been preliminary selected.

Diaphragm metering pumps pulse a flexible membrane to displace liquid with each stroke. They have the advantage of their high reliability on the liquid volumes dispensed making them ideal for high accuracy applications. This pumps are factory calibrated for each stroke and the number of strokes can be regulated either by an external pulse regulator or a 4-20 mA current signal. As a candidate of this type a Prominent gamma/4/G/4a 1601 is proposed (Appendix 1). This pump can supply up to 0.9 l/h. Pulsation on the line is minimised by using a small displacement per stroke (0.16 ml/stroke) at high frequency (120 strokes/min) with an accuracy better than 2%. It has an analogic control (either 0-20 mA or 4-20 mA) and the possibility to switch on an alarm relay in case of fault. A teflon coated pumping head assures its resistance to any type of corrosion.

An alternative of this type of pumps can be the diaphragm dosing pump Alldos M205 Etron M (205-0.8/E05) . With similar characteristics to the other manufacturer this one has a stroke of 0.14 cm^3 and can reach 1 l/h at 50 Hz and has a 0(4)-20 mA current signal control (Appendix 1). The precision of the liquid delivery pump can make the necessity of a liquid flow metering system prescindible. As a drawback it can be mentioned that those type of pumps require to change the membrane heads with some frequency. The periodical replacement of the membrane can be as often as every two months.

Gear pumps operate via a two or three rotating gears, the spaces between the gear teeth carry the fluid from the inlet to the outlet. When they are magnetically coupled, shaft seals are eliminated, avoiding leaks and contamination and allowing autoclaving of the head prior to its use. They are of low maintenance requiring only occasional replacement of the head. Pump heads are usually purchased independently of the motor drive. As a candidate the Ismatech compact drives and a pressure loaded style pump head (Appendix 2) is proposed. It is pulse less and can supply a flow in the range of 0.06-6 l/h. It has an analogue input signal (0-20 mA or 4-20 mA) for speed control. Speed regulation is linear between 50-5000 rpm. It must be mentioned that at low rpm the pump head can be blocked. The teflon coated head can be autoclaved and requires barely no maintenance. As a drawback it can be required to implement a liquid flow measuring system to continuously monitor it and, as the pumps can operate against high pressures, a pressure measuring system and a relieve valve are advisable. This will avoid

the case were a block on the liquid line (for example due to sterility filter clogging) can result in an increase of the pressure and can cause the tubes to explode. Also the high shear produced will probably have an adverse effect on the biomass in the output of the bioreactor, which is of no major problem as that biomass will not have to be recirculated.

Between those two types, the diaphragm pump will require more maintenance than the gear pump. It provides a small pulsating flow but will be more precise than the gear pump. The gear pump will require very low maintenance but its cost will be higher. Proper operation in the long run working continuously is a matter to be tested. Under such circumstances gear pumps would be proposed as the most adequate candidate.

In a continuous culture one of the most important variables to control or to monitor is the liquid flow. Up to now the computer system relies on the proper calibration of pumps, and the operator has to manually check-it. The incapacity of the control system to detect any deviation from the expected flow can result in a number of problems that should be avoided. To correct such a situation it is proposed to install a liquid flow meter on the input and/or output of the bioreactor.

Different technologies are available for liquid mass flow meters/controllers. Of those the ones based on the thermal fluid conductivity or the ones based on magnetic effects look appropriate for this task.

Flow meters based on thermal conductivity properties of the measured fluid. It increases the fluid temperature 1 degree with a heater and measures the decrease in temperature at some distance, what depends on the characteristics of the fluid and on its flow rate. The measured quantity is the mass of the liquid and its volume is readily calculated through its density. As a candidate of this type of pumps the ones manufactured by the Dutch company Bronkhorst are proposed. They offer and adequate range of flows (for example 0.020-1 kg/h) with an accuracy of 0.5% and a precision of 0.1% of full scale. The flow meters can be sterilised and do not contain any moving parts or elastomer seals. They can supply a signal of 0-5 Vdc or 0(4)-20 mA, making them suitable to be connected to the actual system. They can be supplied with internal teflon covering to prevent any kind of corrosion. More details can be found on appendix 3.

Flow meters based on magnetic forces rely on the effects that the measured liquid has on an oscillating system, by means of the coriolis force, while the measured mass passes orbits of different velocities. This resulting force creates a phase shift between two sinusoidal signals from the sensor. This shift is proportional to the measured flow. The system is affected by the temperature ; this one is also measured and therefore is available for other purposes. The accuracy of this systems is about +/-0.2-0.5% of the range with a repeatability better than 0.1%. As a candidate the Rheonik RHM007 (Appendix 3) has a measuring range of 0.12-2.4 l/h. Each RHM sensor is factory calibrated together with a RHE unit that calculates the flow from the sinusoidal signals of the sensor, and compensates for temperature. Both items are factory calibrated as a unit. The RHE unit has 2 analogic outputs 0(4)-20 mA and supplies mass flow and temperature. Additionally, and as an option, it can also supply the density and volume of the liquid flow.

A simple alternative that has to be mentioned to monitor the liquid flow is to measure the decrease of the weight of the input bottle. It is easy to implement a system were the weight of the bottle is continuously monitored by the controllers. In this case the decrease in weight can be converted to the liquid flow rate in an easy way by means of the density of the liquid. This system is the cheaper to implement but it needs several samples to be accurate and it is not capable to detect flow changes in the input flow, for

example due to a leak, unless the weight of the output bottle is also measured. As a candidate the manufacturer Ayats supplies a balance for 60 kg that can measure small increments of weight down to 0.01kg. It is equipped with analogic outputs 0(4)-20 mA from were the controllers can get the weight and calculate the flow.

However the direct, reliable and fast method to measure the flow is the liquid mass flow flow meter, of which the one based on thermal conductivity is the selected alternative.

- Biomass concentration on the bioreactor.

The biomass measurement system that is currently used consists in a probe that measures the absorbance of the liquid in the bioreactor and relates this to the dry weight of the bacteria through a calibration plot. It is proposed to continue with the same system with a recalibration of the sensor for the new bacteria and a previous substitution of the actual filter (746 nm wavelength) for another one less prone to be affected by pigment concentration modifications (710-720 nm wavelength).

- CO_2 concentration on the gas line. Gas flow and Pressure.

The CO_2 concentration on the gas line is not presently measured. However there is a measurement device available among the equipment transferred from ESTEC. This device, a Maihak IFC/GFC IR detector (0-20% vol.) is currently not working properly. It is proposed, as a first approximation to repair this CO_2 measurement device. This will allow to measure the production CO_2 from acetic acid or its consumption when using other carbon sources. This way the carbon balance can be followed and deviations used to calculate its loss or accumulation by non accounted effects.

On the other hand to be able to use the measurements on the gas line were the device is located it should have a known and preferably constant gas flow and pressure. Therefore this gas line should be modified accordingly . Presently there are in use MKS mass flow meters/controllers which can be maintained in the modified system.

- Carbon source on the culture media.

This is one of the measurements that is not presently existing and that would be very interesting to have for the future control system. It is expected that this compartment will consume volatile fatty acids. Measurement of those sources of carbon can be done, either in the input or the output flows, by a system based on gas chromatography. Its consumption is one of the key targets of the culture and therefore the control system should be able to measure them and take appropriate action.

The system of choice for this measurements would be a gas chromatographic system with an automatic sampling system. There are very few companies supplying an automated system for the sampling and measuring of the liquid phase due to the complexities of the discrete sample handling system and the calibration steps required for it.

The Swiss company Biospectra has several of this systems already working in several european companies/universities (Appendix 4). It basically consists of a Hamilton module able to take samples from a filtered sample line, add internal standards and introduce the mixture of them in the gas chromatograph. A PC (industrial model)

handles the sampling system, washing cycles and the periodic calibration of the chromatograph. It also determines the component for each peak, calculates the area and finally determines the concentration of each component. Frequency analysis is of between 2-12 samples/hour depending on the substances in the effluent. Precision of the measured components is evaluated in less than 2% of error. It can be used for any of the volatile fatty acids expected including acetic acid, and can measure up to 10 compounds in the same sample. Theoretically it can monitor more than one bioreactor. The system is customer specific so the manufacturer can supply any required connection accessories like analogic or digital interfaces for data transmission. According to the manufacturer either a RS-232 line or a 4-20 mA output signal can be provided. A s it is intended to analyze several compounds at the same time, the use of a RS-232 line is the preferred choice. This signal can be read by the GPS to be able to use the results of the analysis. In parallel the industrial PC can make available the results as an excel worksheet file which can be used as a security system. Therefore the GPS software will have to be modified to incorporate this data.

The equipment prepared by Biospectra is based on a Hewlett Packard HP5890 gas chromatograph, conveniently modified to adapt the on-line sample handling and analysis. From preliminary enquires, and from the economical point of view it seems preferable to purchase the GC directly from Hewlett Packard and make it adapted for on-line analysis by biospectra.

Additionally it should be mentioned that as an alternative to GC analysis, specific on-line analysers for some compounds that could be expected, such as acetic acid, were not found available from various companies.

Therefore the proposal is to acquire and HP 5890 GC in Spain and to request the upgrade of this to Biospectra to implement the measurement/sampling system.

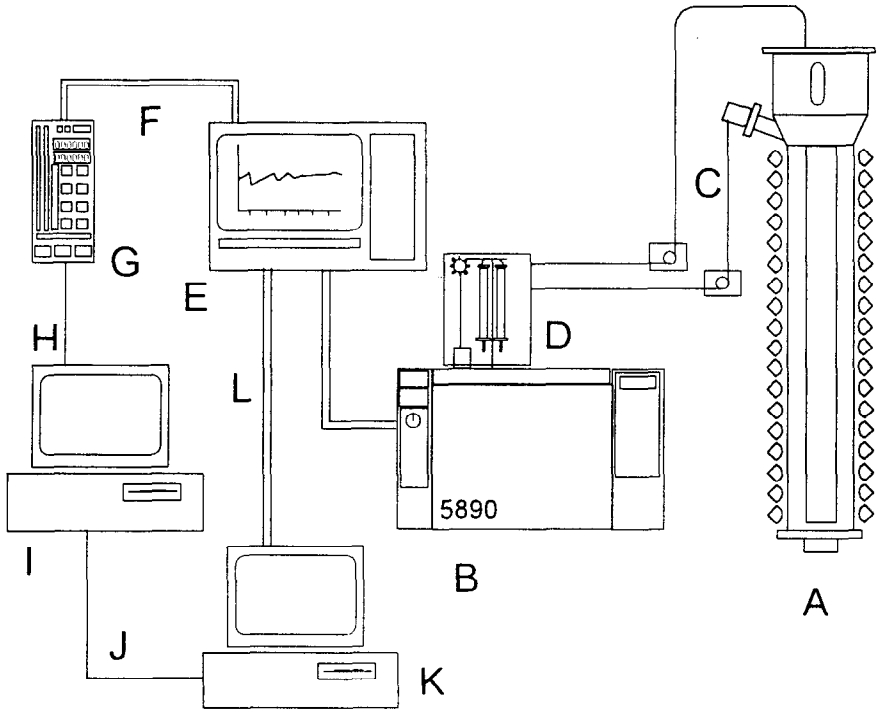


Figure 1: Schematic drawing of the online GC analyser connection. A: Airlift. B:HP5890 GC with injection valve. C: Filtered culture media line. D: Hamilton sampling system. E: Custom industrial PC. F: 4-20 mA connection. G: P-100 controller. H: RS-422 line. I :System station. J : ARCNET network. K : GPS. L : RS-232 line.

- Nitrogen source on the culture media.

Although the bacteria that is going to be used in this compartment can consume several sources of nitrogen, it shows the highest affinity for the ammonium. This is the reason that in the near future the main experiments are going to be done with this nitrogen source. Measurement of this nitrogen source to allow the proper assesment of its consumption by the control system is the desired goal. Of the different technologies available to have a continuous measure of this variable two of them have been selected. One based on potentiometric characteristics of the liquid and the other on the indophenol blue method.

The potentiometric system relies on the use of an ammonium permeable membrane which allows to separate the ammonium from the main flow, which is thereafter measured by a potentiometric probe. The system is periodically calibrated (from 30 minutes to any time) using two samples of known ammonium concentration. As a candidate it is proposed the EASI-Technol. Ammonium analyser Mod. 255 (Appendix 5). This one can measure ranges from 0.1-1000 ppm of ammonium. It has analogic outputs of 0-5 V or 4-20 mA. It measures continuously and there is a response time delay of 10 min with an accuracy of about 3% of the measurement. The limit of detection is of 0.1 ppm and it requires the use of two standards and one reagent and a minimum flow of 0.6 l/h sample. Reagent supply, approximately 1 month.

The spectrophotometric reaction relies on the fact that at pH 12.6 ammonium ions react with hypochlorite ions and salicylate ions in the presence of nitropruside sodium, to produce a green dye (indophenol complex). As a candidate it is proposed the Dr-Lange AMTAX (Appendix 5) ammonium analyser. In this one the reaction takes place at 50 °C. The measurement is continuous and has a 0(4)-20 mA analogic output. Calibration is performed periodically using samples of zero ammonium concentration and a sample with known concentration (for example 5 mg/l). Measurement is done according to the dual beam , dual filter method. The delay response time is of 12 minutes and measurement accuracy is about +/-2% of maximum value. It requires the use of two reagent solutions, two standards and a minimum flow of 0.5 l/h ultrafiltered sample. Reagent supply, approximately 21 days.

Of the two systems the potentiometric one has the advantage of its lower use of reagents and its independence of the filtration of the sample. The spectrophotometric one has a higher requirements for reagents and is sensitive to the turbidity of the sample (due to the optical measurement) and therefore the sample has to be free of any suspended particles and ultrafiltration is recommended. However the spectrophotometric system is already in use at the laboratory. It is fully automated and the connections to the controllers have already been solved. It has been tested and up to now it does not present a major problem. Moreover having two systems of the same kind will simplify the reagents supply. In this conditions the spectrophotometric measurement system supplied by Dr. Lange AMTAX is the proposed method.

-Automation hardware and software modifications of the bioreactor

Once the new sensors will be incorporated and the unnecessary ones removed, the controllers wiring and its software will have to be modified. For the same reasons the Industar software will have to be updated together with the GPS groups. The GPS modification itself, which will be taken into account as a separate package, will consist

mainly in the incorporation of the new ADERSA software subroutines for the control of this compartment in place of the actual software.

The modifications to be done in the control loops will be as follows :

-Loop 1 : Alarms and Storage of LOCs.

Alarms and LOC memory storage positions will have to be updated to incorporate the new variables. The measurement of CO_2 concentration can be maintained in this loop. Its value can be used by the GPS to close the mass balance and ascertain if the metabolism is following the expected traits or if a deviation occurs.

-Loop 2 : Pressure.

This loop will be maintained . However it will have to be updated for the new pressure measuring/controlling system, in order to maintain constant the pressure in the output of the bioreactor. The pressure measuring unit will be maintained and only the gas tubes set up will be modified.

If the volatile fatty acids measuring system is finally incorporated, this loop can read the values of the fatty acid concentration. The values of the fatty acid concentration will depend on its input concentration but also on the values of the flow rate and light availability. Therefore if control of the VFA is desired, its concentration will be modified acting mainly on the light and flow rate variables (for example if VFA is too high the GPS can either increase the light supply or decrease the flow rate). This task is currently in charge of the GPS which can optimise the values of those variables to obtain the desired output.

-Loop 3 : NO_3^- converted to NH_4^+.

This loop will have to be reconverted to measure the ammonium concentration using the new ammonium measuring system, instead of the actual nitrate measuring system.

-Loop 4 : pH

This loop will be maintained. However instead of regulating the pH with the CO_2, it will be modified it so as to use an acid/base addition in a similar manner as it has been done with the *Nitrosomonas* bioreactor.

-Loop 5 : Light.

As the new bacteria to culture in this bioreactor is also photosynthetic, this loop will be maintained to set the light intensity via the lamps power. However, instead of using the light measured by the internal sensor to regulate the light intensity, it will be set up so as to maintain a light intensity according to a calibration table relating the controlling action to the lamps with a desired F_0.

-Loop 6 : Temperature.

This loop will not be modified

-Loop 7 : Biomass concentration.
In this loop the calibration of the biomass concentration according to the measured medium absorbance will have to be modified. After the proper modification of the light filter. Its action on the input pump is currently commanded from the GPS which sets the desired input liquid flow. This way of work will not be modified. However the loop can also read an analogic input with the measure of the liquid flow, which the GPS can use to verify that the desired liquid flow has been attained.

-Loop 8 : Bioreactor liquid level.
In a first approximation this loop will not be modified.

The result of the modifications on this loops will require to modify the names and variable ranges of the old variables (v.g. the NH_4^+), or incorporation of new ones (v.g. the VFA variable) in the INDUSTAR database. Also the corresponding modifications on the display screens and GPS groups will be required.

Estimation of the refurbishment cost.

In order to evaluate the cost of the refurbishment of the bioreactor, the suppliers have been requested to give an approximate cost of the equipment to supply. The prices supplied are stated below. However final cost will only be given one month before the purchase. As the cost is not the final one, the given values have been rounded upwards. The cost is given in millions of spanish peseta units.

ITEM	COST (milions pesetas)
Liquid flow meters + pumps	0.8
Ammonium analyser	2.6
On-line VFA gas chromatograph	5.5
TOTAL AMOUNT	8.9

PROPOSAL OF EXPERIMENTS FOR COMPARTMENT II USING THE PREVIOUS COMPARTMENT IV BIOREACTOR

Once the new bioreactor will be ready, experimental studies for the photoheterotrophic compartment will be continued. As a general scheme two main lines of work can be followed.

On the one hand, from previous experimental data (Albiol 1994 ; Viprey 1994), and first stoichiometric analysis (Phoughon 1995) three factors have already been shown to have an important influence on the biomass composition. As found for the *Spirulina* cultures, the effect of biomass composition on the loop behaviour is very important. Therefore one important line of work is to continue to evaluate the effect of this and other factors on biomass composition, to allow for a better quantification of the effects.

On the other hand the light transmission model, developed previously for the Spirulina bioreactor , and used by the control system will be adapted for the its use by the new control system. This work has already been started in Tn 23.4 and will require further light and growth measurements on the actual bioreactor to be used. Afterwards the effects of other culture conditions on biomass composition can also be incorporated into the model.

Both lines of work have a first common requirement, that is a proper determination of illumination conditions and available light inside the bioreactor. Therefore the first experiments will have to define and measure the input light (F_0) and light availability for this bacteria and possibly include one culture as a reference. This results will further be combined with other determinations, like the ones in TN 23.4 to have a definitive model describing the light availability for this bacteria in this bioreactor.

With this data, the effect of light limitation on biomass composition and carbon and nitrogen consumption, together with the effect of light variation on the kinetic behaviour of the biomass, can be reached. This can be done in a series of experiments, similar to the ones already done at the high dilution rate cultures for the Spirulina bioreactor. To speed up the collection of data, parallel experiments can be done in roux flascs and other more conventional bioreactors.

Once completely defined the light effects on the *R. rubrum* cultures, experiments under carbon source limitation and under nitrogen source limitation are the logical continuation line of work.

With all this data, the stoichiometric model, already started at TN 23.3, can be advanced enough so as to be able to develop either a simulator similar to Photosim but for compartment II, as well as a control system taking into account, besides the light effects, also the effect of carbon and nitrogen sources on biomass behaviour and composition.

All this data will allow a further improvement of the complete loop simulator, allowing a more accurate evaluation of its behaviour and of the conditions needed for its operation and improvement if necessary.

Of this general line of work, the first experiments can possibly be started on the next contract phase. Taking into account that the development and construction of the new *Spirulina* bioreactor will take about 8 months, one has to consider that during this time the old bioreactor will still be used for the *Spirulina* cultures. That leaves only four months for the implementation of the modifications and its test. The equipment can be ordered previously so that as soon as the bioreactor can be used for the *R.rubrum* cultures, the mounting and testing of equipment can be done. After that, the remaining

time of phase 2, can be used for the first experiments on the light availability in the bioreactor and first effects of light intensity on the *R.rubrum* behaviour.

Mounting and testing the new instruments can be expected to take around one month, and for each experiment around two weeks, depending on the dilution rate used. This leaves the amount of experiments that could be done in this last part of this phase between two and four. Assuming one week is taken for the illumination definition tests, like for example a light availability measure by a chemical method, some continuous cultures can be started at one flow rate (for example 0.035 h^{-1}, will allow to compare the data with previous *Spirulina* results in the same bioreactor) and two or three illumination conditions tested. After that flow rate can be changed and new tests performed, the number of them depending on the time remaining. The results of those previous experiments will indicate if higher dilution rates can be tested in this bioreactor. The obtained results will further indicate the values for those variables like flow rates and illumination conditions to be tested in future experiments.

REFERENCES

Albiol J. (1994) Study of the MELISSA photoheterotrophic compartment. Kinetics and effect of C limitation. ESTEC working papers ESA-EWP-1808.

Cornet J.F. (1996) Model parameters for growth of *Rhodospirillum rubrum* under light limitation in photobioreactors. MELISSA Technical note 23.4

Phoughon L. (1995) Modelling of the MELISSA artificial ecosystem. Compartment II stoichiometries and experimental data analysis. MELISSA Technical note 23.3.

Viprey E. (1994) MELISSA Culture continue de *R. rubrum*. Raport de project. ESA-X-1102.

APENDIX 1

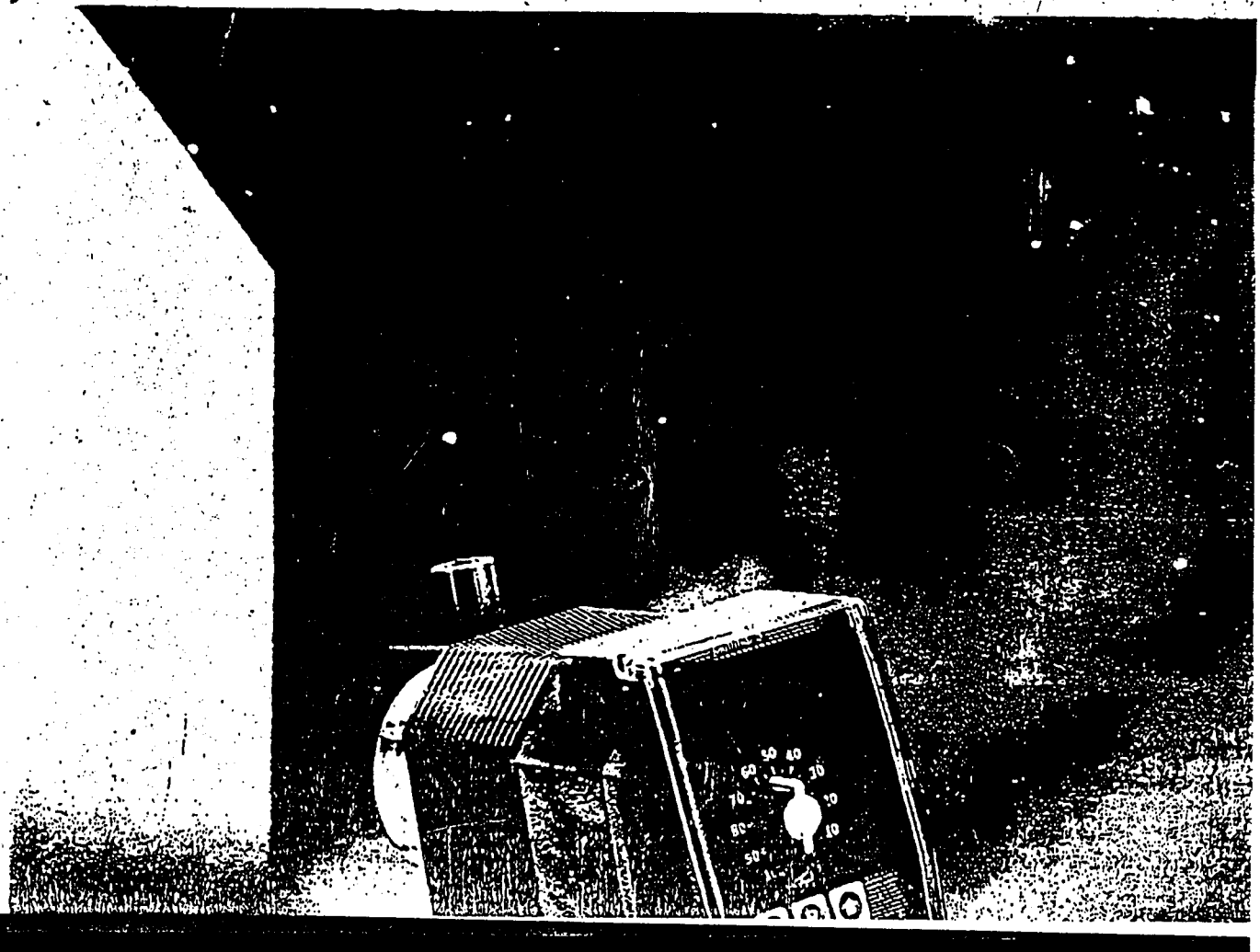
Diaphragm Metering Pumps

ProMinent®

ProMinent® gamma.

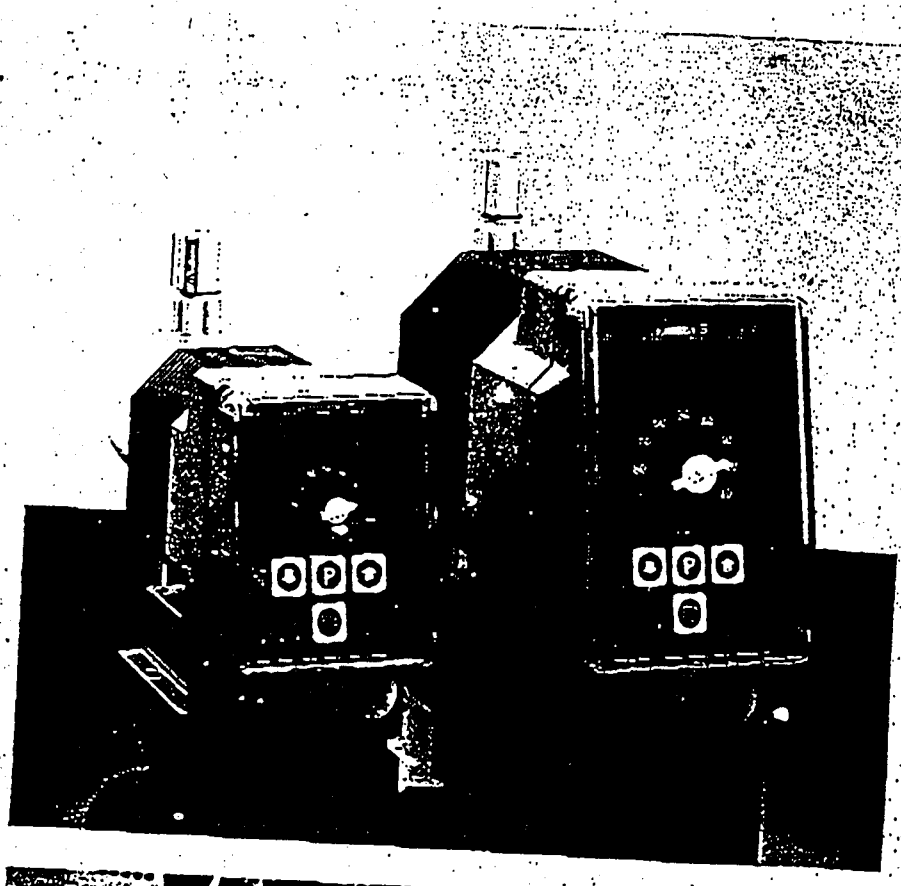
Un sistema de dosificación inteligente, programable e interactivo.

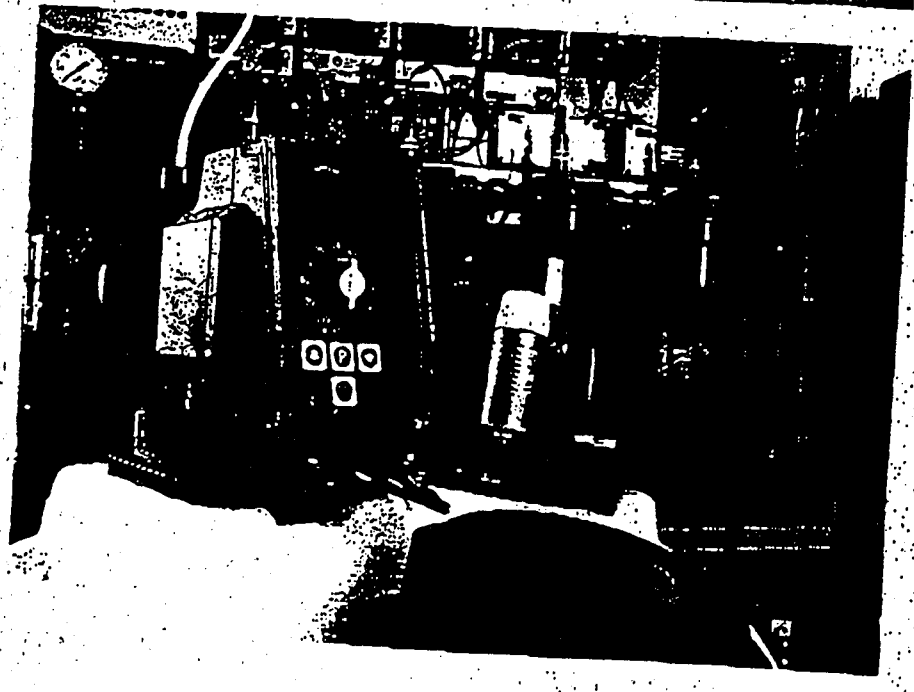
Gamma/4 y gamma/5: la nueva generación de bombas dosificadoras electromagnéticas interactivas ProMinent® (versión "a"), controladas por microprocesador, que garantiza una gran seguridad en la dosificación en el rango de caudales desde 0.01 ml/impulso a 30 l/hora, gracias al control automático del caudal y a la identificación de fallos, incluso de perturbaciones externas.



seguridad de funcionamiento garantizan un proceso óptimo.

Las bombas ProMinent® gamma son bombas electromagnéticas de membrana, controladas por microprocesador, que se utilizan para la dosificación de líquidos. Estas bombas combinan componentes mecánicos de probada eficacia y la más moderna técnica de control. A partir de la experiencia acumulada durante varias décadas como empresa líder en el mercado de bombas dosificadoras electrónicas, y de las exigencias de los usuarios, ProMinent® ha desarrollado una generación completamente nueva de bombas dosificadoras. Las bombas gamma/4 y gamma/5, y la bomba dosificadora de precisión mikro g/5, son de fácil manejo, gracias a indicaciones en texto no cifrado. El diagnóstico de fallos, incluso de perturbaciones externas, garantiza la máxima seguridad de funcionamiento. Las bombas ofrecen posibilidades de adaptación prácticamente ilimitadas para los sistemas de automatización de procesos, garantizando una elevada seguridad de dosificación.





Componentes mecánicos

La carcasa

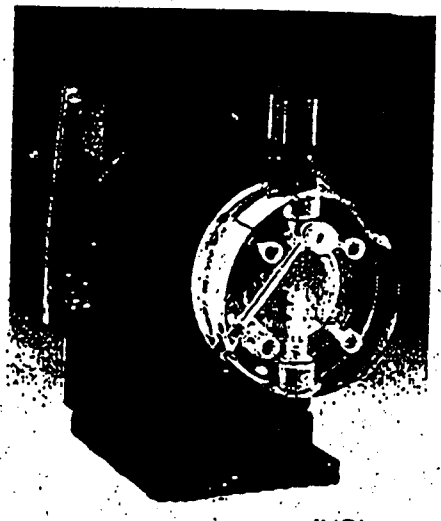
Diseño estético y funcional, de material sintético reforzado con fibra de vidrio, clase de protección IP65. Esto garantiza una gran protección contra productos químicos, así como contra posibles manguerazos. Además, la carcasa de la bomba ProMinent® gamma es robusta, resistente a los golpes y de peso reducido.

El accionamiento magnético

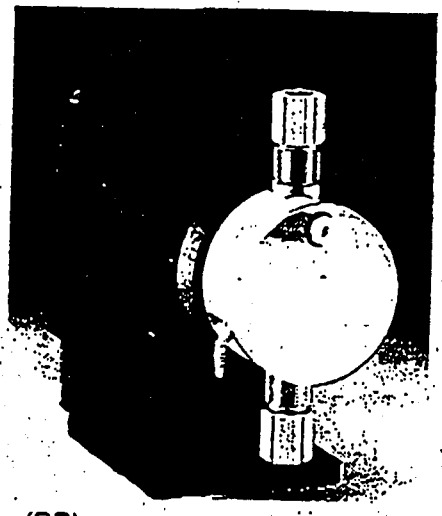
Los sistemas convencionales de accionamiente de una bomba consisten en un motor eléctrico y engranajes, con un gran número de piezas móviles. El accionamiento electromagnético de ProMinent®, en cambio, cuenta con una única pieza móvil: el inducido del electroimán. En el caso de la bomba ProMinent® gamma, se trata de un electroimán de carrera corta con un recorrido máximo de 1,25 mm, que no exige ningún tipo de mantenimiento. La bomba incorpora, asimismo, un moderno sistema de amortiguación de ruidos, que garantiza un funcionamiento silencioso. El ajuste de la longitud de la carrera está acoplado directamente al electroimán. De esto modo, se obtiene una máxima precisión en el ajuste de la carrera, sin retención ni desajuste involuntario.

La membrana dosificadora

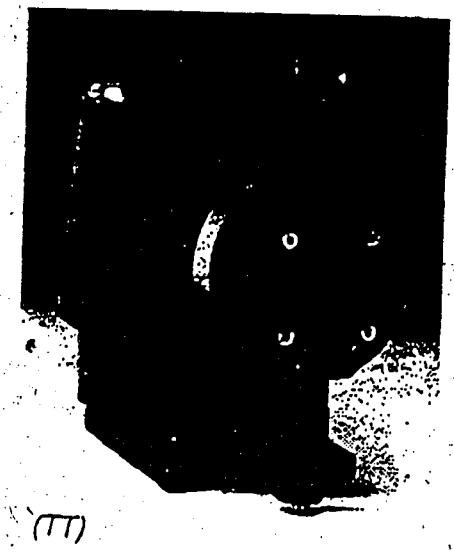
La membrana dosificadora DEVELOPAN® está fabricada en material EPDM de alta calidad, reforzado con malla de Nylon, con el núcleo de acero vulcanizado y estás recubierta de Téflon en la parte en contacto con el líquido. La combinación de estos materiales asegura una amplia vida útil a la membrana. La membrana dosificadora DEVELOPAN® de ProMinent® es resistente a casi todos los productos químicos y puede utilizarse en un amplio rango de temperaturas, admitiendo contrapresiones de hasta 16 bar.



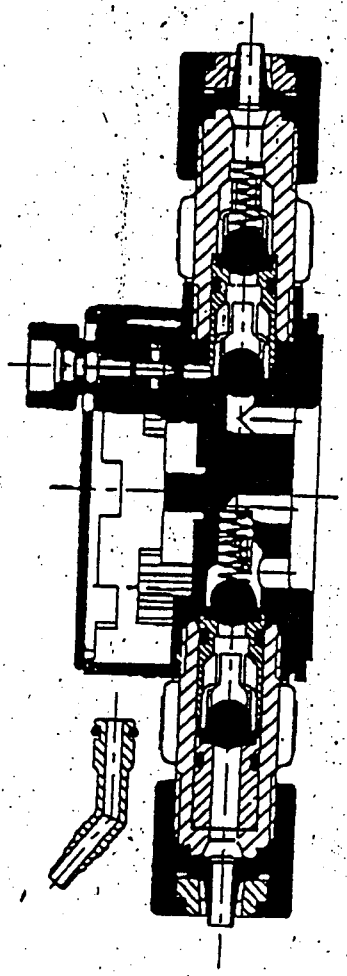
(NP)



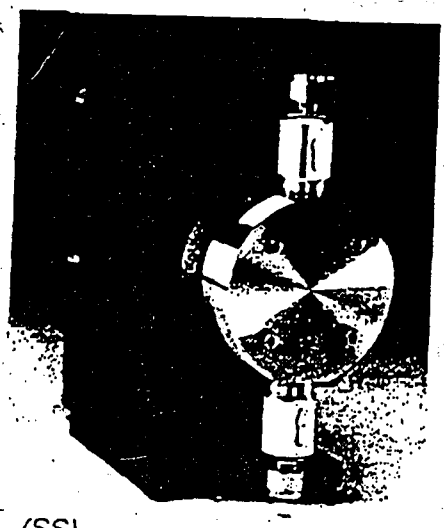
(PP)



(TT)



(Seccion transversal del cabeza! en PP)



(SS)

El cabezal dosificador

Los cabezales dosificadores de las bombas ProMinent® gamma pueden suministrarse en cuatro materiales diferentes:

- polipropileno (PP)
- Plexiglas (NP)
- Teflón (TT)
- acero inoxidable 1.4571 (SS)

Se han incorporado válvulas de doble bola en la aspiración e impulsión. Los cabezales dosificadores del tipo 1000-0417 PP y NP cuentan, asimismo, con una válvula combinada de purga de aire para facilitar la aspiración cuando la bomba se pone en marcha. Además, la válvula está provista de un dispositivo de ajuste fino, que controla la desaireación automática en continuo, p. ej. cuando se dosifican líquidos que producen gases. (Los tipos 0423 y 0230 están equipados con válvulas de una bola y no llevan la válvula de purga de aire.)

Los cabezales dosificadores de la serie HV, fabricados en polipropileno "PP4", han sido diseñados especialmente para líquidos altamente viscosos. Disponen de una mayor sección de paso de líquido, e incorporan válvulas de una bola más grandes, sometidas a la presión de un muelle.

Amplio rango de voltajes

Las bombas dosificadoras gamma se suministran en dos versiones principales: 230 y 115 voltios, que admiten amplias variaciones de voltaje: de 195 hasta 265 V en el rango superior, y de 98 hasta 132 V en el inferior, para una frecuencia de la red de 50 o 60 Hz. La versión de 230 V puede suministrarse con enchufe plano, suizo o australiano; la versión de 115 V, con enchufe de EE. UU.

NUEVO: TÜV-GS

Las bombas dosificadoras gamma tienen la garantía de comprobación TÜV GS y han sido homologadas según la norma DIN-VDE 0700 y además, están protegidas contra las interferencias vía radio, clase, B, según norma DIN-VDE 0871.

por microprocesador.

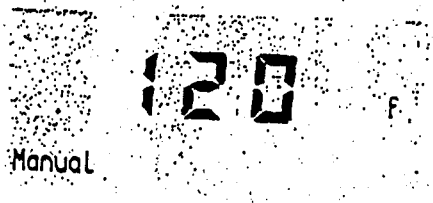
Se puede ampliar el rango de funciones de las bombas dosificadoras de la serie ProMinent® gamma en función de las exigencias específicas del cliente. La versión básica satisface los requerimientos planteados en un gran número de aplicaciones. Si se requieren prestaciones adicionales, se puede incorporar a la versión escogida el correspondiente tipo de control y las funciones opcionales deseadas.

LA VERSIÓN BÁSICA

El rango de ajustes

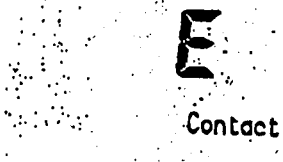
Operación en continuo

Se pueden regular manualmente el caudal del 100% al 10%, variando la longitud de recorrido mediante un mando giratorio, y, mediante un pulsador, la frecuencia de impulsos "f" desde 120 (100) hasta 1 impulso/minuto, es decir, en el rango 1:1.200 (1:1.000). El número de impulsos/min. seleccionado está indicado. Se incorporan cristales de cuarzo que mantienen con muchísima precisión la frecuencia de los impulsos.



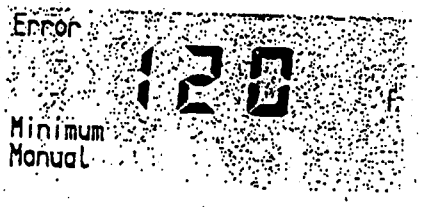
Control externo "Contact"

La frecuencia de impulsos de las bombas dosificadoras ProMinent® gamma se puede controlar mediante contactos externos, p. ej. por medio de los de un contador de agua. Para ello hay que conectar el cable de control externo a la entrada de contactos de la bomba. Cada impulso recibido (contador de agua o regulador de frecuencia) da un solo impulso a la bomba. La bomba admite un máximo de 120 impulsos/min. No se tiene en cuenta ninguna frecuencia de impulsos que exceda esta cantidad, evitándose, por lo tanto, cualquier sobreexcitación de la bomba.



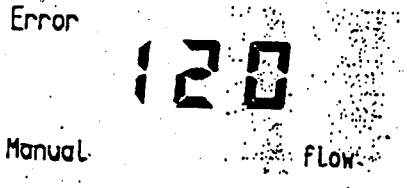
Control de nivel "Minimum"

Se puede conectar en el correspondiente terminal un control de nivel ProMinent® de dos etapas para controlar el nivel del líquido. Cuando se alcanza un cierto nivel mínimo, se activa una señal de alarma preventiva. En este caso, se pone en intermitencia la indicación "Minimum" y se enciende el indicador LED rojo y se activa el relé opcional de aviso de fallos, pero la bomba dosificadora sigue funcionando. La bomba se detiene sólo cuando el nivel en el depósito dosificador ha bajado otros 20 mm. Entonces se encienden las indicaciones "Error" y "Minimum". El relé opcional de aviso de fallo continúa cerrado.



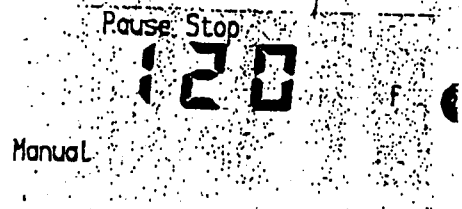
Control de caudal "flow"

La misma bomba dosificadora gamma controla el caudal de dosificación. Se puede instalar en el cabezal dosificador una alarma regulable para controlar el caudal. Una rez conectada, capta cada impulso completo de la bomba, dando una señal de realimentación al circuito electrónico de la misma. Cuando esta señal de realimentación, que indica el caudal correcto, falta durante 8 impulsos seguidos, la bomba se para y se encienden las indicaciones "Error" y "flow" en el display digital, así como el indicador LED rojo.



Conexión adicional "Pause"

La bomba gamma se puede conectar y desconectar, sin potencial, a través del cable de control. Esta función trabaja según el principio de corriente en reposo, es decir, cuando los contactos se abren, la bomba se para y se encienden las indicaciones "Pause" y "Stop".



Autorregulación

El sistema de mando electrónico de la bomba gamma se autocontrola de manera automática y permanente. En caso de registrar algún fallo de sistema en el microprocesador, la bomba se desconecta y se activa una señal de alarma. Se ponen en intermitencia todas las indicaciones en el display digital y se enciende el indicador LED rojo.

Tipo de bomba gamma		Caudal a contrapresión máxima bar	l/h	ml/impulsos	Caudal a contrapresión media bar	l/h	ml/impulsos	Frecuencia de impulsos impulsos/min	Conexión Ø ext. x Ø int. mm	Altura de aspiración mCA	Peso kg
gamma/4											
G/4a	1000	10	0.20	0,028	5	0,26	0.036	120	6 x 4	1,5	2,7- 3,4
	1601	16	0.90	0,125	8	1,17	0,16	120	6 x 4	6	2,7- 3,4
	1201	12	1,55	0,215	6	1,80	0,25	120	6 x 4	6	2,7- 3,4
	0703	7	3,40	0,47	3.5	3,67	0,51	120	6 x 4	3	2,7- 3,4
	1002	10	2,09	0,29	5	2.81	0,39	120	8 x 5	6	2,9- 4,1
	0308	3	7,78	1,08	1.5	8,5	1,18	120	8 x 5	6	2,9- 4,1
	0215	1.5	14,8	2.05	1	15.8	2.20	120	12 x 9	1,5	3,1- 4,7
gamma/5											
G/5a	1602	16	2.09	0,29	8	2,74	0.38	120	8 x 5	6	4,6- 5,8
	1605	16	4,74	0,79	8	5.76	0,96	100	8 x 5	6	6,7- 7,9
	1006	10	5,83	0,81	5	7,06	0,98	120	8 x 5	6	4,6- 5,8
	1310	13	9,54	1,59	6	10,8	1,8	100	8 x 5	6	6,9- 8,5
	0613	6	13,1	1,82	3	14.9	2.08	120	8 x 5	5,5	4,8- 6,4
	0813	8	13,3	2,21	4	14,6	2,44	100	12 x 9	6	6,9- 8,5
	0417	3,5	17,4	2,42	2	17.9	2,48	120	12 x 9	4,5	4,8- 6,4
	0423	3,5	22,5	3,75	2	24.6	4,10	100	DN 10	5	8,0-11,4
	0230	2	30,3	4,21	1	34,5	4,80	120	DN 10	2,5	5,9- 9,3
Bombas dosificadoras gamma "HV" para líquidos altamente viscosos											
G/4a	1002	10	2,09	0,29	5	2.81	0.39	120	DN 10	–	3,2
G/5a	1006	10	5,83	0,81	5	7.06	0,98	120	DN 15	–	5,1
G/5a	1310	10	9,54	1,59	5	10,8	1,80	100	DN 15	–	7,4
G/5a	0813	8	13,3	2.21	4	14,6	2.44	100	DN 15	–	7,4

*versiones en acero inoxidable con rosca interior 6 x 5, 8 x 7, 12 x 10, DN 10-R 3/8"

Materiales empleados para los elementos en contacto con el líquido a dosificar:

	Cabezal dosificador	Conexión de aspiración/impulsión	Juntas	Bolas de las válvulas
PP1	polipropileno	polipropileno	EPDM	cerámica
PP2	polipropileno	polipropileno	Viton	cerámica
PP4*	polipropileno	polipropileno	EPDM	Duran
NP1	Plexiglas	PVC	Viton	cerámica
TT1	Teflón grafitado	Teflón grafitado	Teflón	cerámica
SS	acero inoxidable 1.4571	acero inoxidable 1.4571	Teflón	cerámica

*PP4 con muelles de Hast. C. en las válvulas
Membrana dosificadora DEVELOPAN® recubierta de Teflón

Plexiglas (NP), Viton (FKM) y Duran (vidrio de laboratorio) son marcas registradas.
La repetitividad de la dosificación es superior a ± 2% del valor ajustado, en caso de condiciones de servicio constantes y de instalación correcta, ajustando la longitud de la carrera en un valor entre el 30% y el 100% ...
Temperatura ambiente admisible: –10 °C a +45 °C.
Potencia absorbida media a frecuencia máxima de impulsos (W)/Pico de corriente absorbid al efectuar un impulso (A):

G/4a	23 W/0.9 A	a máx. 12[illegible] imp./min.	– todos los tipos
G/5a	54 W/2.1 A	a máx. 120 imp./min.	– tipo 1602, 1006, 0613, 0417, 0230
G/5a	77 W/3.1 A	a máx. 100 imp./min.	– tipo 1605, 1310, 0813, 0423

Conexión eléctrica: 230 V ± 10%; 115 V ± 10%; 50/60 Hz. Margen de tolerancia: 195-265 V; 98-132 V.
Clase de protección IP 65; clase de aislamiento F.
Volumen de suministro: Bomba dosificadora con cable de red (2 m) y enchufe, juego de conexiones para conectar mangueras o tubos según lo indicado en la tabla.

Para informarse de las direcciones de los distribuidores, dirigirse al fabricante:

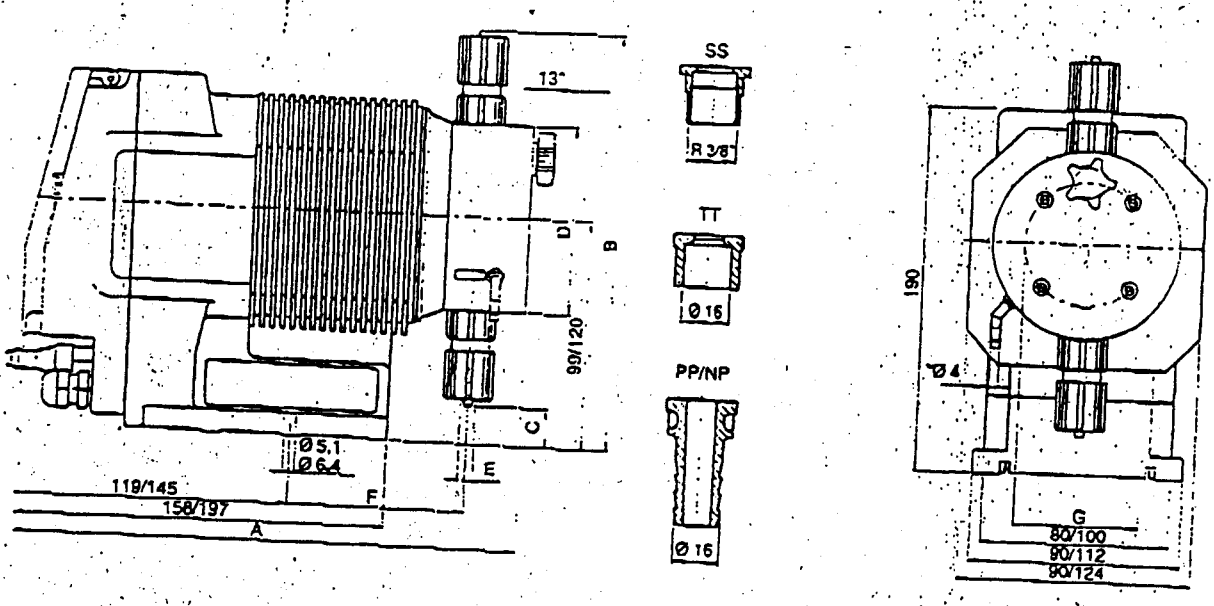
ProMinent Dosiertechnik GmbH
Im Schuhmachergewann 5-11
69123 Heidelberg
Postfach 10 17 60
69007 Heidelberg
Germany
Tel. + 49 (62 21) 8 42-0
Télex 46 16 97
Télefax + 49 (62 21) 8 42-419

PM-PT-257/8.93

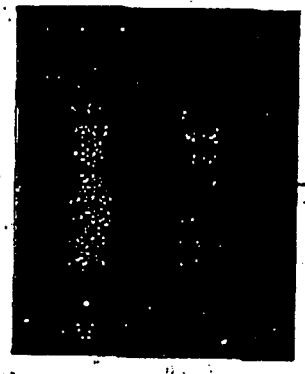
ProMinent®

gamma/4		A	B	C	D	E	F	G
1000. 1601	PP	232	186	17	70	6x4	81	38
1201	NP	230	179	19	70	6x4	81	38
	TT	213	173	25	60	6x4	79	38
	SS1	211	164	34	60	6x5	79	38
	SK1	211	162	36	60	1x8"	79	38
0703	PP	232	186	17	70	6x4	81	38
	NP	230	179	19	70	6x4	8	38
	TT	213	178	20	70	6x4	79	38
	SS1	211	169	29	70	6x5	79	38
1002. 0308	PP	225	186	17	70	8x5	76	50
	NP	223	187	11	85	8x5	76	50
	TT	216	206	-8	80	8x5	79	50
	SS1	214	206	-8	80	8x7	77	50
0215	PP	225	197	6	90	12x9	76	66
	NP	223	195	3	100	12x9	76	66
	TT	216	214	-16	95	12x9	79	66
	SS1	214	209	-11	95	12x10	77	66
1002 HV	PP4	214	172	-4	70	DN.10	60	50
gamma/5								
1602 a 1006	PP	271	207	38	70	8x5	95	50
	NP	269	208	32	85	8x5	95	50
	TT	259	208	13	80	8x5	97	50
	SS1	259	220	20	80	8x7	97	50
(a): 1310 a	PP	271	218	27	90	8x5/12x9	95	66
0613	NP	269	216	24	100	8x5/12x9	95	66
(b): 0813 a	TT	259	237	4	95	8x5/12x9	97	66
0417	SS1	259	230	11	95	8x7/12x10	97	66
0423 a 0230	PP	258	275	-18	135	DN 10-23x16	96	117
	NP	258	275	-18	135	DN 10-23x16	96	117
	TT	258	234	7	135	DN 10-d16	96	117
	SS1	258	234	7	135	DN 10-3/8"	96	117
1006 HV	PP4	269	193	47	85	DN 15	103	50
1310 HV	PP4	270	193	47	85	DN 15	104	66
0813 HV	PP4	269	200	40	100	DN 15	104	66

*Válvula de purga de aire y derivación sólo en los tipos 1000-0417 PP y NP
Dimensiones en mm



pedido de las bombas dosificadores ProMinent® gamma.



PP 1 | 0 0 0 A 0 0 0 0 0

Material del cabezal dosificador:
PP 1 = polipropileno con juntas de EPDM
PP 2 = polipropileno con juntas de Viton
PP 4 = polipropileno HV para líquidos altamente viscosos con juntas de EPDM, y muelles de Hast. C en las válvulas; sólo para 1002, 1006, 1310, 0813
NP 1 = Plexiglas con juntas de Viton
TT 1 = Teflón grafitado con juntas de Teflón
SS 1 = acero inoxidable 1.4571 con juntas de Teflón
SS 2 = acero inoxidable con rosca R 1/4" NPT
SK 1 = acero inoxidable con conexión capilar R 1/8", sólo para G/4 a 1000, 1601, 1201

Muelles en las válvulas:
0 = sin muelle
1 = con 2 muelles en las válvulas 1.4571 0,1 bar

Conexión:
0 = standard según las características técnicas

Tapa transparente:
0 = versión standard
1 = con llave

Conexión eléctrica:
con cable de 2 m de largo
A = 230 V, 50/60 Hz, enchufe plano
B = 230 V, 50/60 Hz, enchufe suizo
C = 230 V, 50/60 Hz, enchufe australiano
D = 115 V, 50/60 Hz, enchufe EE.UU.

Versión de control básica:
0 = versión básica*
1 = versión opcional
2 = versión opcional con iluminación del display digital
*Si se escoge la versión básica "0", todas las funciones opcionales especificadas a continuación deben ser también "0".

Tipo de control:
0 = manual + externo + pausa
1 = ídem 0 + c. analógico 0...20 mA, 4...20 mA
2 = ídem 0 + c. analógico 0-60 mV, 0-1 V, 0-10 V

Control de impulsos:
0 = sin control de impulsos
1 = con control de impulsos

Temporizador:
0 = sin temporizador
1 = con temporizador

Posibilidades de ajuste del relé:
0 = sin relé
1 = relé de alarma, vuelve a reposo en caso de alarma (normalmente cerrado)
2 = relé generador de impulsos, opera cuando se cierra
3 = relé de alarma, se cierra en caso de alarma*
4 = relé temporizador, opera cuando se cierra
*(normalmente abierto)

Ejemplo de un pedido

Se precisa una bomba dosificadora con una capacidad máx. de 1,8 l/h para dosificar, en función del caudal, silicato sódico concentrado en una tubería de agua potabel, a una contrapresión de 6 bar. La bomba se controlará a través de los contactos de un contador de agua ya existente, con un intervalo de impulsos excesivo, o bien a través de un caudalímetro magnético-inductivo (IDM), con una señal de 4-20 mA. En caso de fallos, se debe activar la correspondiente alarma en la central, y la bomba deba tener un sistema de seguridad para evitar que sea manipulada por personas no autorizadas. Será instalada en Francia.

El número de referencia de la gamma es el siguiente:

[redacted] | PP1 | 1 0 1 A 1 1 1 0 1

[redacted]	Serie	1	Con muelles en las válvulas, por tratarse de un líquido viscoso
[redacted]	Presión máxima de 10 bar	0	Conexión standard 8 x 5 mm
[redacted]	Caudal máximo de 2,09 l/h	1	Tapa con llave
PP1	Resistencia del material cabezal dosificador y juntas)	A	230 V, 50-60 Hz enchufe plano
1	Versión opcional		
1	Control analógico 4-20 mA		
1	Con control de impulsos para la multiplicación de los impulsos		
0	Sin temporizador		
1	Relé de aviso de fallos, vuelve a reposo en caso de alarma		

...funciones opcionales. Ud. puede elegir el tipo de bomba que satisfaga sus exigencias personales.

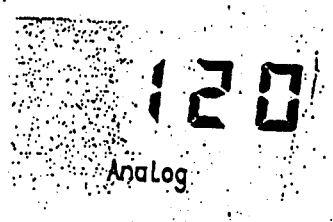
CONTROLES ADICIONALES Y FUNCIONES OPCIONALES

Iluminación

Se puede iluminar por detrás el display digital, lo que hace posible una perfecta legibilidad de las indicaciones, incluso en condiciones deficientes de luz o en caso de montaje en un sitio desfavorable. Todos los controles adicionales y las funciones opcionales se pueden suministrar por separado o como paquete combinado libremente.

Analog Control (control analógico)

Se pueden emplear señales analógicas para controlar de forma proporcional la frecuencia de impulsos entre 0 y 100%, dependiendo de la señal (0/4-20 mA). Se puede ajustar el número máximo posible de impulsos por minuto. Si se utiliza una señal analógica de 4-20 mA, la bomba se para y se activa la alarma cuando la señal de entrada es inferior a 4 mA (p. ej. en el caso de rotura de cable). Al formular el pedido, se pueden solicitar otras señales de entrada (0-1 V, 0-10 V, 0-60 mV), mediante el código especial de identificación.



Pulse Control (control de impulsos)

Adapta la bomba ProMinent® gamma a cualquier tipo de generadores de impulsos. No es necesario disponer de otras unidades de control. Las siguientes funciones pueden ajustarse mediante pulsadores:

Multiplicación y División de impulsos

La multiplicación y división se define entrando un factor entre 0,01 y 9999. p. ej.:
división-entrando con el factor
0,01: (100 impulsos externos = 1 impulso de la bomba)
0.25: (4 impulsos externos = 1 impulso de la bomba)
1: (1 impulso externo = 1 impulso de la bomba)
Multiplicación – entrando el factor
4: (1 impulso externo = 4 impulsos de la bomba)
9999: (1 impulso externo = 9999 impulsos de la bomba)

Contador de preselección "N —"

El número de impulsos preseleccionado, p. ej. 20 (máx. 9999) se activa mediante un contacto libre de potencial o el pulsador P, indicándose el número de impulsos pendientes en el display digital.

Memoria "Mem."

Se puede conectar adicionalmente una memoria intermedia, con una capacidad de almacenamiento de 65.535 (2^{16}-1) impulsos. Si la frecuencia de los impulsos recibidos es superior a la frecuencia máxima de la bomba, éstos quedan almacenados y la bomba continúa dosificando hasta finalizar la secuencia. Es decir, se puede emplear una bomba dosificadora de menor capacidad en algunas aplicaciones. Esto es un ejemplo concreto de cómo se pueden minimizar los costos.

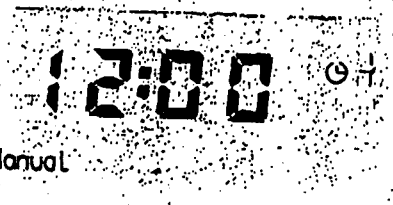
Contador de impulsos "N"

Totalizador del número de impulsos, hasta un máximo de 19998 impulsos.

FUNCIONES OPCIONALES

Temporizador

Esta función permite programar hasta 31 tiempos de dosificación, con reiteración diaria o semanal y con intervalos de 1 minuto a 24 horas. Se utiliza p. ej. para la dosificación automática de microbicidas, para tratamientos de choque en la industria del papel y en torres de refrigeración contra la formación de algas y limos.



Salida de relé

Sirve para la telestransmisión de señales, p. ej. del aviso de fallo a la central de mando, o bien para el control externo de p. ej. una segunda bomba dosificadora ProMinent® que trabaja en régimen sincronizado. Posibilidades de ajuste:

Alarma general

Alarma previa del control de nivel y desconexión final de la bomba, control de dosificación, fallos del sistema, aviso de fallo de los fusibles y de la red. Principo de funcionamiento: el relé vuelve al estado de resposo en caso de alarma (normalmente cerrado).

Relé de alarma

Alarma previa del control de nivel y desconexión final de la bomba, control de dosificación, fallos del sistema. El relé se excita en caso de alarma (normalmente abierto).

Relé generador de impulsos

Con generación de impulsos paralelos a cada impulso del electroimán de la bomba; duración del contacto: 150 mseg. La función deseada debe especificarse en el pedido.

OTRAS VERSIONES:

Tensión reducida 12/24 V y versión RS

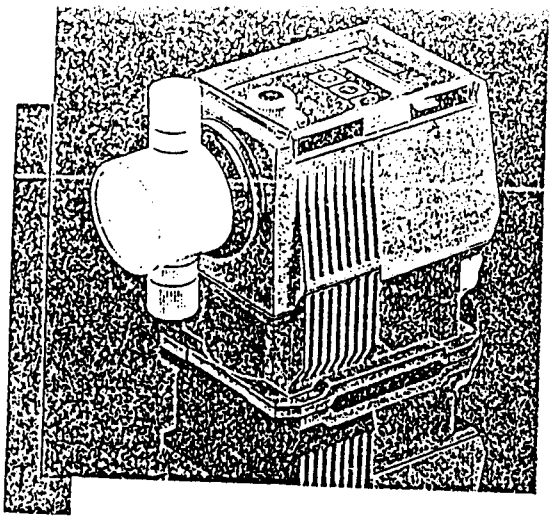
Disponemos de las versiones g/4-W y g/4-I de la gamma/4 para tensiones reducidas de 12 V c. c. y 24 V c. a./c. c. y de la versión g/4-RS con interfase serie RS 232 para control a través de los ordenadores del cliente. Las gamma G/4a para tensiones reducidas, G/4a y G/5a para control por ordenador con interfase RS 232/RS 485 se encuentran en vías de preparación.

ProMinent® Remote Control

La combinación ProMinent® Remote Control, compuesta por una bomba dosificadora gamma G/4Ra o G/5Ra y un mando a distancia, permite controlar y operar la bomba desde una distancia de hasta 100 m.

ProMinent® mikro g/5

Es una bomba dosificadora interactiva de precisión, controlada por microprocesador, de uso en laboratorios y la industria. La carcasa, el manejo y las opciones de la mikro MG5a son idénticos a los de la gamma G/5a. Tiene un rango de caudales desde 1 µl/impulso a 1500 ml/hora; la presión de trabajo máx. es de 40 bar y la precisión de dosificación es superior a ± 0,5%. Les facilitaremos gustosamente información más detallada, si Vds. la solicitan.



Microcontroller - Diaphragm Dosing Pump M 205 Etron M

Construction and function

The new diaphragm dosing pump M 205 Etron M is a reciprocating displacement pump equipped with an efficient electric motor and microcontroller electronics for diverse control applications.

The pump is driven by an overload - proof synchronous motor. The rotation of the motor is transformed into the suction and stroke movements of the diaphragm by a precise eccentric - tappet - spring system, secondary to the gears.

Thus a defined volume (stroke volume) of the dosing medium is sucked up via the suction valve into the dosing head and displaced through the pressure valve into the dosing line.

The suction and pressure valves are reliable double ball valves.

Mechanical variation of the stroke length at the stroke adjustment knob enables linear adjustment of the dosing output in the ratio 1 : 10.

The integrated microcontroller electronics facilitate the application of the pump to nearly all control tasks occurring in liquid dosing techniques.

The dosing pump can be configured by the customer to the required function via the alphanumeric display with multilingual operator prompting and only four operator buttons (function chart see overleaf).

Mains cable and mains plug are standard equipment of the pump.

Design variants

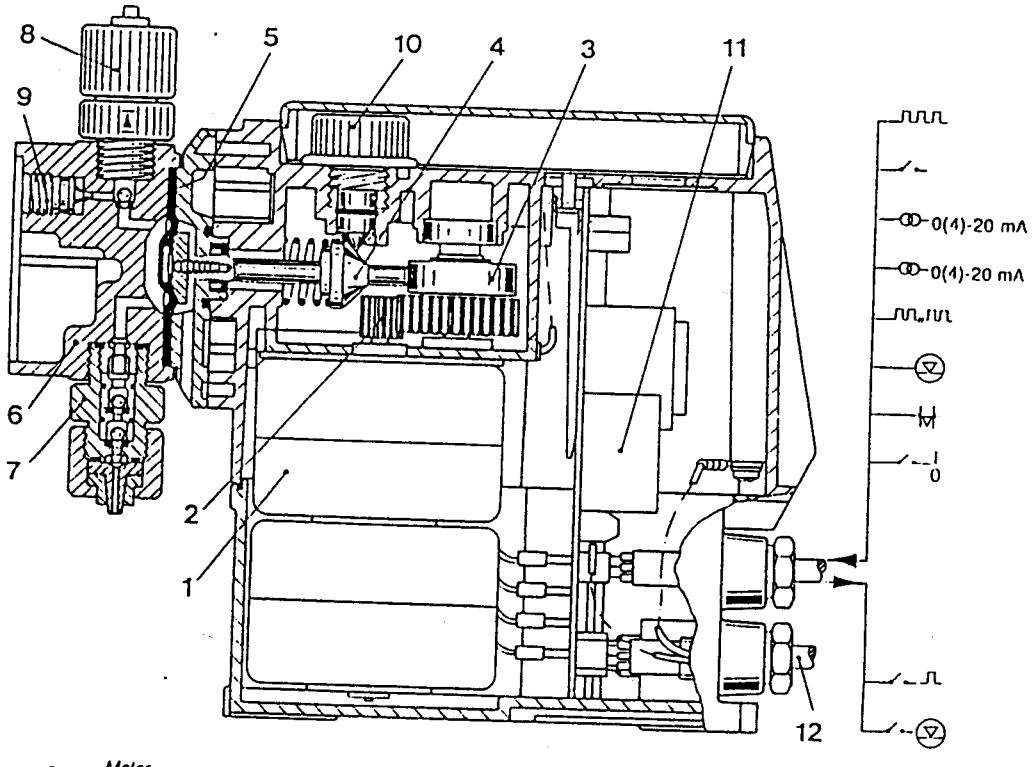
The pump variant described in this product information is available in different material combinations of dosing head and valves as well as for different supply voltages.

The pump series M 205 also includes a standard version without electronics and two electronic versions for simple control applications.

For these versions refer to the product information 1.2/205-01.

Advantages at a glance

- high control function flexibility due to the capable microcontroller electronics
- high dosing precision and linear dosing characteristic
- harmonic dosing process thanks to the electric motor preventing pulsation strokes
- optimal for application in humid locations due to the high degree of protection of the pump
- ideal for the use in laboratories due to the low - noise operation and chemically resistant pump enclosure
- universally resistant, PTFE - coated dosing diaphragm
- easy start up by integrated dosing head deaeration with ecologically beneficial medium recirculation into the dosing receptacle



1	-	*Motor*	5	-	*Dosing diaphragm*	9	-	*Dosing head deaeration*
2	-	*Gears*	6	-	*Dosing head*	10	-	*Stroke adjustment knob*
3	-	*Eccentric*	7	-	*Suction valve*	11	-	*Electronics*
4	-	*Tappet*	8	-	*Pressure valve*	12	-	*Mains cable*

Function chart / diaphragm dosing pump M 205 Etron M

- Display - operator prompting selectable in German, English or French
- Mains frequency adjustable to 50 or 60 Hz
- Configuration error detection with error indication on the display

Basic functions

Manual control
- Continuous operation, stroke frequency selectable 1 - 121 strokes / min. with 50 Hz and 1 - 145 strokes / min. with 60 Hz
- Batch dosing, stroke frequency per batch selectable 1 - 10.000

Pulse signal control
- Proportional dosing, multiplication or devision factor of the input contacts freely selectable
- Batch dosing, stroke frequency of the batch per input contact selectable 1 - 10.000

Current signal control
- Proportional dosing, input signal range 0 - 20 mA or 4 - 20 mA and 20 - 0 mA or 20 - 4 mA selectable

Measured value dependent control
- selpoint of the controlled variable adjustable
- weighting factor for actual value, proportional factor K_p, reset time T_n, control direction, control response (linear or logarithmic) selectable

General technical data

Accuracy	dosing flow ± 1,5 % / linearily ± 4 %	
Suction height*	6 m water gauge (except for 205-0,2)	
Materials	parts in contact with media: PP / Viton, PVDF / PTFE, steel 1.4571 / Viton dosing diaphragm: PTFE - coated	
Drive	synchronous motor optionally 230 V, 110 V, 240 V or 120 V, 50 / 60 Hz, 8,9 W (up to 205-5,0), 23 W (205-6,0 / 205-10 / 205-14)	
Protection	IP 65 (degree of pump protection)	
Weight	ca. 2,8 kg	
Colour	RAL 6017 (May green) / black	
Dosing head - connections	all types except 205-10 and 205-14: DN 4 for PE / PVC - hose 4/6, PVDF - tube 4/6, steel - tube 4/6	205-10 and 205-14: DN 8 for PVC - hose 6/12 or PP - tube DN 10 (16 x 2), PVDF - tube DN 10 (16 x 2), steel tube 1/4"
Signal inputs	contact signal input, max. load 5 mA 2 current signal inputs, input load each 22 Ω input for remote On / Off, contact load 5 mA input for dosing controller (NAMUR) input for receptacle empty indication (ALLDOS - empty indication sensor)	
Signal outputs	stroke signal output, max. load 250 V / 2 A (ohmic load), contact time 250 msec. / stroke output empty indication, max. load 250 V / 2 A (ohmic load)	

** Referring to media not viscous and not outgassing*

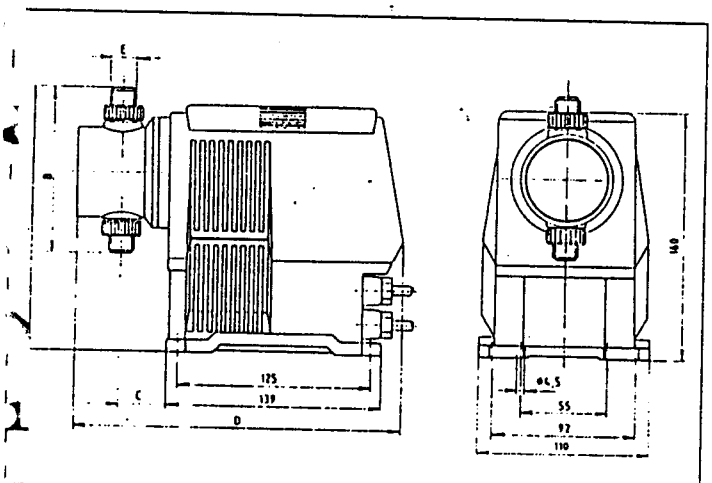
Version: dosing head and valves of PP, operating voltage 230 V (+ 6 % / - 10 %), 50 / 60 Hz, with microcontroller electronics E05

Order number	Stroke cm³	50 Hz l/h	50 Hz bar	50 Hz s/min	60 Hz l/h	60 Hz USg/h	60 Hz bar	60 Hz psi	60 Hz s/min
205-0,2 / E05	0,04	0,3	10	121	0,36	0,095	10	145	145
205-0,8 / E05	0,14	1	10	121	1,20	0,317	10	145	145
205-1,6 / E05	0,22	1,6	10	121	1,92	0,51	10	145	145
205-3,0 / E05	0,42	3	10	121	3,90	1,03	6,8	100	145
205-5,0 / E05	0,69	5	6	121	6	1,58	5	72	145
205-6,0 / E05	0,84	6	8	121	8	2,11	6	90	145
205-10 / E05	1,24	9	6	121	11	2,90	5,5	80	145
205-14 / E05	1,92	14	4	121	17,2	4,54	3	45	145

Range of further materials for dosing head and valves

Ref. no.*	Material (body / gaskets / valve ball)
D02	1.4571 / PTFE / 1.4401 without deaeration valve
D03	PVDF / PTFE / ceramics with deaeration valve
D57	1.4571 / PTFE / 1.4401 with deacration valve

** When ordering these versions indicate their reference numbers*



Pump type	Measurements in mm				
	A	B	C	D	E
205-0,2 to 205-6,0	170	108	30	211	R 3/8"
205-10 and 205-14	182	131	36	213	R 5/8"

Range of further mains voltages

Ref. no.*	Data
V00	230 V (+ 6 % / - 10 %), 50 / 60 Hz
V01	110 V (+ 10 % / - 10 %), 50 / 60 Hz
V02	240 V (+ 10 % / - 10 %), 50 / 60 Hz
V06	120 V (+ 10 % / - 10 %), 50 / 60 Hz

** When ordering these versions indicate their reference numbers*

Signal transmission cable, 4-core, length 2 m, including circular connector for the panel jack of the pump

Order no.	
321-205	for control signal input and remote On / Off
321-206	for potential-free output for empty indication and stroke signalling

Technical data subject to change without notice

ALLDOS Eichler GmbH
Reetzstr. 85 · D-76327 Pfinztal (Söllingen)
Postfach 12 10 · D-76318 Pfinztal
Tel. (0 72 40) 61-0, Fax (0 72 40) 61 177
Tx. 7 826 524 dos

APENDIX 2

Gear Pumps

ISMATEC VARIABLE-SPEED DRIVES

STANDARD DIGITAL DRIVE

- *Pulseless flow from 0.3 to 6650 ml/min*
- *Numeric speed adjustment*
- *Remote control capability*

This standard variable-speed drive accepts any MICROPUMP® pump head with standard canister (series B and D). Select pump heads and service kits from the table at the bottom of the facing page.

Precisely control speed from 70 to 6100 rpm with an accuracy of ±1% of setting over full range. Electronic feedback system compensates for changes in load. Tach-generator on motor shaft produces a 0-7 VDC output signal for remote indication of motor rpm.

Use the three-digit potentiometer to set pump speed from 0.1 to 99.9%. **NOTE:** Avoid running drive continuously at less than 20% or more than 85% of full speed. Press the "max" button for extra rpm; ideal for quick pump priming.

Control input port (DB15 female connection) lets you use peripheral instruments to actuate many of the drive functions from a remote location (remote cable required). Use a remote controller (with NO contact) to turn the pump on and off; use an external control signal (0-4.7 VDC, 0-10 VDC, 0-20 mA, or 4-20 mA) to vary pump speed.

Permanent-magnet DC motor provides smooth acceleration. Motor magnetically couples to pump head so there are no shaft seals to wear out or leak. Drive housing measures 9½"W x 6⁵⁄₁₆"H x 7¹³⁄₁₆"D. Both the 110 and 220 VAC models include a 6-ft power cord with U.S. standard plug. Order drive and remote cable from the table on the facing page.

NEW PROGRAMMABLE DIGITAL DRIVE

- *LED display indicates flow rate*
- *Built-in RS-232-C interface and optional software let you automate pumping processes*

Choose this new programmable digital drive for versatility! Drive offers the same features as the standard digital drive at left plus the advantages of a built-in RS-232-C interface. Order RS-232-C interface cable 78098-50 separately below to connect drive to any IBM® PC/XT/AT® or 100% compatible computer. You can also use the optional software with additional cables to control up to eight drives simultaneously!

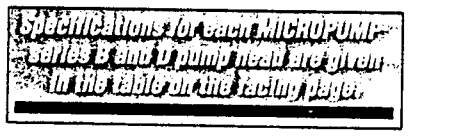
Front-panel keypad lets you set all operating parameters including pump speed (1-6100 rpm) and dispensing mode.The 4-digit LED with adjustable scale indicates flow rate or drive rpm. Use drive for continuous pumping or select one of the three dispensing modes for added convenience. Use the time mode to set dispense and pause times. The step mode lets you set the number of shaft rotations for precise dispensing. Use the valve mode to control an external diverter valve (not included) for dispensing two liquids in the same batch. You can even use all three modes simultaneously for maximum versatility and dispensing accuracy.

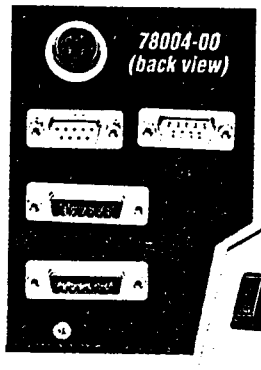
Control pump speed remotely via an analog input signal (0-4.7 VDC, 0-10 VDC, 4-20 mA, or 0-20 mA); start and stop flow remotely via contact closures. Make all remote control connections via the back panel DB15 female connector. Tachometer output sends a voltage signal (0-7 or 0-4.35 VDC) proportional to drive speed. Or, order optional software 78002-99 (sold below) to control all drive functions including calibration, ramp and on/off times, and fluid direction.

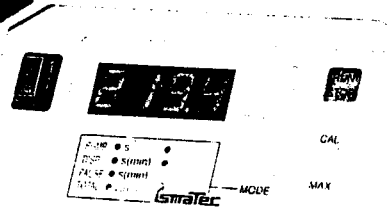
Drive measures 6"W x 10⅜"H x 8½"D: includes a 5-ft cord with U.S. standard plug. Operates on 110/220 VAC, 50/60 Hz (switch selectable). Order drive from table on facing page.

H-78002-99 Software **$353.00**
H-78098-50 RS-232-C interface cable **$177.00**
H-07610-25 Optional remote foot switch **$206.00**

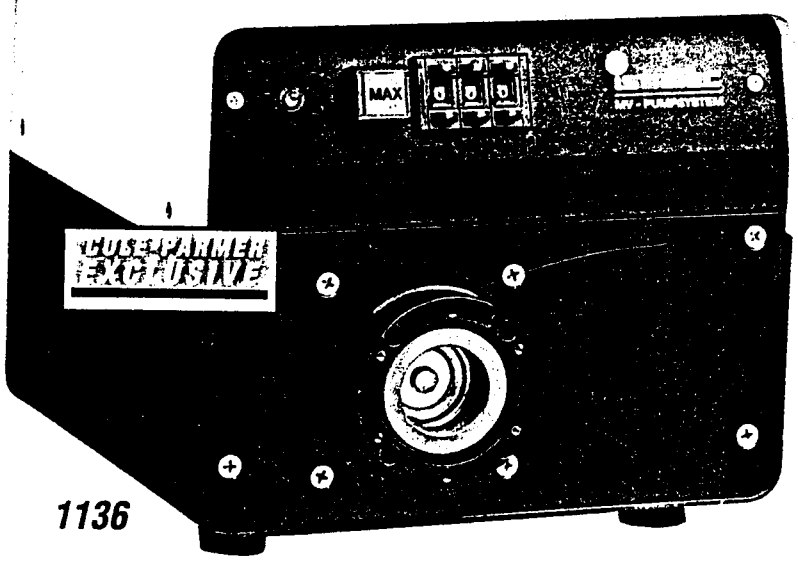
IBM, PC/XT/AT—Reg TM International Business Machines Corp.

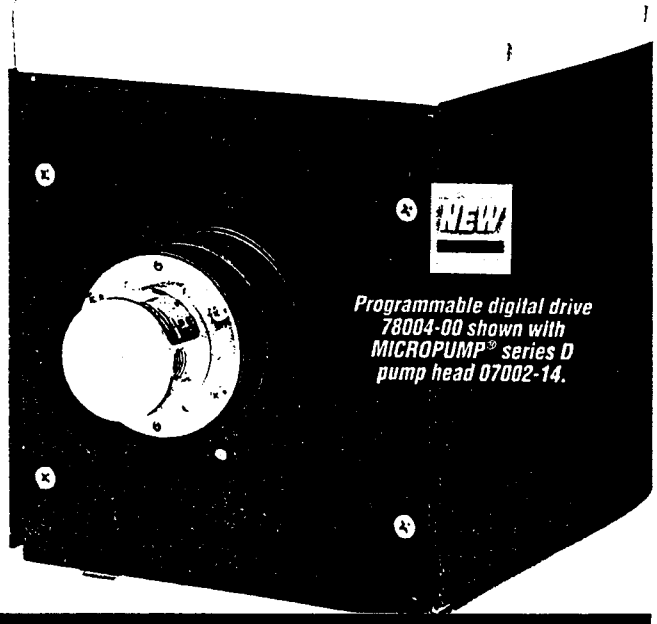






Standard digital drive 07617-70 accepts any MICROPUMP® series B and D pump heads.

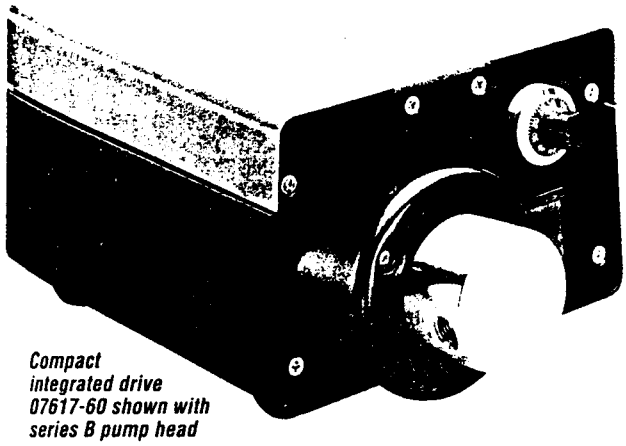




Programmable digital drive 78004-00 shown with MICROPUMP® series D pump head 07002-14.

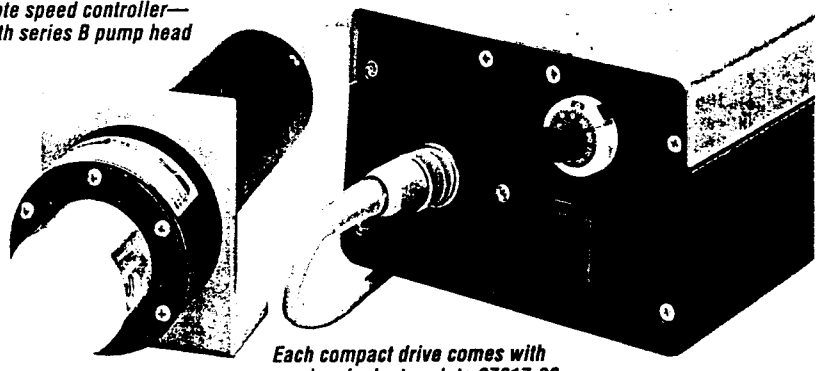
COMPACT DRIVES

- Flow from 0.1 to 4700 ml/min
- Remote control capability



Compact integrated drive 07617-60 shown with series B pump head

Compact, unmounted drive 07617-75 with remote speed controller—shown with series B pump head



Each compact drive comes with pump head adapter plate 07617-90.

Use these space saving, variable-speed drives with MICROPUMP pump heads with standard canister (series B and D except models 07003-02 and -04). Each compact drive comes with adapter plate 07617-90 for mounting pump head.

Adjust speed with the 10-turn potentiometer—get linear speed regulation from 50 to 5000 rpm with an accuracy of ±1% over the full range. **NOTE:** Avoid running drives continuously at less than 20% or more than 85% of full speed.

Five-pin remote-input port on back panel accepts a 0-4.7 VDC, 0-10 VDC, 0-20 mA, or 4-20 mA signal for speed control; couples with relay contact for on/off control (order remote cable from table at right).

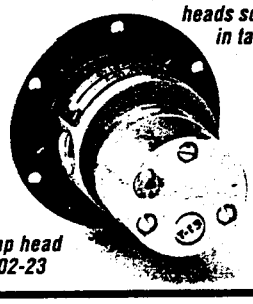
Choose either an integrated drive or a modular drive. The integrated drive measures just 7¾"L x 5"W x 3¾"H. The modular drive connects to a remote speed controller via a 6-ft cord (drive measures 6¾"L x 2½"W x 3⅛"H; controller measures 7¾"L x 5"W x 3¾"H). Both the integrated and the modular drives are available in 110 and 220 VAC versions; include a 6-ft power cord with U.S. standard plug.

H-07617-90 Replacement adapter plate for mounting MICROPUMP series B and D pump heads (except models 07003-02 and -04) on compact drives **$13.75**

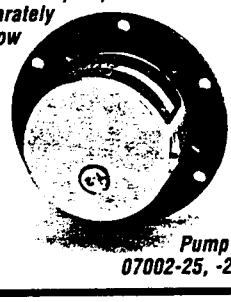
ORDERING INFORMATION FOR DRIVES

Catalog number	Power VAC, Hz	Shpg wt lbs (kg)	Price	Remote cable	
				Cat. no.	Price
Standard digital drive					
H-07617-70 H-07617-72	110, 60 220, 50	19 (8.6) 19 (8.6)	$2060.00 2060.00	H-07339-50	$136.00
Programmable digital drive					
H-78004-00	115/230, 50/60	16 (7.3)	2820.00	—	—
Compact integrated drive					
H-07617-60 H-07617-62	110, 60 220, 50	7 (3.2) 7 (3.2)	1390.00 1500.00	H-07339-54	82.50
Compact modular drive and controller					
H-07617-75 H-07617-77	110, 60 220, 50	6 (2.7) 6 (2.7)	1590.00 1590.00	H-07339-54	82.50

MICROPUMP® series B and D pump heads sold separately in table below



Pump head 07002-23



Pump heads 07002-25, -26, -27

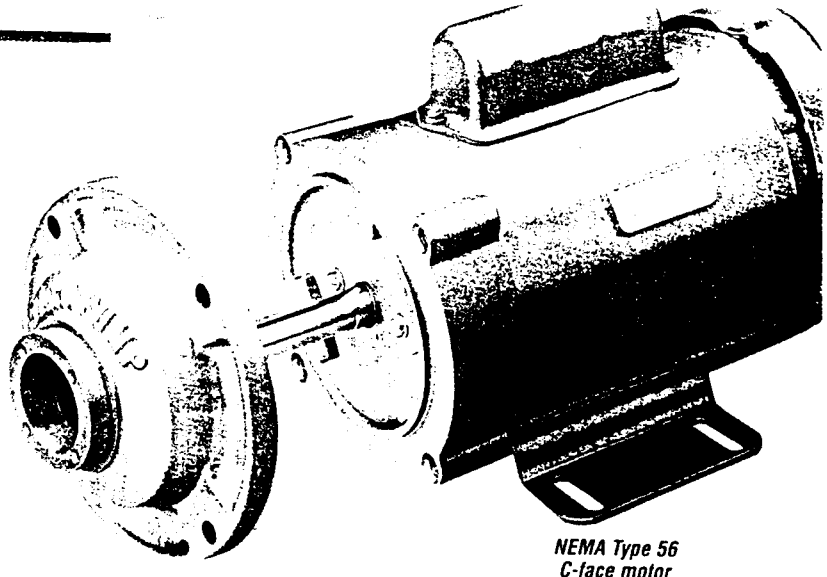
SPECIFICATIONS AND ORDERING INFORMATION FOR MICROPUMP® PUMP HEADS

Pump head series		Max flow (ml/min)		Max pressure (psi)		Materials of construction			Temperature range	Bypass valve	Price	Service kit	
Series	Cat. no.	Digital	Compact	System	Diff	Body	Gears[1]	Seals				Cat. no.	Price
Canister heads with standard canister													
B	H-07002-16	1950	1580	300	45	316 SS	Teflon®	Teflon	-50 to 130°F[2]	No	$405.00	H-07144-38	$136.00
B	H-07002-17	1950	1580	300	45	316 SS	Teflon	Teflon	-50 to 130°F[2]	Yes	405.00	H-07144-38	136.00
B	H-07002-23	3900	3200	300	45	316 SS	Teflon	Teflon	-50 to 130°F[2]	Yes	373.00	H-07002-08	84.50
B	H-07001-80	3900	3200	300	45	316 SS	Ryton®	Teflon	-50 to 250°F	Yes	373.00	H-07001-89	84.50
B	H-07001-40	5730	4700	300	45	316 SS	Ryton	Teflon	-50 to 210°F	Yes	373.00	H-07001-41	84.50
Pump head only, with adapter plate													
D	H-07002-25	104	85	300	50	316 SS	Teflon	Teflon	-50 to 130°F[2]	No	419.00	H-07144-42	141.00
D	H-07002-26	250	210	300	50	316 SS	Teflon	Teflon	-50 to 130°F[2]	Yes	419.00	H-07144-44	141.00
D	H-07002-27	510	420	300	50	316 SS	Teflon	Teflon	-50 to 130°F[2]	Yes	419.00	H-07144-47	141.00
D	H-07002-14	560	460	300	50	316 SS	Ryton	Teflon	-50 to 210°F	Yes	419.00	H-07144-34	141.00
D	H-07003-02	3440	—	300	50	316 SS	Teflon	Teflon	-50 to 210°F	Yes	392.00	H-07003-12	101.00
D	H-07003-04	6650	—	300	45	Ryton/316 SS	Ryton	Viton®	-50 to 250°F	Yes	392.00	H-07003-14	101.00

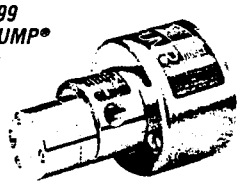
[1]See pages 1130-1131 for complete information on these pump heads and service kits. [2]Port size for all models is ⅛" NPT(F). [3]Temperatures up to 210°F can be reached using optional high-temperature seals 07002-05 on page 1130. **MICROPUMP**—Reg TM Micropump Corp. **Ryton**—Reg TM Phillips Petroleum Co. **Teflon, Viton**—Reg TM E. I. du Pont de Nemours & Co.

MICROPUMP® PUMP HEAD ADAPTER KITS

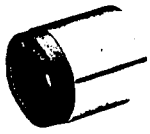
Use these adapter kits to attach MICROPUMP® pump heads with standard canister (series B and D; pages 1130-1131) to your own specialty motor. Choose from four types including IEC/ISO kits for metric frame drives.



Adapter kit 07003-99 couples a MICROPUMP® series B or D pump head to your NEMA Type 56



MICROPUMP® pump head



Hub assembly

Metal adapter

NEMA Type 56 C-face motor

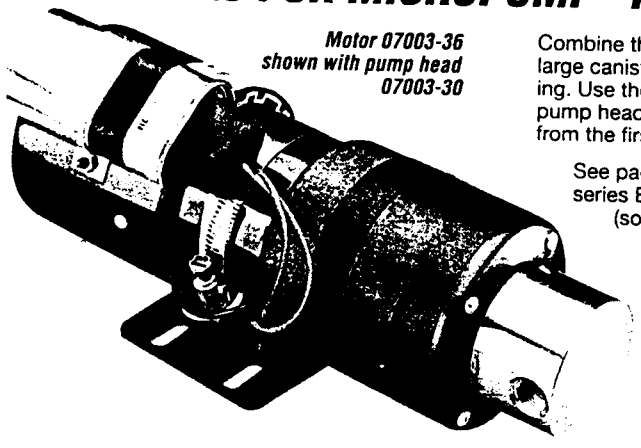
H-07003-97 IEC 72/ISO 71 pump head adapter kit for IEC/ISO 71 drives.Includes hub assembly (drive magnet), hex key, mounting bolts, and mounting plate. Shpg wt 3 lbs (1.4 kg) **$228.00**

H-07003-98 IEC 72/ISO 63 pump head adapter kit for IEC/ISO 63 drives. Includes hub assembly (drive magnet), hex key, mounting bolts, and mounting plate. Shpg wt 3 lbs (1.4 kg) **$228.00**

H-07003-99 NEMA Type 56 C-face pump head adapter kit for 3450 rpm, 56 C-face drives. Includes metal adapter, hub assembly (drive magnet), mounting screws and bolts, and an Allen wrench. Shpg wt 3 lbs (1.4 kg) **$228.00**

H-07002-15 MICROPUMP pump head adapter for 600 rpm Masterflex® L/S drives **$144.00**

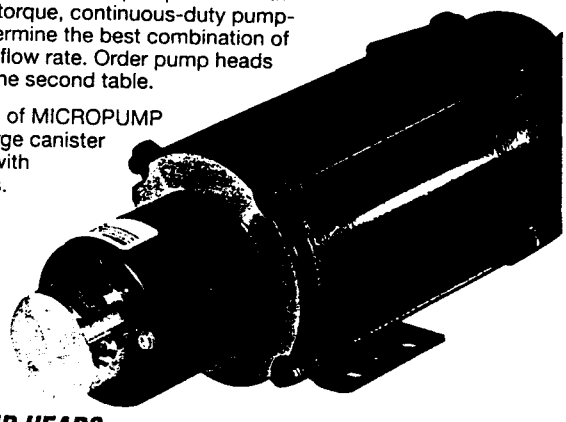
MOTORS FOR MICROPUMP® PUMP HEADS WITH LARGE CANISTER



Motor 07003-36 shown with pump head 07003-30

Combine these powerful motors with MICROPUMP pump heads with large canister (series E and G) for high-torque, continuous-duty pumping. Use the table directly below to determine the best combination of pump head and motor for your desired flow rate. Order pump heads from the first table; order motors from the second table.

See page 1132 for a full description of MICROPUMP series E and G pump heads with large canister (sold below) and pump heads with 56 C-face flange adapters.



Motor 07002-49 shown with pump head 07003-06

SPECIFICATIONS AND ORDERING INFORMATION FOR MICROPUMP® PUMP HEADS

Pump heads		Max flow (liters/min) using indicated pump motor					Price	Service kits	
Series	Cat. no.	07002-51, -49	07003-36	07003-37	07003-83	07003-82		Cat. no.	Price
E	H-07001-92	—	5.4	5.4	5.4	5.5	$3680.00	—	—
E	H-07001-94	—	10.9	10.9	10.9	11.3	4220.00	—	—
G	H-07003-06	3.0	—	—	—	—	816.00	H-07003-16	$114.00
G	H-07003-08	5.4	—	—	—	—	816.00	H-07003-18	114.00
G	H-07003-30	—	5.5	4.5	5.5*	7.4†	855.00	H-07003-38	114.00
G	H-07003-31	—	11.3	9.0	11.3*	14.9†	855.00	H-07003-39	114.00

*Due to torque limitations, maximum intermittent pressure may be lower in these pump head/motor combinations.
†These pump head/motor combinations require 40 psi air to inlet pressure.

SPECIFICATIONS AND ORDERING INFORMATION FOR MOTORS

Cat. no.	Type	rpm	Motor	hp	Power source	Termination	Dimensions	Shpg wt	Price
H-07002-51	AC	3400	TEFC/PSC	0.125	115/230 VAC, 50/60 Hz, 2.1 A	14" wire leads	7½"L x 4¾"W x 5¼"H	9 lbs (4.1 kg)	$340.00
H-07003-36	AC	3200	TEFC/PSC	0.250	115 VAC, 50/60 Hz, 3.0 A	15" wire leads	7½"L x 4¾"W x 5½"H	10 lbs (4.5 kg)	340.00
H-07003-37	AC	3200	TEFC/PSC	0.250	230 VAC, 50 Hz, 1.5 A	15" wire leads	7½"L x 4¾"W x 5½"H	10 lbs (4.5 kg)	340.00
H-07002-49	AC	3150	XPRF/PSC	0.170	115/230 VAC, 50/60 Hz, 1.8 A	6" wire leads	12¼"L x 4¾"W x 5¼"H	25 lbs (11.3 kg)	634.00
H-07003-83	AC	3150	XPRF/PSC	0.170	115/230 VAC, 50/60 Hz, 2.2 A	6" wire leads	12¼"L x 4¾"W x 5¼"H	20 lbs (9.1 kg)	634.00
H-07003-82	Air	4300	Air/vane	0.300	10 to 16 SCFM, 20 to 60 psi	¼-28 UNF	8¾"L x 4¾"W x 6"H	7 lbs (3.2 kg)	653.00

Masterflex—Reg TM Cole-Parmer Instrument Co. MICROPUMP—Reg TM Micropump Corp.

CAVITY-STYLE PUMP HEADS

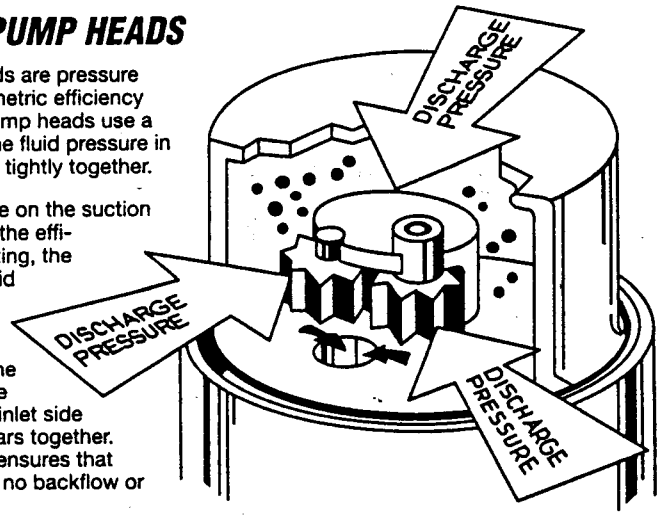
Series A, B, E, and F pump heads use conventional cavity-style gear technology. These cavity-style pump heads feature suction lift capabilities, are easier to clean and service, and are less expensive than the pressure-loaded type.

Cavity-style gear pumps do not use a suction shoe but depend on the surrounding pressure in the magnet cup cavity to hold the gears tightly together. Since it is imperative that the gear tips mesh exactly, cavity-style pump heads often use helical gears composed of extremely low friction material—such as Teflon®.

PRESSURE-LOADED PUMP HEADS

Series C, D, G, and H pump heads are pressure loaded, thus increasing the volumetric efficiency of the pump. Pressure-loaded pump heads use a suction shoe which works with the fluid pressure in the magnet cup to seal the gears tightly together.

The higher the discharge pressure on the suction shoe and mesh point, the higher the efficiency of the pump. While operating, the magnetic cup is filled with the fluid being pumped. The suction shoe is positioned around the inlet and meshing point (see diagram at right). The pressure on the outlet side of the pump should be greater than the pressure on the inlet side to force the suction shoe and gears together. In this manner, the suction shoe ensures that fluid transport is complete—with no backflow or leakage between gear tips.



MICROPUMP® PUMP HEAD AND MOTOR COMPATIBILITY GUIDE

Use the following charts to compare the maximum flow rates that are achievable with various motor and MICROPUMP® pump head combinations. Maximum flow rates (given in ml/min) were determined under conditions of nominal back pressure.

For a complete description of each motor, see the "Motors" section on pages 741-745. For details on pump heads, see pages 1130-1132.

MOTORS FOR MICROPUMP® PUMP HEADS WITHOUT CANISTER (SERIES A AND C)

Motor model number	Max motor speed (rpm)	Maximum flow rate (ml/min) using indicated pump head model at given speed*				
		Series A cavity-style	Series C pressure-loaded			
		07002-20	07002-32	07002-33	07002-35	07002-12
07002-39	500	N/R	8.5	20	40	N/R
07002-42	6000	1920	N/R	N/R	N/R	N/R
07002-38	8000	N/R	135	335	670	740

*N/R = not recommended for use with indicated motor.

MOTORS FOR MICROPUMP® PUMP HEADS WITH STANDARD CANISTER (SERIES B AND D)

Motor model number	Max motor speed (rpm)	Maximum flow rate (ml/min) using indicated pump head model at given speed*											
		Series B cavity-style						Series D pressure-loaded					
		07002-16	07002-17	07002-23	07001-80	07001-70	07001-40	07002-25	07002-26	07002-27	07002-14	07003-02	07003-04
07002-58	1550	495	495	990	990	1040	1460	25	65	130	145	870	1690
07144-93, -94	3000	960	960	1920	1920	2000	2800	50	125	250	275	1690	3300
07144-95, 07003-83	3150	1010	1010	2000	2000	2100	3000	55	130	265	290	1780	3400
07144-00, -02, 07144-05, -07, 75210-00, -05, 75210-10, -15	3600	1150	1150	2300	2300	2400	3400	60	150	300	330	2000	3900
07003-90, 78200-22, 78200-27, 07144-91	4000	1280	1280	2600	2600	2700	3800	70	170	335	370	2300	4400
07617-60, -62, 07617-75, -77	5000	1600	1600	3200	3200	3300	4700	85	210	420	460	N/R	N/R
07617-70, -72 78004-00	6100	1950	1950	3900	3900	4100	5700	105	255	510	560	3400	6600
07144-97	8000	2600	2600	5100	5100	5400	7500	135	335	670	735	4500	8700
07002-44, -45, 07002-46, -47	9000	2900	2900	5800	5800	N/R	N/R	N/R	N/R	760	830	N/R	9800

*N/R = not recommended for use with indicated motor.

MOTORS FOR MICROPUMP® PUMP HEADS WITH LARGE CANISTER (SERIES E AND G)

Motor model number	Max motor speed (rpm)	Maximum flow rate (ml/min) using indicated pump head model at given speed*				
		Series E cavity-style	Series G pressure-loaded			
		07001-52	07003-06	07003-08	07003-30	07003-31
07003-36	3150	9000	N/R	5000	N/R	N/R
07003-37 07002-49	3200	9200	2700	5100	5500	11,100
07002-51	3400	9700	2900	N/R	N/R	11,800
07003-82	4300	N/R	N/R	N/R	7400	N/R

*N/R = not recommended for use with indicated motor.

NEMA TYPE 56 C-FACE MOTORS FOR MICROPUMP® PUMP HEADS WITH NEMA TYPE 56 C-FACE FLANGE ADAPTER (SERIES F AND H)

Max motor speed (rpm)	Maximum flow rate (ml/min) using indicated pump head model with any NEMA Type 56C-face motor at given speed						
	Series F cavity-style			Series H pressure-loaded			
	07001-54	07003-25	07003-27	07003-34	07003-35	07003-32	07003-33
1725	4900	10,400	33,300	1500	2800	3000	6000
3450	9900	20,700	66,600	2900	5500	6000	11,900

MICROPUMP—Reg TM Micropump Corp.
Ryton—Reg TM Phillips Petroleum Co.
Teflon—Reg TM E. I. du Pont de Nemours & Co.

MICROPUMP® PUMP HEADS

■ *Easily interchangeable on various motors* ■ *Pulse-free flow* ■ *Teflon® PTFE, Ryton®, or graphite gears*

These MICROPUMP® pump heads feature an enclosed gear assembly designed for smooth, quiet operation. Driven magnets are encapsulated in 316 stainless steel (SS) and either Teflon® PTFE or Ryton® for good durability and chemical resistance. All-plastic PVDF and Teflon® PTFE pump heads are available—call for details.

Use series A through D (on pages 1130-1131) for your low-flow general-purpose applications—up to 7500 ml/min. Models with an internal bypass valve recirculate excess discharge pressure to the inlet side of the pump to protect the pump head and entire system from excessive pressures. Use series E through H (on page 1132) for your high-capacity applications—up to 38.6 liters/min.

Use the flow performance graphs on pages 1130-1132 for guidance in choosing the best pump head for your application. The graphs and tables are color-coded according to materials of construction; refe the pump head ordering tables for the specific materials. See page 1129 for the maximum flow rates of specific pump head and moto combinations.

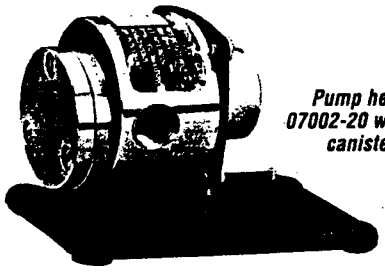
MICROPUMP pump heads feature a ⅛" NPT(F) port size and are i changeable to satisfy a variety of flow rate, pressure, and fluid con patibility requirements. All of these pump heads can be used with motors identified on page 1129.

Optional service kits contain gears, bushings, seals, and suction s (for pressure-loaded pump heads); order kits separately from pum head ordering tables.

MICROPUMP—Reg TM Micropump Corp. Ryton—Reg TM Phillips Petroleum Co. Teflon, Viton—Reg TM E. I. du Pont de Nemours & Co.

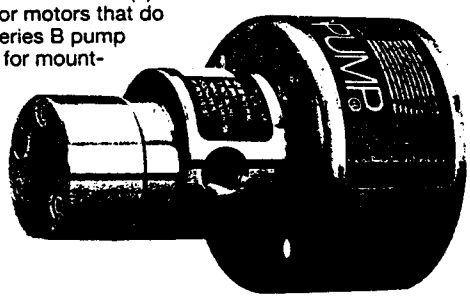
CAVITY-STYLE PUMP HEADS

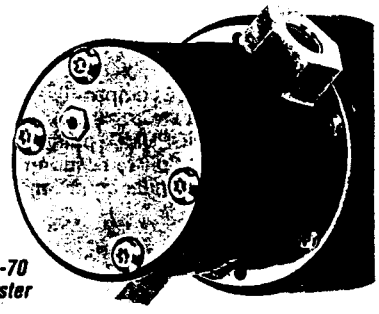
These conventional cavity-style pump heads provide nominal flow rates from 1100 to 3200 ml/min (see table below). Ports are ⅛" NPT(F). Choose series A pump head (model 07002-20) for motors that do not require a canister for mounting. Select any series B pump head for motors that require a standard canister for mounting. Series B pump heads are available with an internal bypass valve.



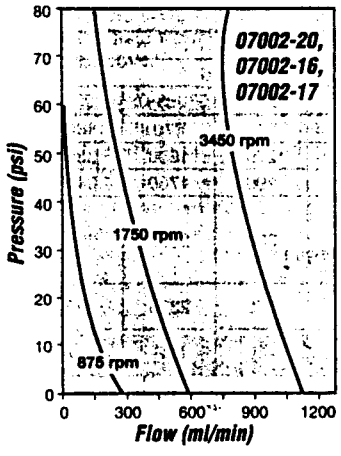
Pump head 07002-20 without canister

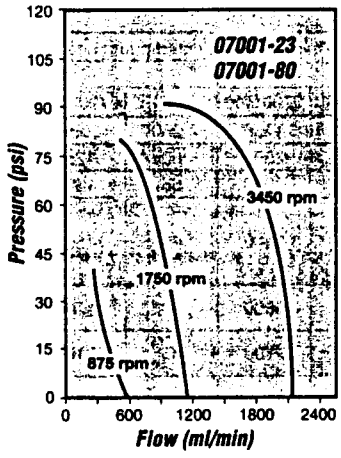
Pump head 07002-23 with internal bypass valve

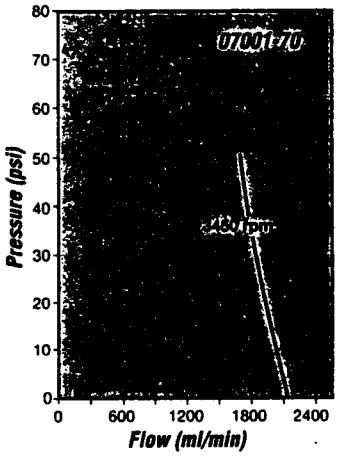


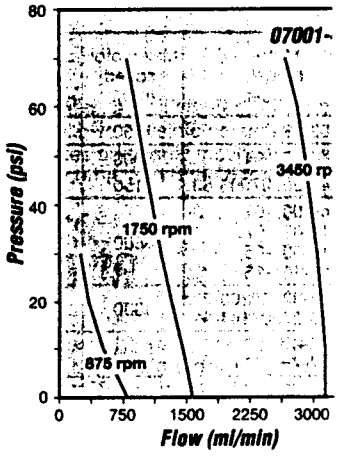


Pump head 07001-70 with standard canister









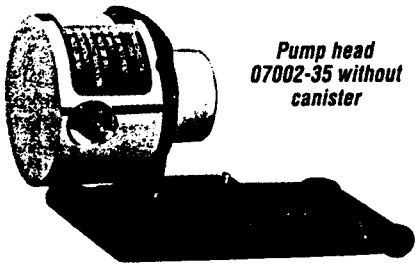
Series	Catalog number	ml/rev	Nominal flow rate (ml/min)*	Max system psi	Max diff psi	Materials of construction: Body	Gears	Seals	Max rpm	Temperature range	Bypass valve	Price	Service kits: Catalog number	Service kits: Pric
Cavity-style pump heads without canister														
A	H-07002-20	0.32	1100	300	45	316 SS	Teflon PTFE	Teflon PTFE	9000	–50 to 130°F†	No	$405.00	H-07002-10	$136
Cavity-style pump heads with standard canister														
B	H-07002-16	0.32	1100	300	45	316 SS	Teflon PTFE	Teflon PTFE	9000	–50 to 130°F†	No	405.00	H-07144-38	136
B	H-07002-17	0.32	1100	300	45	316 SS	Teflon PTFE	Teflon PTFE	9000	–50 to 130°F†	Yes	405.00	H-07144-38	136
B	H-07002-23	0.64	2200	300	45	316 SS	Teflon PTFE	Teflon PTFE	9000	–50 to 130°F†	Yes	373.00	H-07002-08	84
B	H-07001-80	0.64	2200	300	45	316 SS	Ryton	Teflon PTFE	9000	–50 to 250°F	Yes	373.00	H-07001-89	84
B	H-07001-70	0.67	2310	200	45	Ryton/316 SS	Ryton	Viton	9000	–50 to 150°F	Yes	267.00	—	—
B	H-07001-40	0.94	3240	300	45	316 SS	Teflon PTFE	Teflon PTFE	8000	–50 to 210°F	Yes	373.00	H-07001-41	84

*Nominal flow rate pumping water with no back pressure at 3450 rpm. †Up to 210°F using the high-temperature seals below.

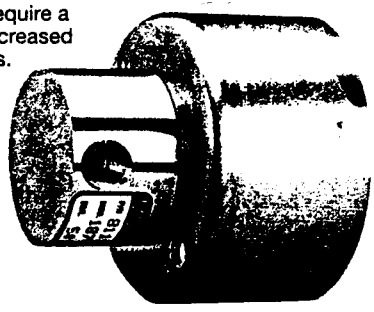
H-07002-05 High-temperature Teflon FEP seals let you use pump heads 07002-16, -17, -20, and -23 (this page) and 07002-12, -25, -26, and - (facing page) at temperatures up to 210°F. Pack of two seals.....$5.9

PRESSURE-LOADED PUMP HEADS

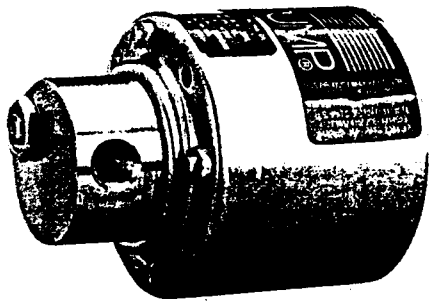
These pressure-loaded pump heads provide nominal flow rates from 60 to 3800 ml/min (see table below). Ports are ⅛" NPT(F). Select series C pump heads for motors that do not require a canister for mounting. Choose series D pump heads for motors that require a standard canister for mounting. All models give you the increased volumetric efficiency common to pressure-loaded systems.



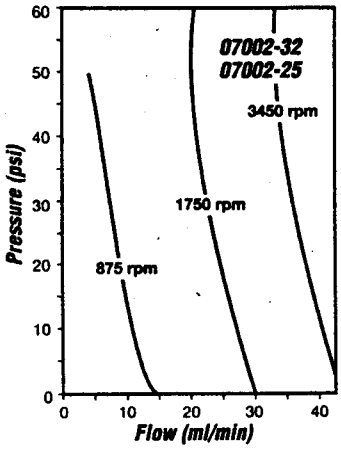
Pump head 07002-35 without canister

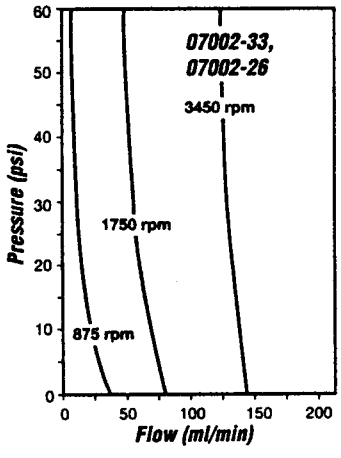


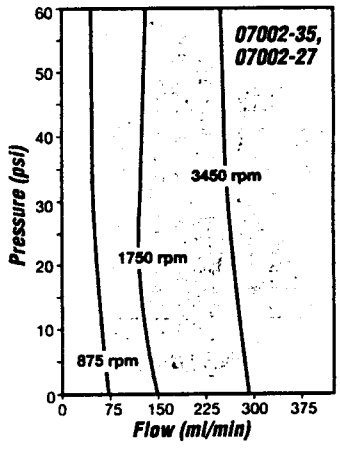
Pump head 07002-25 with standard canister

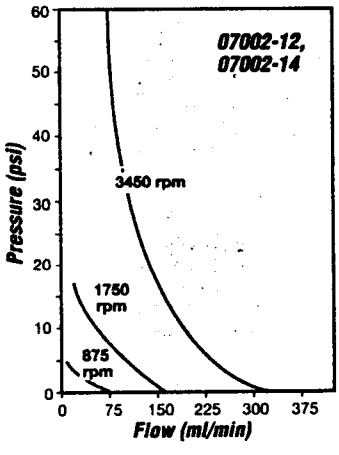


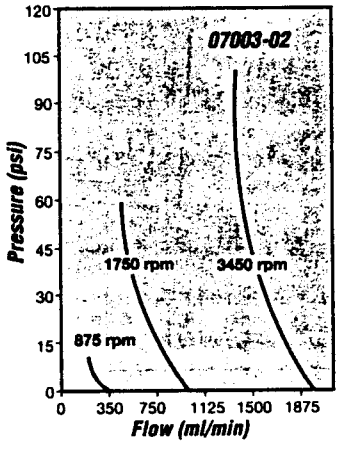
Pump head 07003-02 with standard canister and internal bypass valve

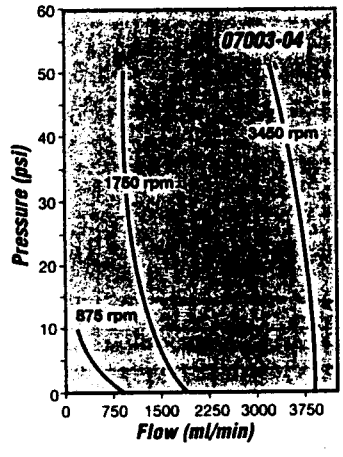










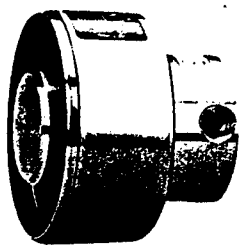


Series	Catalog number	ml/rev	Nominal flow rate (ml/min)*	Max system psi	Max diff psi	Materials of construction			Max rpm	Temperature range	Bypass valve	Price	Service kits	
						Body	Gears	Seals					Catalog number	Price
Pressure-loaded pump heads without canister														
C	H-07002-32	0.017	55	300	50	316 SS	Graphite	Teflon PTFE	8000	-50 to 250°F	No	$419.00	H-07144-42	$141.00
C	H-07002-33	0.042	140	300	50	316 SS	Graphite	Teflon PTFE	8000	-50 to 250°F	No	419.00	H-07144-44	141.00
C	H-07002-35	0.084	290	300	60	316 SS	Graphite	Teflon PTFE	8000	-50 to 250°F	No	419.00	H-07144-47	141.00
C	H-07002-12	0.092	310	300	50	316 SS	Ryton	Teflon PTFE	9000	-50 to 130°F†	No	419.00	H-07144-36	141.00
Pressure-loaded pump heads with standard canister														
D	H-07002-25	0.017	55	300	50	316 SS	Graphite	Teflon PTFE	9000	-50 to 250°F	No	419.00	H-07144-42	141.00
D	H-07002-26	0.042	140	300	50	316 SS	Graphite	Teflon PTFE	9000	-50 to 250°F	Yes	419.00	H-07144-44	141.00
D	H-07002-27	0.084	290	300	50	316 SS	Graphite	Teflon PTFE	9000	-50 to 250°F	Yes	419.00	H-07144-47	141.00
D	H-07002-14	0.092	310	300	50	316 SS	Ryton	Teflon PTFE	9000	-50 to 210°F	Yes	419.00	H-07144-34	141.00
D	H-07003-02	0.564	1940	300	50	316 SS	Ryton	Viton	8000	-50 to 210°F	Yes	392.00	H-07003-12	101.00
D	H-07003-04	1.090	3760	300	45	316 SS	Ryton	Viton	9000	-50 to 250°F	Yes	392.00	H-07003-14	101.00

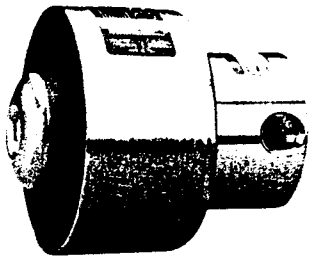
*Nominal flow rate pumping water with no back pressure at 3450 rpm. †Up to 210°F using the high-temperature seals on facing page.

MICROPUMP® PUMP HEADS (continued from page 1131)

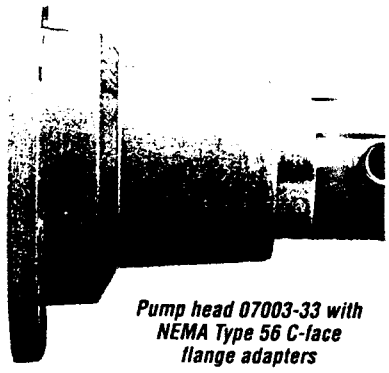
We offer these high-capacity MICROPUMP® pump heads in conventional cavity-style and pressure-loaded types. Both types are available with large canisters or with NEMA Type 56 C-face flange adapters. Order a pump head according to your required mounting configuration.



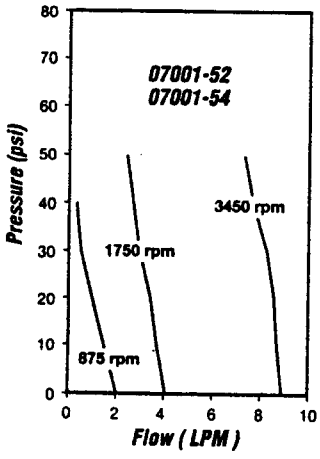
Pump head 07003-08 with large canister

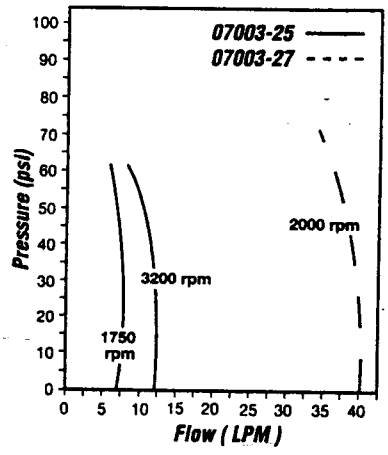


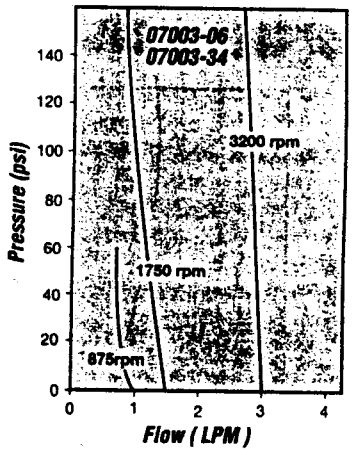
Pump head 07003-30 with large canister

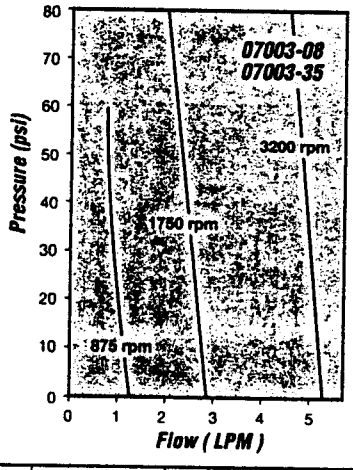


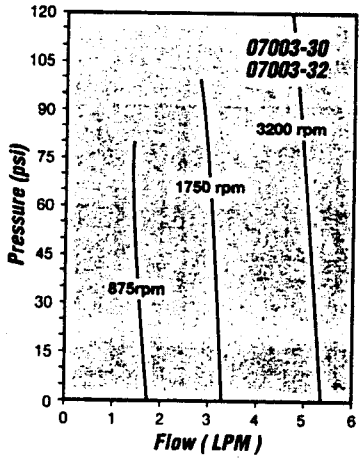
Pump head 07003-33 with NEMA Type 56 C-face flange adapters

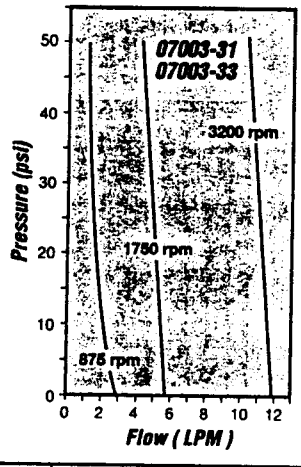












Series	Catalog number	ml/rev	Nominal flow rate (liters/min)*	Max system psi	Max diff psi	Materials of construction: Body	Gears	Seals	Max rpm	Temperature range	Bypass valve	Price	Service kits: Catalog number	Service kits: Price
Cavity-style pump heads with large canister														
E	H-07001-52	2.86	9.8	300	45	316 SS	Teflon® PTFE	Teflon PTFE	3450	32 to 125°F	No	$1520.00	H-07001-55	$357.00
Cavity-style pump heads with NEMA Type 56 C-face flange adapter														
F	H-07001-54	2.86	9.8	300	45	316 SS	Teflon PTFE	Teflon PTFE	3450	32 to 125°F	No	1710.00	H-07001-55	357.00
F	H-07003-25	6.00	20.8	500	70	316 SS	Teflon PTFE	Teflon PTFE	4000	-50 to 210°F	No	2400.00	H-07003-26	627.00
F	H-07003-27	19.30	38.6	500	100	316 SS	Teflon PTFE	Teflon PTFE	4000	-50 to 210°F	No	4450.00	—	—
Pressure-loaded pump heads with large canister														
G	H-07003-06	0.85	3.0	1500	60	316 SS	Ryton®	Viton®	8000	-50 to 250°F	No	816.00	H-07003-16	114.00
G	H-07003-08	1.60	5.2	1500	60	316 SS	Ryton	Viton	6000	-50 to 250°F	No	816.00	H-07003-18	114.00
G	H-07003-30	1.73	6.0	1000	50	316 SS	Ryton	Viton	6000	-50 to 250°F	No	855.00	H-07003-38	114.00
G	H-07003-31	3.46	12.3	1000	50	316 SS	Ryton	Viton	4000	-50 to 250°F	No	855.00	H-07003-39	114.00
Pressure-loaded pump heads with NEMA Type 56 C-face flange adapter														
H	H-07003-34	0.85	3.0	1500	60	316 SS	Ryton	Viton	8000	-50 to 250°F	No	1050.00	H-07003-17	114.00
H	H-07003-35	1.60	5.2	1500	60	316 SS	Ryton	Viton	6000	-50 to 250°F	No	1050.00	H-07003-19	114.00
H	H-07003-32	1.73	6.0	1000	50	316 SS	Ryton	Viton	6000	-50 to 250°F	No	1080.00	H-07003-38	114.00
H	H-07003-33	3.46	12.3	1000	50	316 SS	Ryton	Viton	4000	-50 to 250°F	No	1080.00	H-07003-39	114.00

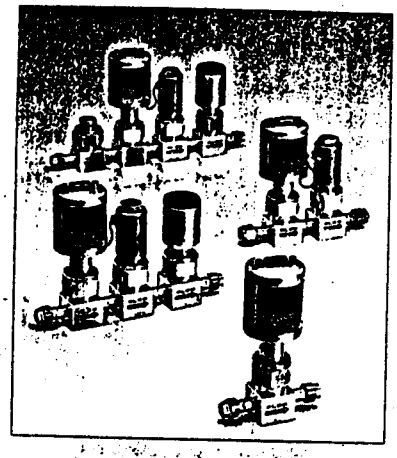
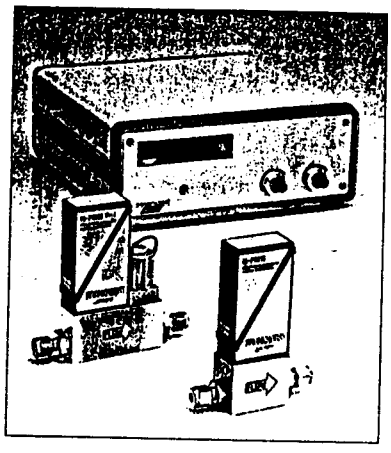
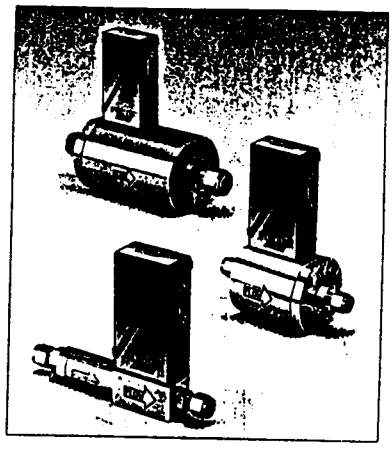
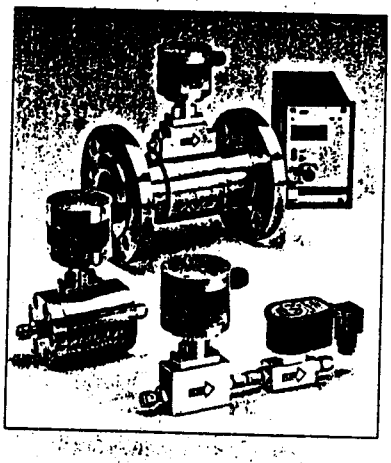
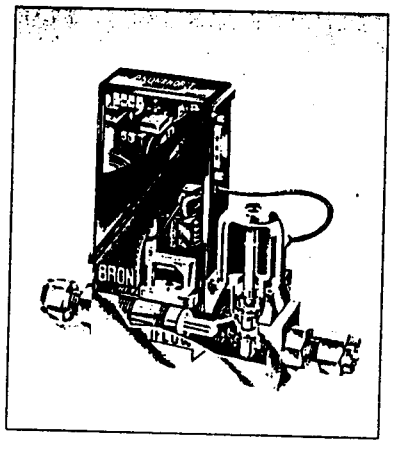
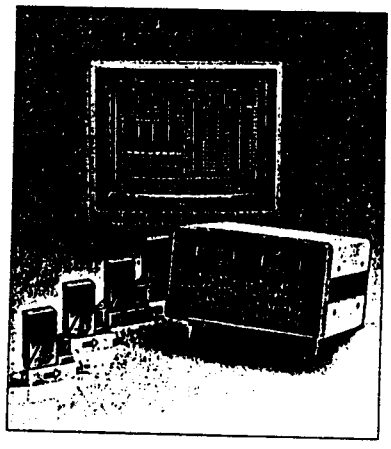
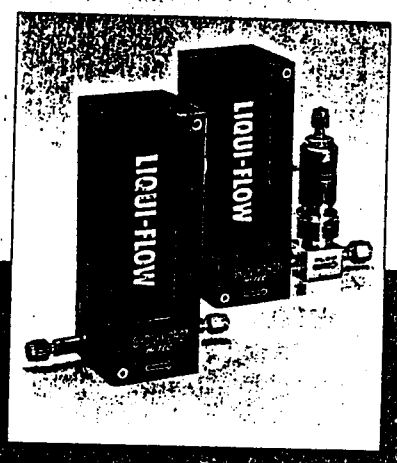
*Nominal flow at 3450 rpm pumping water with no back pressure.

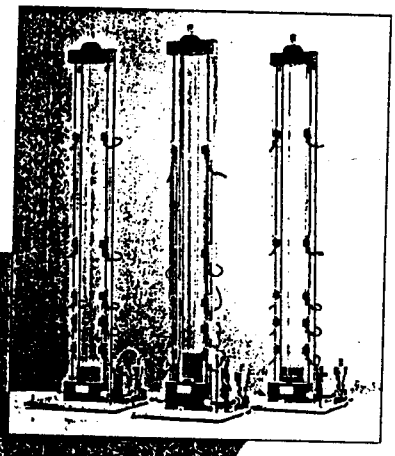
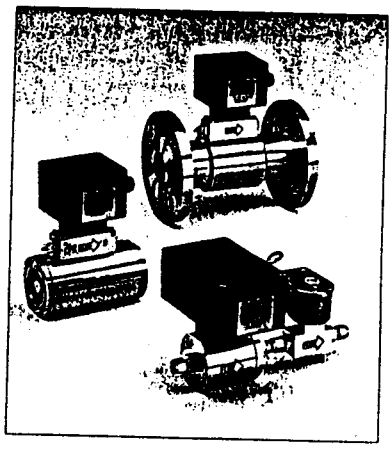
MICROPUMP—Reg TM Micropump Corp. Ryton—Reg TM Phillips Petroleum Co. Teflon, Viton—Reg TM E. I. du Pont de Nemours & Co.

APENDIX 3

Liquid Mass Flow Meters

MASS FLOW AND PRESSURE MEASUREMENT AND CONTROL

CE

CERTIFIED ISO 9001
INNOVATIVE
WIDE PRODUCT RANGE
RELIABLE
GLOBAL SERVICE

BRONKHORST
HI-TEC

LIQUI-FLOW Mass Flow Meters/Controllers

General

The LIQUI-FLOW series thermal mass flow meters/controllers for liquids are suitable for measuring flows of 0...5 g/h up to 0...1000 g/h, at pressures from vacuum up to 400 bar.

The flow meter is basically an obstructionless tube with an internal diameter of 1 mm, bent in U-form, with patented heater/sensor. In the sensor, the liquid gets merely 1 degree warmer than the environmental temperature, so that the chance that the liquid will decompose or gas-out is negligible.

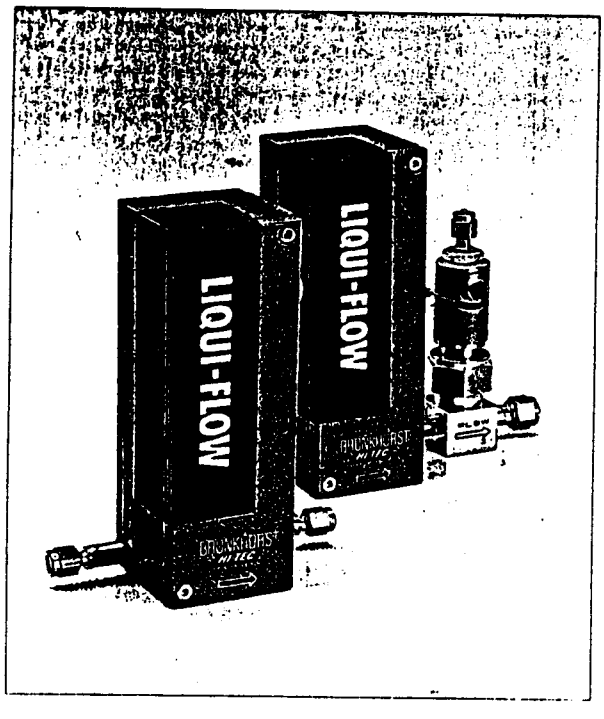
The instrument has a "thru-flow" measuring principle and it is insensitive to its mounting position.

Moreover, the flowmeter can be sterilized and does not contain any moving parts or elastomer seals.

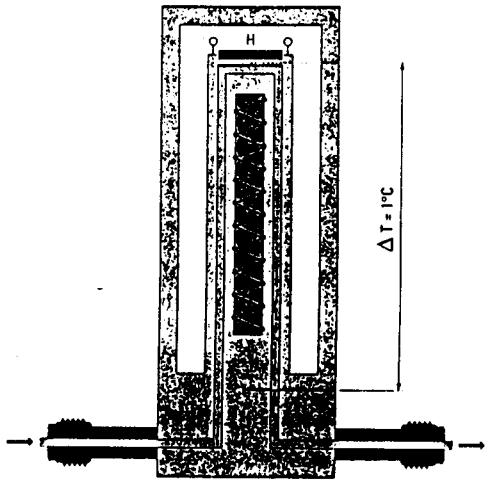
The LIQUI-FLOW meter has an integrated control function and can be connected to a COMBI-FLOW control valve to form a control loop. The control valve with standard purge connection on the top of the sleeve takes care of steady flow control, not pulsating, even when controlling flows lower than 1 g/h.

Applications in

- Pharmaceutical industry
- Food industry
- Biotechnical industry
- Analytical laboratories
- Semiconductor industry
- Evaporation processes (see page 15)



Measuring Principle



THERMOPILE WITH APPROX. 5000 THERMOELEMENTS

Features

- Thru-Flow measurement
- 1°C temperature rise in sensor
- Superstable zero
- Attitude insensitive
- Wide flow ranges 1 : 50
- Sterilizable
- Orbitally welded
- Metal sealed

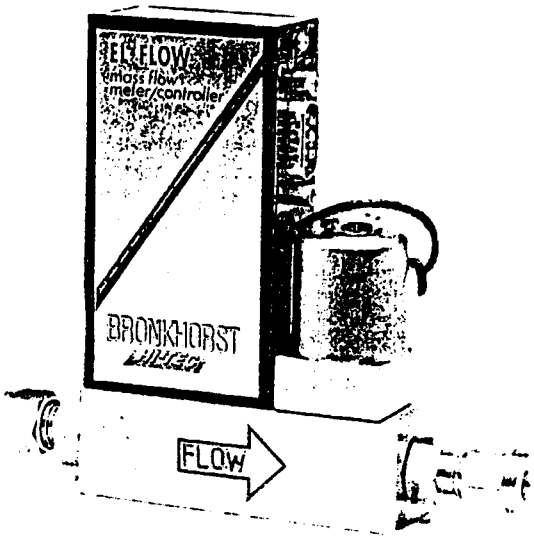
Flow Capacities (based on water)

Mass Flow Meters:			
Series L1:	min.	0,1 5	g/h
	max.	2 100	g/h
Series L2:	min.	2 100	g/h
	max.	20 1000	g/h
Mass Flow Controllers:			
Series L1C2:	min.	0,1 5	g/h
	max.	2 100	g/h
Series L2C2:	min.	2 100	g/h
	max.	20 1000	g/h

Other BRONKHORST HI-TEC products

EL-FLOW

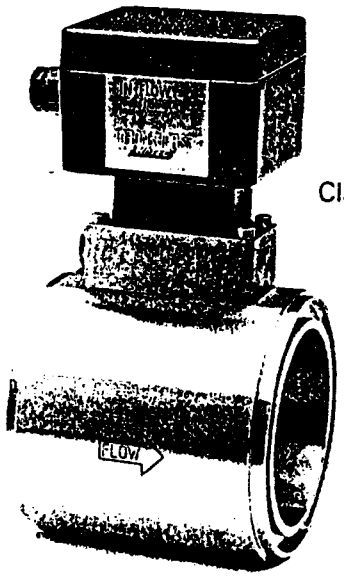
Mass Flow Meters/Controllers for Gases



Ranges : smallest 0.1 ... 5 ml_n/min
highest 25 ... 1250 l_n/min
Pressure : up to 400 bar

IN-FLOW

Industrial Mass Flow Meters/Controllers for Gases

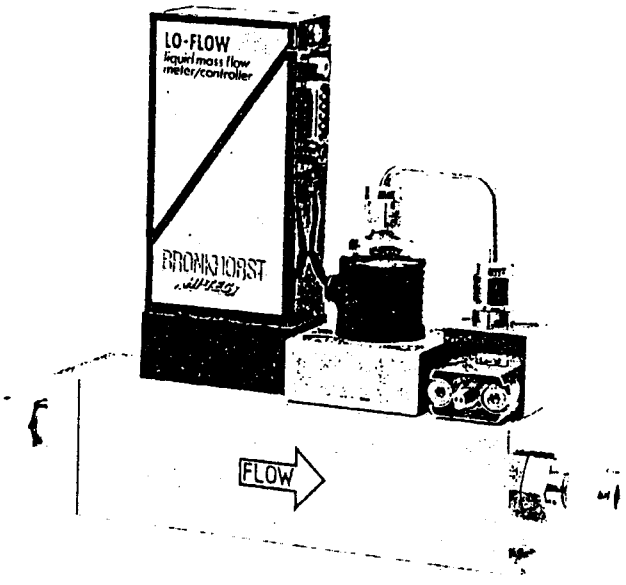


Classification IP 65

Ranges : smalles 0.3 ... 15 ml_n/min
highest 50 ... 1000 m^3_n/h

LO-FLOW

Mass Flow Meters/Controllers for Liquids

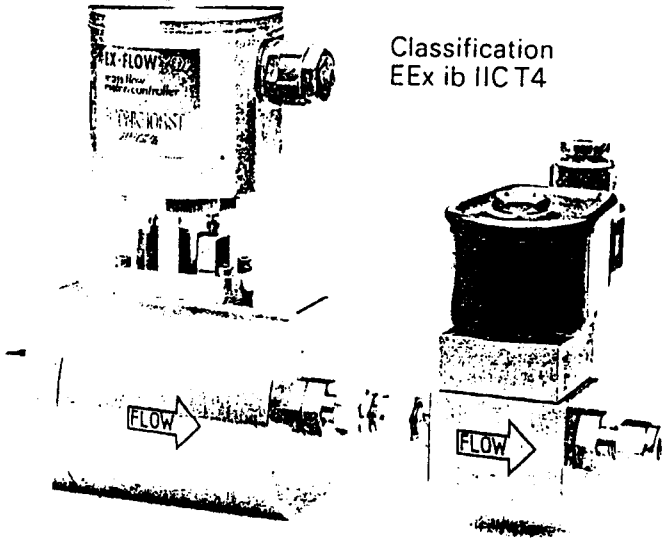


Ranges : smallest 0.05 ... 1 g/h
highest 1 ... 20 kg/h

EX-FLOW

(Ex) Cenelec (PTB) approved systems for Gas Mass Flow and Pressure

Classification EEx ib IIC T4



Flow ranges : smallest 0.2 ... 10 ml_n/min
highest 50 ... 1000 m^3_n/h
Pressure ranges : smallest 0.005 ... 0.25 bar
highest 8 ... 400 bar

BRONKHORST HI-TEC

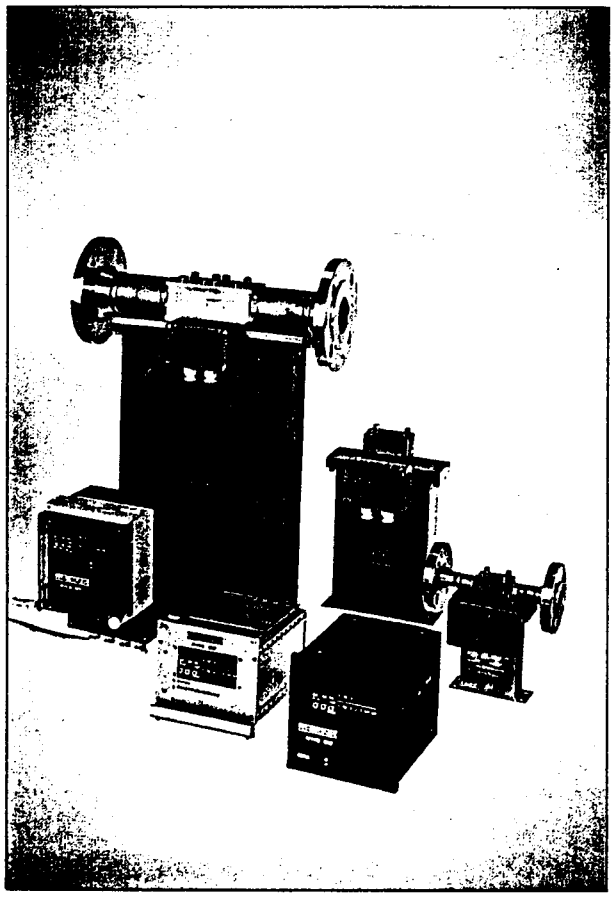
Nijverheidsstraat 1A, 7261 AK Ruurlo, The Netherlands
Tel.: 05735-2929* – Tlx.: 49066 – Hitec NL – Telefax: 05735-3297

Distr.:

8-93

RHEONIK

MASSFLOWMETER



PRECISE DIRECT MASS MEASUREMENT
(flow ranges from 2 g/min up to 2000 kg/min)

FRACTURE PROOF TRANSMITTER DESIGN

NO MOVING PARTS IN THE PRODUCT FLOW

SIMPLE INSTALLATION

Application

The instrument series RHM/RHE solves the problem of measuring directly the massflow of liquids and gases.

Nearly all flowing mediums such as:

- ☐ fluids of different viscosities with abrasive particles.
- ☐ sludges
- ☐ suspensions
- ☐ corrosive fluids
- ☐ gases

can be measured.

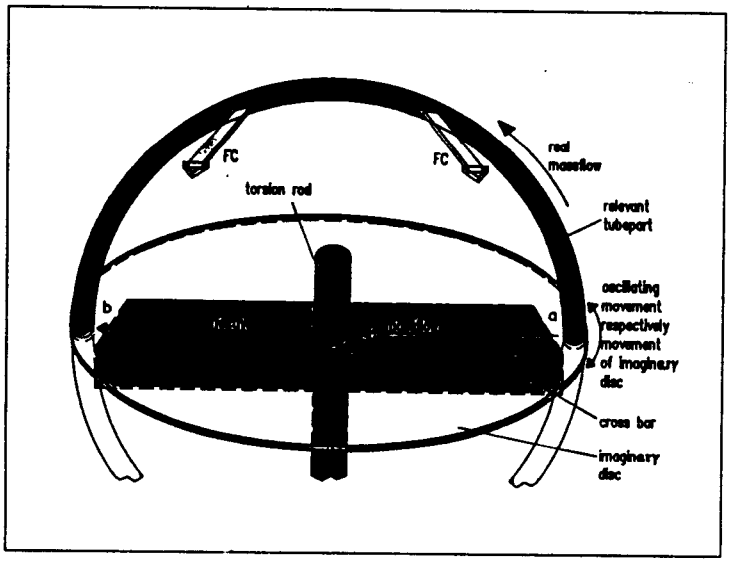
physical properties such as

- ☐ pressure and pressure pulsations
- ☐ temperature
- ☐ density
- ☐ viscosity
- ☐ flow profile
- ☐ multiphase flow

have no significant influence on the measurement.

Function and Construction of Transmitter RHM

The Rheonik transmitter contains two tubeloops outlining the shape of a tennis racket, fluid flow direction being the same in both loops. These loops form part of an oscillating system which also includes two horicontally mounted crossbars and two vertically mounted torsion rods. The torsion rods are connected together on both ends. The natural frequency of the oscillating system depends mainly on the mass of the cross bars and the modulus of elasticity of the torsion rods. This oscillating system is excited by electromagnetic coils with a controlled amplitude, the resulting oscillation being sensed by a pair of pick-up coils.



Since this system is symmetrical, internal acceleration forces are counterbalanced. The measuring section of the loop and its movement is stabilised by two torsion rods and cross bars, resulting is the measuring section (a–b) being kept free of any external influences such as vibration which could affect performance.

This tube section (a–b) makes its oscillating movement upon an imaginary disc, where point a and b are positioned on the circumference.

Measured mass starting at „a" moving on the „oscillating disc" towards „b" passes orbits of different velocities. An additional force (Coriolisforce FC) acting in the plane of the disc, perpendicular to the movement of mass on the disc (a–b), is directly proportional to mass-flow. This force causes an additional deflection of the tubes and is sensed as a phase difference between the outputs of the two pick-up coils.

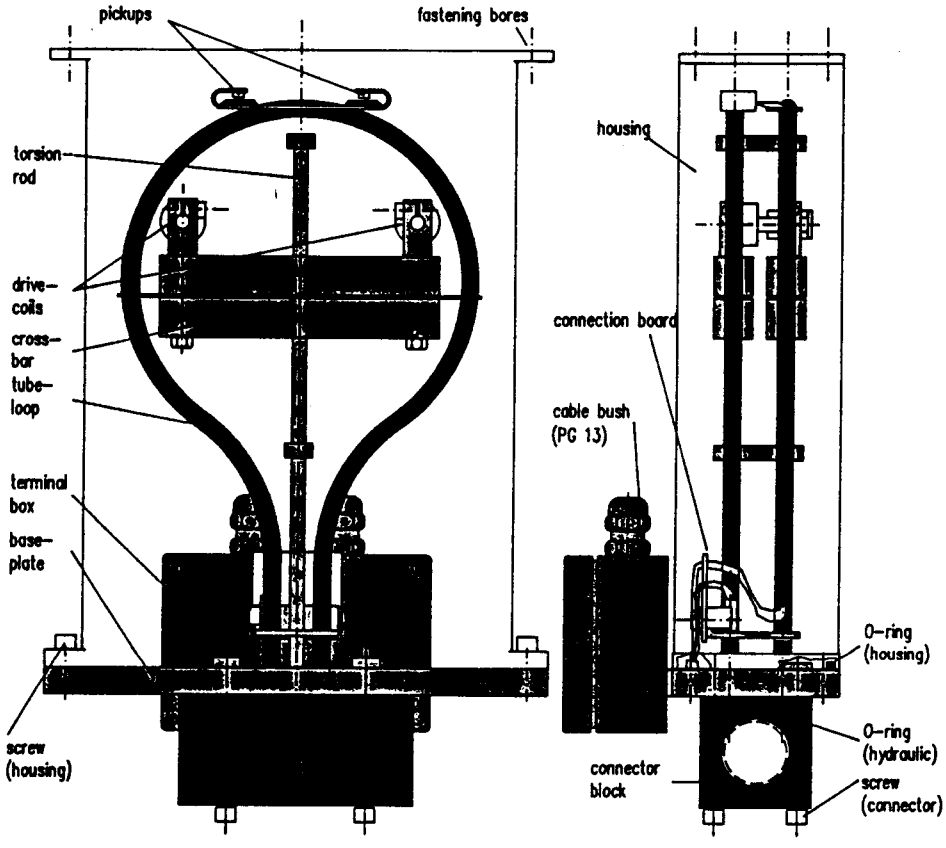
MECHANICAL: The described oscillating structure and all its parts including a baseplate are vacuum-soldered. The housing, covering the transmitter is screwed and sealed by O-ring against the baseplate (IP 65). Hydraulic connectors are also screwed against the baseplate where the O-ring seals against the tube.

This construction shows a big advantage in cleaning and changing purposes, as connectors can easily by removed (referring to this please see also serial and parallel range).

For highly corrosive mediums special materials for wetted parts like
Hastelloy, Tantalum etc. can be provided.

With above material flanges are directly welded upon tube ends, to avoid sealing problems.

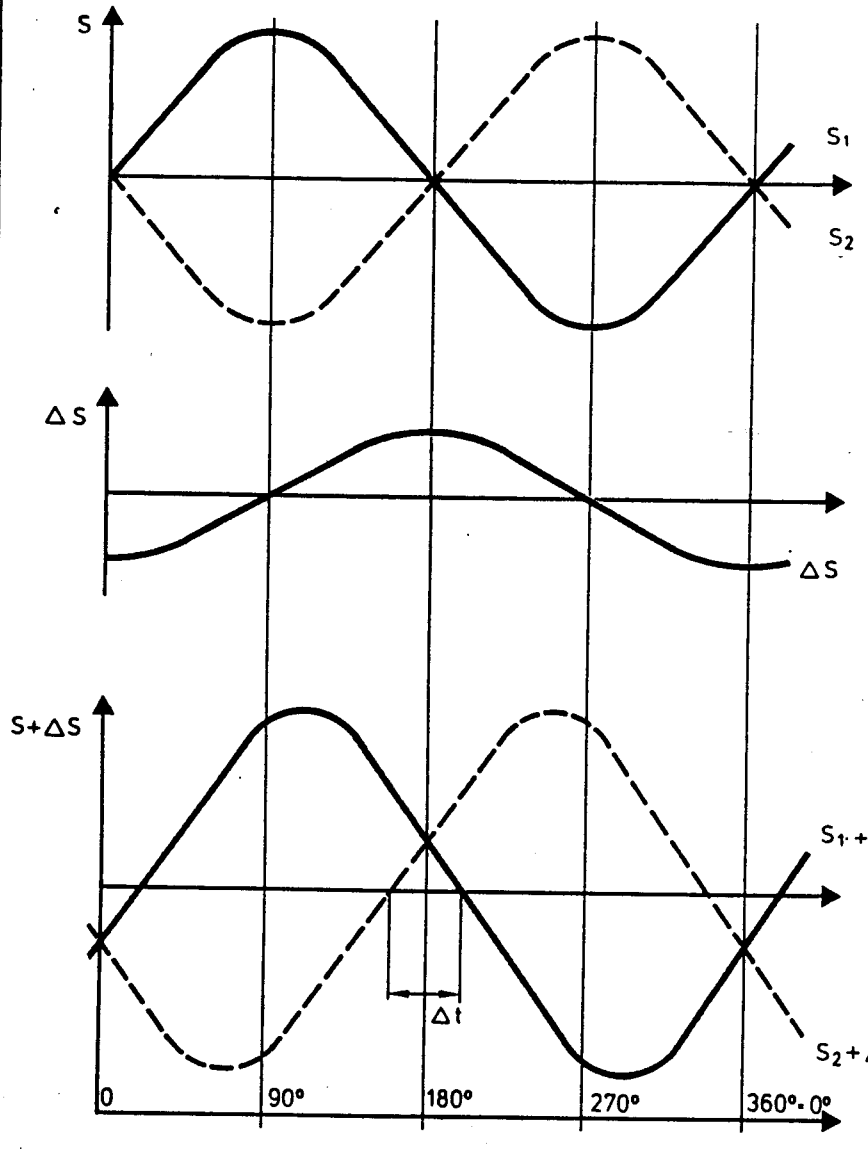
The same principle is also valid with sanitary couplings to avoid harmful deadlocks.



ELECTRICAL: The coils are of polyimidisolated wiring moulded in epoxy resin. Starting at the coils the wiring is fixed onto the tubes by the safest route, via a connection board directly into the terminal box, which has a connector for cabling. The PT-100 temperature sensor which is mounted close to the tubes, is simidarly connected.

HT-execution (up to 350°C) shows ceramic isolated wiring and glue, whereas terminals and other connectors are stainless steel.

Signal Converting



Without flow the signals S_1 and S_2 of the two inductive pick-ups are phase displaced by 180°, ie. without time offset.

When a medium flows through the tube loops, these are subjected to additional deformation by the occuring Coriolis forces.

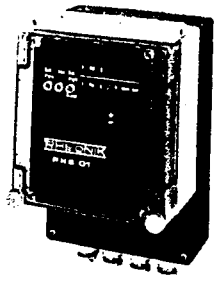
This causes a 90° phase displaced signal Δ_s to be superposed on the basic signals, resulting in a time shift Δt of the pick-up signals which is directly proportional to the mass flow.

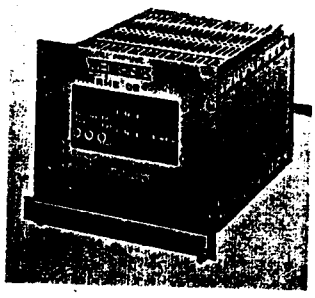
The above described **phaseshift** has a range up to 50 to 100 microseconds. It is measured by two alternatively working pairs of counters which are read by a microprocessor and flow proportional frequency produced, scalable by decade switches. The microprocessor also compensates for temperature variations which are sensed by PT100 as temperature affects the modulus of elasticity. In the basic version the frequency (proportional to phase shift and therefore massflow), scaled by the hardware, is the only output.

With **option DZ03** there is a second microprozessor which drives a display which is programmable in terms of units for both flowrate and totalizer. Four optocoupler outputs for flow limits and totalizer are also available. A programmable analog output is also included which, together with special software, can be used for direct flow control.

A further **option** is an **RS232 interface**, adjustable for 20mA current loop, transmitting total flow, flow rate, temperature values hold and reset functions as standard. Further functions are available on request.

RHE 01
Housing for wall mounting
Size: width 190 × height 190 × depth 140 mm
Type of enclosure protection IP 54





RHE 02
19" rack module
Size: 1/3 – 19" (28TE)
3 HE, depth 170 mm

RHE 05
Enclosure for panel mounting
panel cutout: 138 mm × 138 mm;
depths 170 mm

These instruments in the basic version are supplied with a pulse output, open collector maximum 30 V / 10 mA.

Power supply: 220 V / 110 V / 24 V 50/60 Hz
Ambient temperature range: – 10 to +40° C

OPTION (can be included in basic RHE)
Output module DZ03
for displaying
totalizer 8-digits
flow rate 5-digits (floating decimal point)
units, factors etc. settable.

2 flow limits
2 totalizer limits

settable via pushbuttons
outputs open collector
maximum 30 V / 10 mA

Analog output for flow rate adjustable 0 – 10 V / 2 – 10 V / 0 – 20 mA / 4 – 20 mA to desired full scale flowrate.

OPTION (can be included in RHE... DZ03)
RS232 serial interface
(adjustable for 20 mA current loop)
Standard functions: totalizer, flow rate, temperature, reset, hold.

Technical Data Transmitter RHM

Operating temperature:

– 20° C to +120° C (normal temperature range NT)
–200° C to + 50° C (low temperature range ET1)
– 50° C to +210° C (high temperature range ET2)
0° C to +350° C (high temperature HT)

Materials:

Wetted parts 1.4571 (standard) or 1.4301
Hastelloy, Tantalum etc. available on request
Internal sealings NBR 70 (standard) or PTFE.
Housing, steel PU coated or stainless steel
is screwed and sealed against baseplate (IP 65)
Other parts of construction stainless steel.

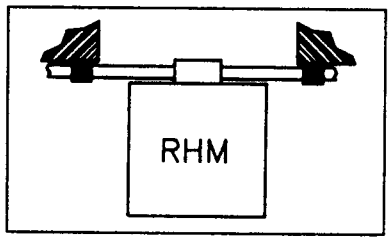
Accuracy:

+/– 0.2 % of rate in range 1 : 20
+/– 0.5 % of rate in range 1 : 50
for corresponding range see table.

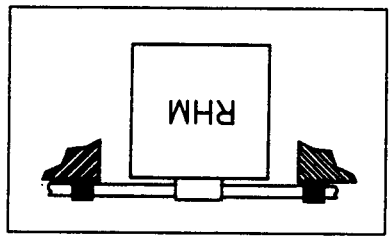
Repeatability:

better than 0.1 %

Installation:



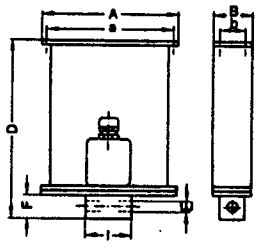
For fluids hanging position



For gases upward position

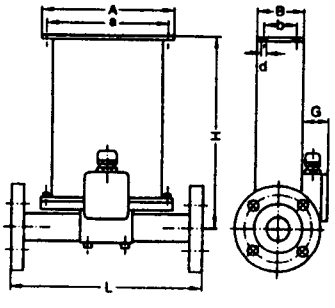
Extension tables

RHM . . . G
threaded connectors, max. permitted pressure, dimensions and weights.



TYPE	E	max. perm. Press.	A	B	D	a	b	F	I	W.
	THREAD	BAR	mm	mm	mm	mm	mm	mm	mm	kg
RHM 007	R 1/4"	400	110	40	165	95	25	30	50	1.5
RHM 01		400								
RHM 03		400								
RHM 04	R 1/4"	150	145	40	180	130	25	30	50	2
RHM 06	R 1/2"	400	180	60	274	165	40	40	70	5
RHM 08		300								
RHM 12	R3/4"	300	300	70	500	285	50	50	120	15
RHM 15		300								
RHM 20	R 1"	250	300	70	500	285	50	60	140	17.5
RHM 30	R 1 1/2"	250	600	120	940	580	90	100	160	67.5

RHM . . . F
flanged connectors, max. permitted pressure, dimensions and weights.

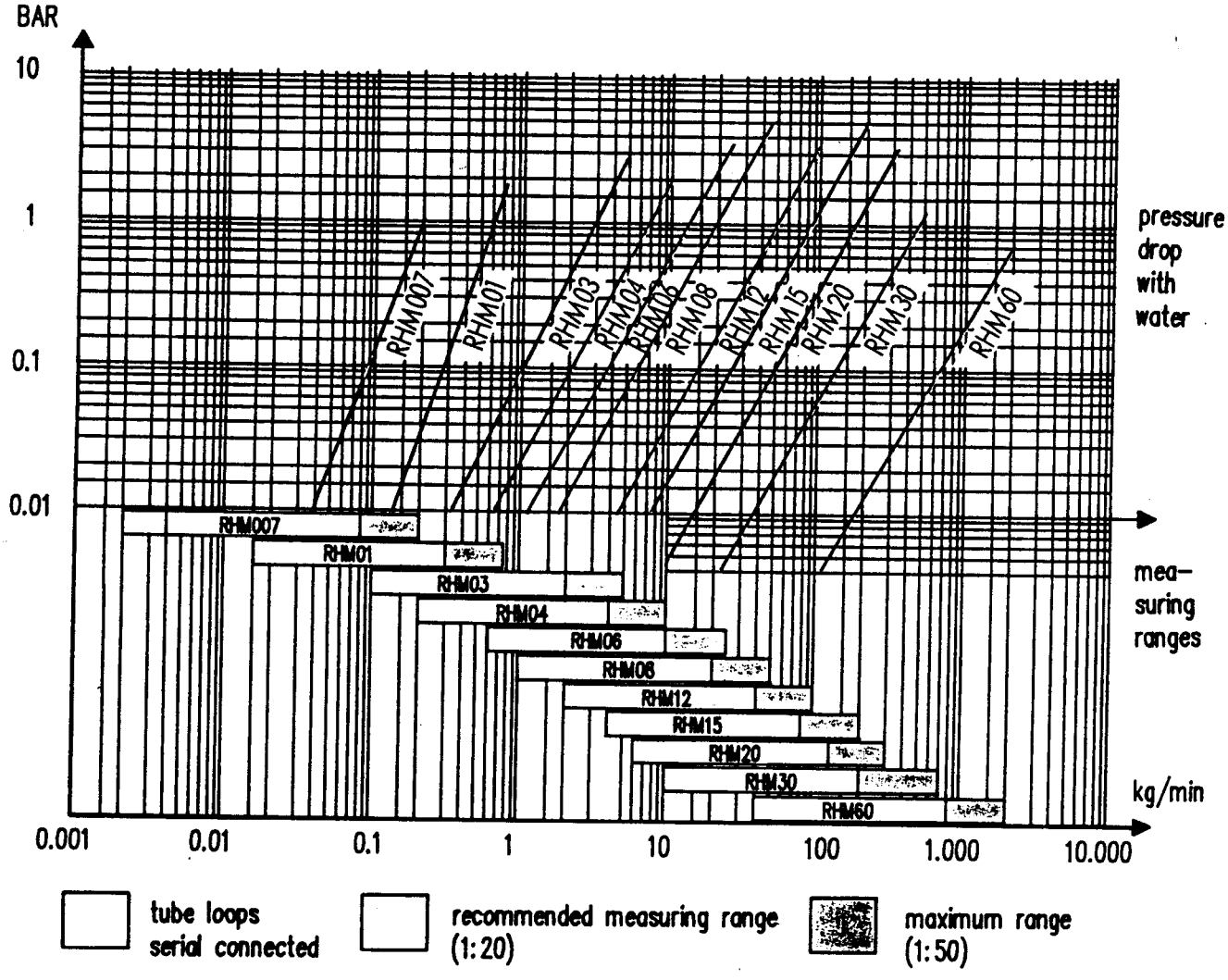


TYPE	flange		A	B	L	a	b	H	d	W.
	PN 40	150/300 RF	mm	mm	mm	mm	mm	mm	mm	kg
RHM 007	DN 15	ANSI 1/2"	110	40	180	95	25	150	5.5	3.7
RHM 01										
RHM 03										
RHM 04	DN 15	ANSI 1/2"	145	40	220	130	25	205	5.5	4.2
RHM 06	DN 25	ANSI 1"	180	60	260	165	40	255	6.5	9
RHM 08										
RHM 12	DN 25	ANSI 1"	300	70	400	285	50	480	6.5	23.7
RHM 15										
RHM 20	DN 50	ANSI 2"	300	70	460	285	50	480	6.5	26.4
RHM 30	DN 50	ANSI 2"	600	120	725	580	90	900	8.5	75
RHM 60	DN 80	ANSI 3"	950	250	725	910	150	1450	18	220

Measuring ranges and pressure loss RHM . . .

How to select a transmitter:

1. Preferrably parallel connected tubes have to be applied (transmitter in recommended range). (optimum of pressure loss and accuracy)
2. Serial tubes have to be applied only:
   a) if the tubes can be blocked by
      - cristallisation
      - sedimentation
      - particles
   b) for sanitary version (in line cleaning)



Above mentioned pressuredrop referres to parallel connected tube loops.
Seriell connection means 4 to 5 times higher pressure losses.

FLOW RANGES SERIELL AND PARALLEL

	RHM / Ranges	007	01	03	04	06	08	12	15	20	30 *	60 *
S	Minimum	0.002	0.008	0.05	0.1	0.25	0.5	1	2	3	5	20
S	Max.(1:20)	0.04	0.15	1	2	5	10	20	40	60	100	400
S	Max.(1:50) *	0.1	0.375	2.5	5	12.5	25	50	100	150	250	1000
P	Minimum	0.004	0.015	0.1	0.2	0.5	1	2	4	6	10	40
P	Max.(1:20)	0.08	0.3	2	4	10	20	40	80	120	200	800
P	Max.(1:50) *	0.2	0.75	5	10	25	50	100	200	300	500	2000

Units kg/min

* Seriell Connection on request (higher prices)

IBERFLUID
INSTRUMENTS, S.A.

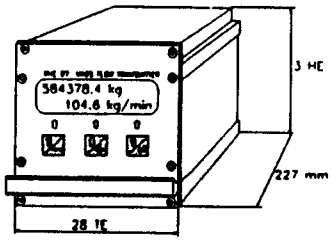
OFICINAS Y ALMACEN: C/. Cardenal Reig, 12-14 - 08028 BARCELONA
Tel.: 333 36 00 - Fax: 334 05 24

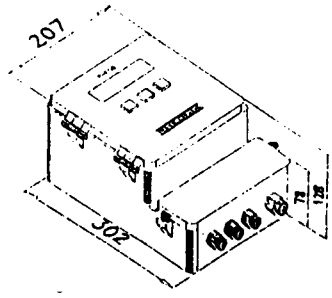
RHEONIK
MESSGERÄTE
GMBH

D - 85235 ODELZHAUSEN
RUDOLF-DIESEL-STR. 5
TELEFON 0 81 34 / 60 50
0 81 34 / 73 59
TELEFAX 0 81 34 / 52 48
USt-ID DE 128 240 185

Technical data

Remote unit **RHE 07** (19" rack version) and **RHE 08** (wall mounting version)





ranges:	mass:	acc. to sensor model
	temperature:	-200 to +350°C
	density:	0.5 to 2.0 kg/l
accuracy:	mass:	+- 0.2 % of rate (1:20) +- 0.5 % of rate (1:50)
	temperature:	+- 1°C , resolution 0.1°C
enclosure	RHE 07: IP 20, 19" rack, 3 HE, 28 TE RHE 08: IP 64, wall mounting (ALU)	
weight	RHE 07 about 1.5 kg RHE 08 about 5 kg	
max. temperature	-20 to + 60° C	
power supply	230/115/24 VAC +-10%, 50 - 60 Hz 24 VDC +-10 %	
power consumption	typ. 10 Watt	
display	2 lines LCD, each 16 charact. (height 8 mm)	
settings	via 3 pushbuttons, easy instructions via display (units, in-, outputs etc.)	
selfdiagnosis	error indication in plain language	
metered variables	massflow, total mass, temperature, density (option), volumeflow (option)	
response time	programmable, up to 60 seconds	
low flow cutoff	programmable , 0 - 20 % of flow scale	
outputs	programmable, galvanically isolated	
	2 analog:	0 - 20 mA or 4 - 20 mA load < 1000 Ohm, accuracy +- 0.05 % v.E.
	1 frequency:	0 to 10.000 Hz, (max. 30V, 50 mA)
	3 status outputs:	limits, alarm, flow direction
optional	RS 422/485 or RS 232 (with converter)	
inputs	programmable, galvanically isolated,	
	2 status inputs:	zero, hold totalisator , reset tot., error ackn.
Ex- version (optional)	intrinsically safe, EEx [ia] II C, standard EN 50014, EN 50020 installation in the safe area sensor RHM in the Ex- area approval: CESI-Ex 95. (off 6/95) alternatively: intrinsically safe and explosionproof Ex d [ia] II C installation in the Ex- area approval: CESI-Ex 95. (ab ca. 8/95)	

description:

Heart of the remote unit is the microcontroller 80C552, processing interrupt controlled all the sensor signals.
The measurement of the massflow rate is digital. According According to the Coriolis principle a flow proportional phaseshift between two sinusoidal signals from the sensor is processed for direct massflow measurement.
The sensor oscillating frequency can be measured in addition to have a reasonable density measurement.
The temperature influence of the tube loops is compensated. Therefore additional temperature information is available.
The unit can be operated via three pushbuttons at the front side of the instrument. All the necessary information is shown on the display in english language.
All the settings are stored in a nonvolatile EEPROM.
The data security is guaranteed for more than 10 years.
During factory calibration of the complete system (RHM and RHE) all necessary datas are preprogrammed.

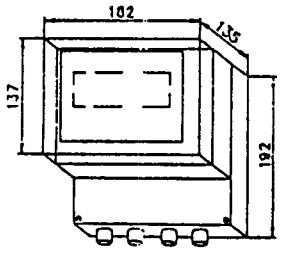
Additional settings at site, f.e. configurations of the 0/4 to 20 mA analog outputs, the frequency-/pulseoutput, the response time, or the cutoff limit can easily be done by the user according to the requirements of the corresponding application.

The selfdiagnosis of the remote unit provides a reliable and safe operation of the system. Errors of the system are immediately detected and indicated.
Exceeding the sensor design limits is monitored. Alarm will be raised immediately , if limits as flow rate or operating temperature are exceeded.

representation:

RHEONIK

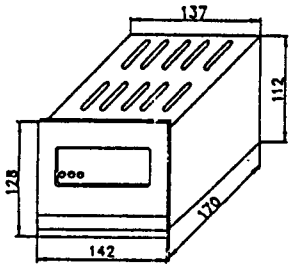
DATASHEET RHE



remote unit type RHE01.03
with pulse output

plastic housing for wall mounting
protection class: IP 54
power supply: 220V AC, 110V AC, 24V AC, 24V DC

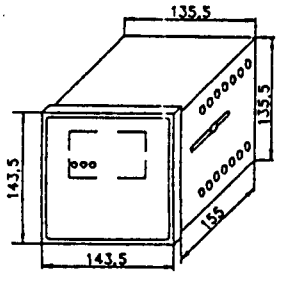
(Option: - display and analog output DZ03 included in RHE..)
- interface RS232



remote unit type RHE02
with pulse output

alu housing for rack mounting (1/3" - 19" / 28TE/3HE)
protection class: IP 20
power supply: 220V AC, 110V AC, 24V AC, 24V DC

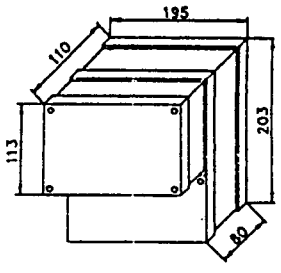
(Option: - display and analog output DZ03 included in RHE..)
- interface RS232



remote unit type RHE05
with pulse output

plastic housing for panel mounting
protection class: IP 20
power supply: 220V AC, 110V AC, 24V AC, 24V DC

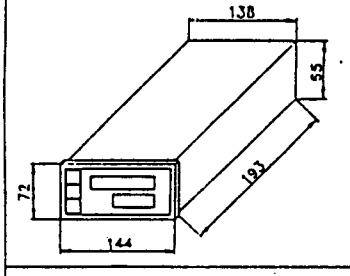
(Option: - display and analog output DZ03 included in RHE..)
- interface RS232



remote unit type RHE06
with pulse output
Ex-specification: [EEx ia] II C (CESI EX-92.C.122X)

Alu housing, PU-coated
protection class: IP 65
power supply: 220V AC

(Options: - display and analog output DZ04 in separate enclosure
- interface RS232 included in DZ04)



massflow indicator DZ04
display and analog output
for connection to RHE ..

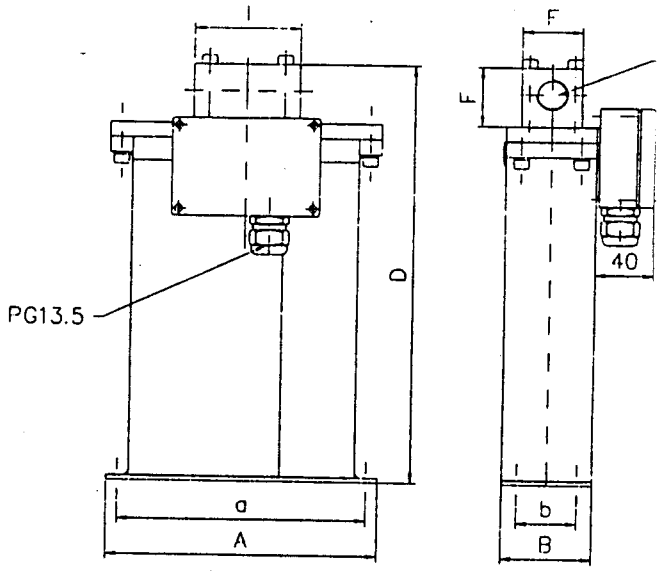
plastic housing for panel mounting
protection class: IP 20

(Options: - interface RS232 included in DZ04)

Datasheet RHM type G.. (threaded version)

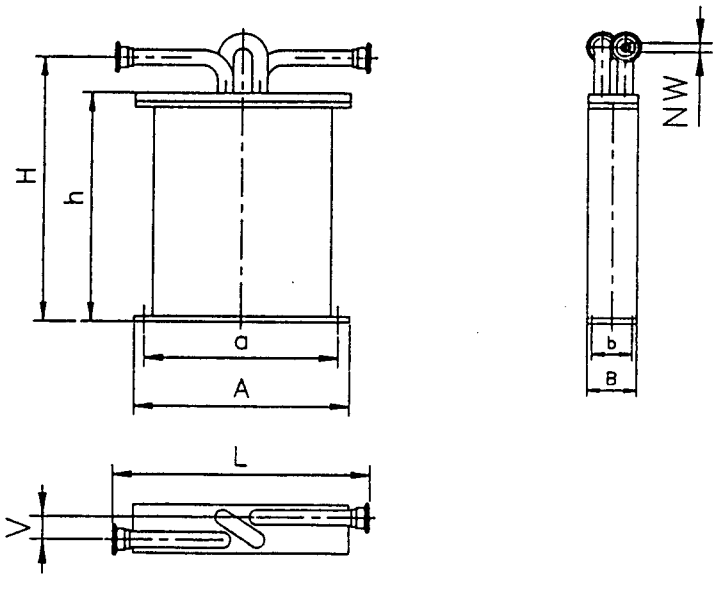
RHM Type	E thread	max. pres.*	A	B	D	a	b	F	I	W.
	R"	bar	mm	mm	mm	mm	mm	mm	mm	kg
.007	1/4"	325	110	40	165	95	25	30	50	1.5
.01		325								
.03		325								
.04	1/4 "	150	145	40	180	130	25	30	50	2
.06	1/2"	400	180	60	274	165	40	40	70	5
.08		300	180	60	274	165	40	40	70	5
12	3/4"	300	300	70	500	285	50	50	120	15
15		300	300	70	500	285	50	50	120	15
20	1"	200	300	70	500	285	50	60	140	18
30	1 1/2"	200	600	120	940	580	90	100	160	68

* maximum pressure rating (max. 120°C) for standard meters



Datasheet RHM type S.. (sanitary version)

RHM TYPE	NW	L	H	h	A	a	B	b	V
	mm	mm	mm	mm	mm	mm	mm	mm	mm
007	10	160	164	132	110	95	40	25	15
01	10	160	164	132	110	95	40	25	15
03	10	160	164	132	110	95	40	25	15
04	10	190	205	173	145	130	40	25	15
06	10	230	322	233	180	165	60	40	19
08	10	230	322	233	180	165	60	40	19
12	15	350	540	455	300	285	70	50	26
15	15	350	540	455	300	285	70	50	26
20	20	380	540	455	300	285	70	50	26
30	32	300	992	835	600	580	120	90	50
40	50	400	1098	965	720	690	180	145	60
60	50	500	1385	1250	950	910	250	240	96



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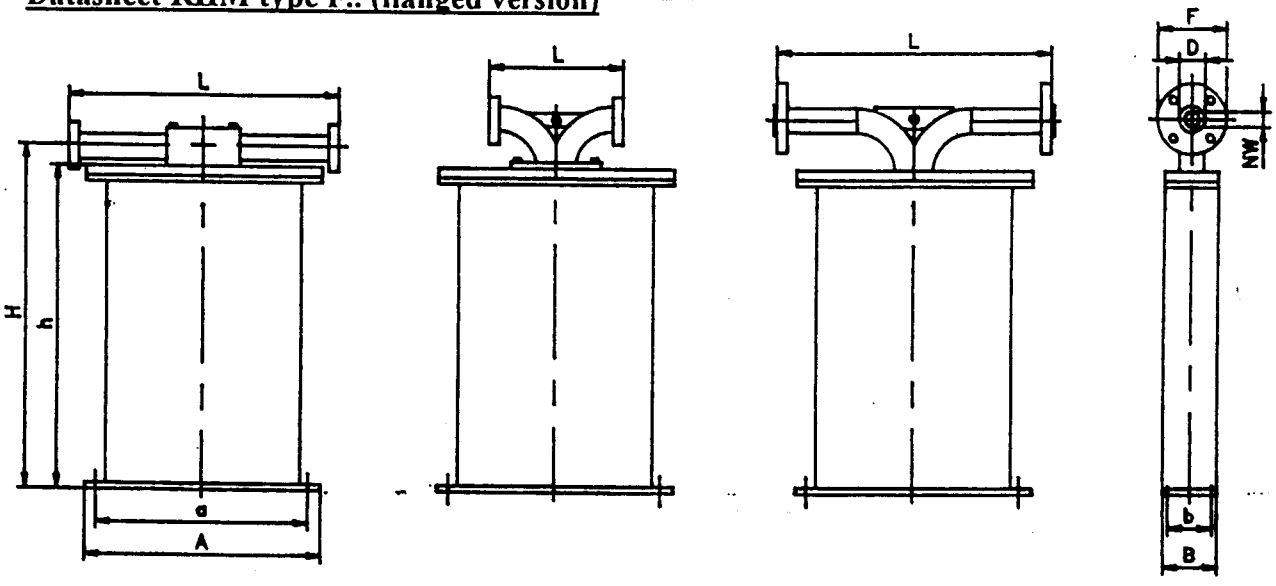
GMBH

Datasheet RHM type F.. (flanged version)



version 1 2 3 1,2,3

1	RHM 007 to 30 (removable flange connector with sealing)
2	RHM 40 to 60 (removable casted flange connector with sealing)
3	RHM welded flange design for special materials or high temperature (without sealing)

									PN40		ANSI (lbs) 150	ANSI (lbs) 300	ANSI 600/900lbs PN100/160	
version		1,2,3					1,2	3	1,2	3	1,2	3	1,2,3	
RHM	h	L	A	a	B	b	H	H	NW	NW	NW	NW	L	weight
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm			mm	kg
007	132	180	110	95	40	25	150	164	15	15	1/2"	1/2"	220	3
01	132	180	110	95	40	25	150	164	15	15	1/2"	1/2"	220	3
03	132	180	110	95	40	25	150	164	15	15	1/2"	1/2"	220	3
04	173	220	145	130	40	25	205	205	15	15	1/2"	1/2"	220	4
06	233	260	180	165	60	40	255	322	25	25	1"	1"*	300	8
08	233	260	180	165	60	40	255	322	25	25	1"	1"*	300	8
12	455	400	300	285	70	50	480	540	25	25	1"	1 1/2"	400	18
15	455	400	300	285	70	50	480	540	25	40	1"	1 1/2"	400	18
20	455	460	300	285	70	50	485	540	50	50	2"	2"	500	25
30	835	725	600	580	120	90	900	992	50	80	2"	3"	725	77
40	965	725	720	690	180	145	1155	.--	80	100	3"	3"	900	140
60	1250	725	950	910	250	150	1450	.--	80	150	3"	3"	900	235
80	1516	900	1170	1070	330	200	.--	1816	.--	150	.--	6"	.--	430

flange length tolerances: +0 mm; -3(2) mm

* L=300

RHEONIK, 01.02.1996

APENDIX 4

Automatic Gas Chromatograph measurement system

BIOSPECTRA AG
Zürcherstrasse 137
CH-8952 Schlieren

Tel.: [++41] 01/730 21 20
Fax.: [++41] 01/730 85 89

ONLINE PROCESS ANALYSER GC

Dear Prof. Godia,

In the enclosure I send you the information sheet about our ONLINE PROCESS ANALYSER GC. Reference systems are in use in four different companies/universities:

NOVARTIS, Basel CH	Dr. J. Kuhla
ETH, Zürich CH	Prof. Dr. B. Witholt
GIVAUDAN, Dübendorf CH	Dr. Th. Münch
NESTEC, Lausanne CH	Dr. P. Niederberger

Since the system is made customer-specific the price is dependent on many details (e.g. the number of reactors to be connected, the type of computer interface(s) (serial or analog), the method(s) to be implemented etc.). As a price indication I can give you a frame between 120'000 and 140'000 Fr. Included is the installation in place and the putting into operation. If you have already an HP5890 (equipped with all options needed) that you want to integrate in the system the price is remarkably lower (by ca. 25'000 Fr.).

I thank you for your interest and hope you have now all informations you need so far.

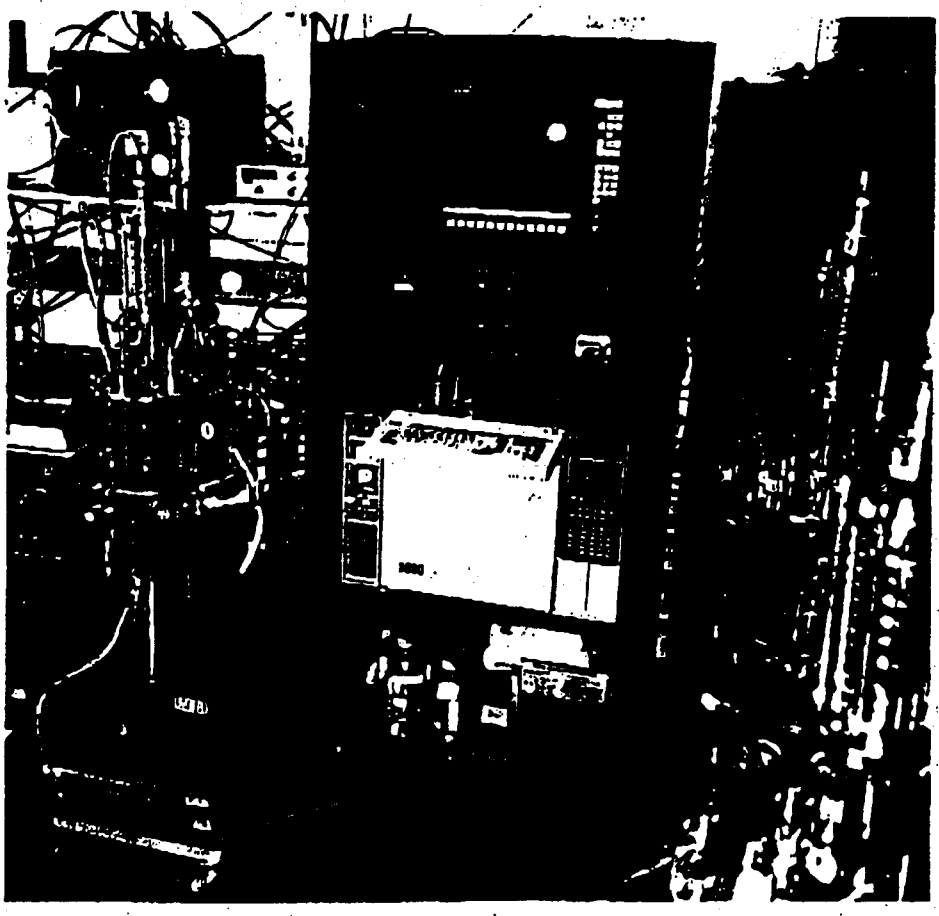
Yours Sincerely

BIOSPECTRA AG

C. Tu

Dr. C. Filippini

Online Process Analyser GC



Automated gas chromatographic analysis of dissolved volatiles in liquid process samples

The system is based on a proved gas chromatograph (preferentially a HP 5890). The coupling with an automatic fluid handling unit for sample preparation (preferentially realised with HAMILTON OEM Modules), the integration of a special injection valve and a series of other specific adaptations enable the system for on-line application. A very simple and user-friendly operation is guaranteed by the WINDOWS™ based special software (SpectraControl™ GC 3.1) running on the integrated industrial PC equipped with touch-screen-technology. Obviously the system is self-calibrating and self-maintaining by periodical wash cycles. The PC is not only controlling the entire system but also evaluating and validating the data acquired. The complete system is built in a solid and mobile industrial housing.

BIOSPECTRA

Your Partner for Online Analysis and Process Information Systems

The most important questions of customers

Which analytes can be monitored by this system ?

In principle all substances so far measured by off-line gas chromatography can be monitored directly at the process.

What is the measuring frequency ?

Generally analysis procedures take between 5 and 30 minutes. Thus depending on the spectrum of substances to be separated frequencies between 2/h and 12/h are practicable. For the analysis of single substances even higher frequencies may be achievable.

How many substances can be determinated at the same time ?

The number of simultaneously determinable substances is depending completely on the specific application. The software allows the automatic evaluation of up to 10 substances.

What are the detection limits ?

The detection limits are depending on the detector type and the substance to be measured. No general rules can be formulated. The limits are identical with the limits in the corresponding analyses with a split ratio of 1:20.

How is standardisation realised ?

Obviously internal standardisation has been included in hard- and software. The automated fluidhandling adds an internal standard to the sample. Thus imprecision caused by variable injection volumes can be completely compensated. The high quality of the dilution unit allows very precise measurements (see later).
The application of internal standardisation results not only in more precise data but is also useful for automated check of system state (see later).

What precision can be achieved ?

Under optimised analysis conditions and with internal standardisation relative standard deviations of less than two percent can be reached. On-line measurements are usually more precise than the corresponding off-line analyses since the chance for equal treatment of the sample is higher than by manual operation.

Is the system long-term stable and suitable for industry ?

Automated wash-cycles are included in hard- and software for permanent system regeneration. Thus a continuous operation over several weeks without interventions is possible.
The exclusive use of proved high-quality components of notable manufacturers guarantees a high stability of the system.

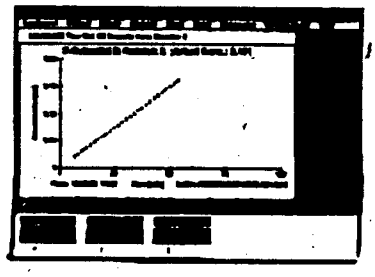
How is data evaluation performed ?

The raw-signal of the detector is validated and plotted by the integrator (HP 3396). The peakdata (retention time, area etc.) are sent via serial communication to the industrial PC, where the final evaluation is performed. Based on retention time windows and the data of external and internal standard the PC calculates the corresponding concentrations (g/l) for all substances selected.
Further the state of the system is validated by comparison of the standard data. The reliability of analyses is determinated (0 - 100%) and in case it is not 100% the reason is indicated by an error message.

In which form are the data available ?

The data are accessible in the following forms:

- As completely evaluated and validated data (concentrations, reliabilites, error codes) in EXCEL™ readable files on the internal harddisk of the industrial PC
- As rawdatafile (integrator-reports) on the harddisk in the industrial PC. Tools for later off-line treatment are also included in the software
- In a trend-graphic on the screen (green points: reliability = 100%; red points: reliability <100%



- As numerical values in the data-window
- Optionally: via the serial interface (RS 232) or an other interface specified by the customer

Which users can operate the system ?

In the software two user levels are implemented:

- The *operator* can handle the basic functions of the complete system with the two buttons 'start' and 'stop'. He can further watch the trend-graphic and the actual values of the substances selected on the screen. All other functions are hidden.

- The *power-user* has access to all functions of the system. This level is password protected. The power-user can change the procedure of the analysis (time sequences, data evaluation etc.). The complete procedure can be saved as 'method' on the harddisk in the industrial PC. If an operator starts the system the analyses are executed according to the 'method' entered by the poweruser.

What are the requirements for the installation ?

The following requirements have to be met: A reactor equipped with a suitable sampling system, a connection for 220 V AC/ 15 Amp., the gazes needed for the analysis and sufficient space for the set-up and the operation of the system (size: w x l x h: 800 x 600 x 2000).
Since the system is designed completely open, the customer is free to implement any method. Usually different off-line methods are already standard in internal use. They can be transferred autonomously with minimal adaptations. Usually the analytical methods are therefore not part of BIOSPECTRA systems. Obviously BIOSPECTRA exerts its best efforts to support the customer in application questions. Optionally the application engineering can be performed completely by BIOSPECTRA.

What are the benefits using this system ?

- Acquisition of fundamental knowledge about a process recognising the relevant chemical parameters
- Efficient process development (maximal production rates, minimal amount of by-products etc.).
- Hold a process in its optimal range by regulation based on chemical parameters
- Shift the quality control directly into the production line
- Introduction of advanced GLP/GMP standards
- Reduction of staff costs

BIOSPECTRA AG
Zürcherstrasse 137
CH-8952 Schlieren

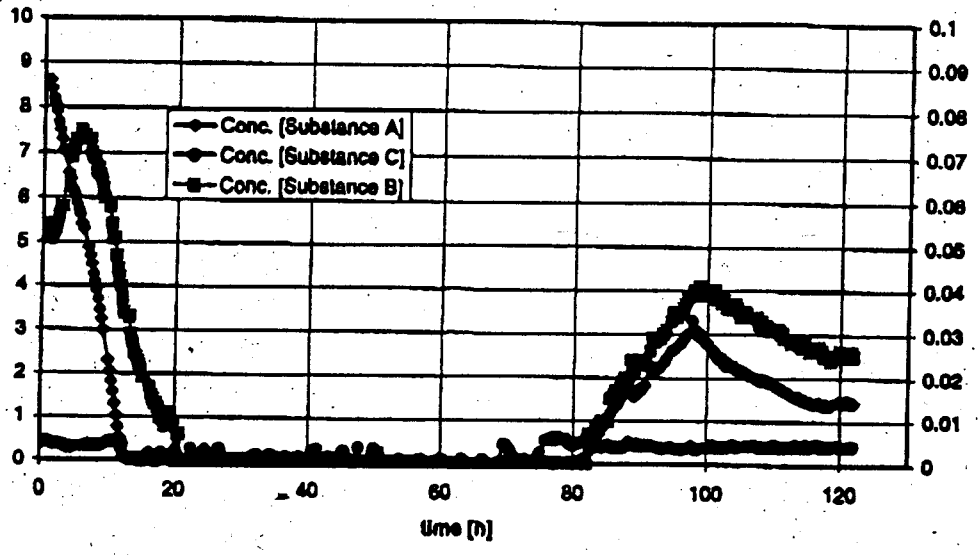
Tel.: [++41] 01/730 21 20
Fax.: [++41] 01/730 85 89

Your partner for on-line process analysis and information systems

Applications

The number of applications is tremendous. For your specific questions we recommend to contact the manufacturers of separation columns.

Online Example: Primary metabolites in a fed-batch cultivation



More products

Online Process Analyser GP/EA

Automated analysis of liquid process samples by various photometric assays

Online Process Analyser HPLC

Automated analysis of liquid process samples by Liquid Chromatography

Sample Bus System / Reaktor Interface

Automated removal of liquid samples from a process, sample pretreatment (lysis, filtration) and transport to analysers/ fraction collectors

Lucullus PIMS

Process Information Managment System based on a workstation for process data acquisition and treatment, advanced control strategies (e.g. pattern recognition) etc.

Lucullus AFE/CS

Basic automation of processes based on Siemens SPS

Acknowledgements: We thank Nestec SA placing us at disposal the picture on the front page

APENDIX 5

Ammonia Analyser System

NEURTEK
MEDIO AMBIENTE S.A.

Instrumentos para control y análisis de aguas

N.I.F. A-20200671

C/ Araba, 45 - Apdo. 220
Telf. (943) 13 14 41
Fax (943) 13 02 41
20800 ZARAUTZ (Spain)

UNIV.AUTONOMA-QUIMICA
ANALITICA.
FAC.CIENCIAS-EDIFICIO C

08193 BELLATERRA
Att.: Sr. Juan Albiol

NEURTEK MEDIO AMBIENTE, S.A. - C/ Araba, 45 - 20800 ZARAUTZ (Spain)

su referencia | nuestra referencia | s/escrito | nuestro escrito | ZARAUTZ

VG/bc

asunto:

Muy Sres. nuestros:

Como continuación a lo tratado con Vds., mediante grata conversación telefónica, nos complace adjuntar a la presente nuestra oferta de referencia, correspondiente a los instrumentos objeto de su interés.

Acompañamos para su mayor información, documentación técnica y descriptiva de los instrumentos ofertados.

Para cualquier aclaración o consulta complementaria sobre la misma, también pueden contactar con nuestra delegación en Barcelona, teléfono 93/3874058.

En la confianza de que nuestra oferta merezca su mejor atención, quedamos a la espera de sus gratas noticias, saludándoles muy atentamente.

p.o.

FDO.: VALERIANO GOMEZ

VISITE NUESTROS STANDS

EXPOQUIMIA :
Palacio 2 Nivel 1 Stand nº 115

EUROSURFAS :
Palacio 4 Nivel 2 Stand nº 17

EQUIPLAST :
Montjuïc 2 Stand nº 307

22-26 Octubre 1996
FIRA DE BARCELONA

PROZESS PHOTOMETER

Overview of Dr. Lange Process Photometer

	AMTAX inter	NITRAX PROBE	PHOSPHAX standard	PHOSPHAX inter	PHOSPHAX sigma	UV-PROBE	SC standard	SC plus
Instrument type	Ammonium process photometer	Nitrate process probe	(Ortho-)phosphate process photometer	(Ortho-)phosphate process photometer	Total phosphor process photometer	Process probe for organic ingredients	Solids and turbidity probe with PVC measuring head	Solids and turbidity probe with noble me measuring he
Measuring principle	2-beam-2-filter photometer	UV-4-beam-photometer	2-beam-2-filter photometer			UV-4-beam-photometer	Infrared pulse sc	
Measuring method	Indophenol blue method, equivalent to DIN 38 406 E5	UV absorption method	Vanadate-molybdate-method		molybdenum blue method, equivalent to DIN 38 405 D 11	UV absorption measurement to DIN 38 404 C2	Turbidity TS-content: eq	
Measurement range limits	0.01–80.0 mg/l NH_4-N	0.5–50.0 mg/l NO_3-N 0.1–200 mg/l NO_3	0.1–15.0 mg/l PO_4-P	0.05–15.0 mg/l PO_4-P	0.01–5.00 mg/l P tot	0.01...200 m^{-1} equivalent to 1–800 mg/l COD_{UV}	Turbidity: 0.01–10.0... TS-Content: 0.01–1. TS (activated slu	
Process variation coefficient according to DIN 38 402	2 %	2 %	3 %	2 %	2 %	2 %	Tur	
Response time	T_{100} = 5 min.	T_{90} ≥ 60 sec	T_{90} = 12 min.	T_{100} = 5 min.	T_{100} = 10 min.	T_{90} ≥ 60 sec	T_{9}	
Measurement interval	5 or 10 min. adjustable	≥ = 1 min. adjustable	continuous	5 or 10 min. adjustable	10 min.	≥ = 1 min. adjustable	≥ ac	
Special features	– Electronic shielding against "electrosmog" (EMC) – Self-monitoring with plausibility check – Automatic cleaning system to eliminate dirt – VIEWTAX data logger	– No sample extraction or conditioning – Reagent-free operation – Life-long constant calibration – Self-cleaning – VIEWTAX data logger	– Automatic calibration – No zero solutions and standard solutions required – Automatic compensation of sample coloration – With simple quick-release hose connection system – VIEWTAX data logger		– Built-in connection – DIN-equivalent process – Without sample filtration – VIEWTAX data logger	– No sample extraction or conditioning required – Delay-free – Reagent-free – Self-cleaning – VIEWTAX data logger	– Plastic probe – alphanumeric display	– Probe made V4A steel – Multifunction Display – VIEWTAX data logger

Different applications for Dr. Lange process photometers are available should you require further detailed information. All Dr. Lange process photometers have

NEURTEK
MEDIO AMBIENTE S.A.
C/ Araba, 45 • 20800 ZARAUTZ (Spain)

07 050 00 **FOTOMETRO DE PROCESOS DE AMONIO -AMTAX-.**

Instrumento electrónico, digital para la determinación fotométrica y continua de la concentración de iones amonio según la norma DIN 38 406 E5.
El AMTAX destaca por:
- Su autodiagnóstico mediante microprocesador.
- Estructura de disposición clara con un mínimo mantenimiento.
- Clara visualización de valores en display alfanumérico.
- Calibración con cero automático.

El suministro comprende:
- La unidad de medición.
- 1 lámpara halógena 6V/10W.
- Manual de instrucciones.
- 1 juego de reactivos para aprox. 21 días.
- 1 juego de accesorios para aprox. 1 año de trabajo.

Precio unidad ... 2.581.360 Pts

07 050 01 **Juego de reactivos A y B para aprox. 21 días de trabajo en continuo.**

Precio unidad ... 18.979 Pts

07 050 02 **Juego de accesorios para 1 año de trabajo compuesto de:**

- 4 juegos de tubos dosificadores.
- 2 juegos de tubos de conexión.
- 2 lámparas 6 V./10 W.

Precio unidad ... 131.580 Pts

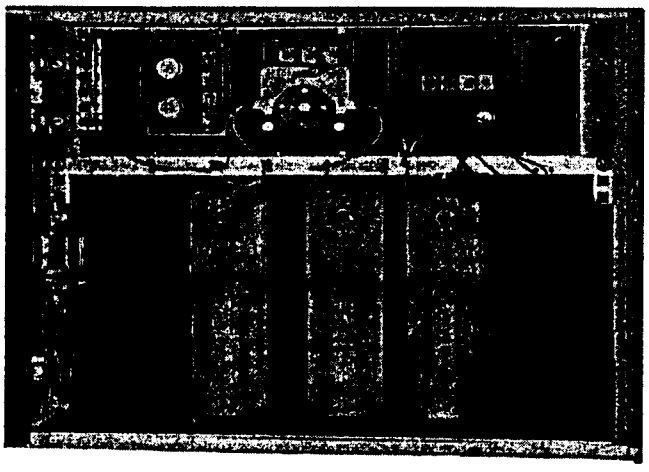
EASI Technologies S.A.
EUROPEAN ANALYTICAL & SCIENTIFIC INSTRUMENTS

EASI Technologies presenta un autoanalizador para medir en continuo el contenido en nitrógeno amoniacal de todo tipo de aguas.

Basado en conceptos de modularidad y de miniaturización, este sistema se caracteriza por su fiabilidad, facilidad de operación y coste reducido.

Analizador de amoníaco (potenciométrico)

Modelo 255



Totalmente automático.

Método: electrodo selectivo (método normalizado APHA-AWWA-WPCF 4500-NH_3 F, aprobado por la EPA).

No es necesario filtrar la muestra.

Un mes de autonomía, 15 minutos por mes de mantenimiento.

Programa de control en entorno Windows™.

El instrumento utiliza una sistema de extracción en contracorriente con membrana permeable al amoniaco para separar el amoniaco antes de medir potentiometricamente su concentración.

El sistema está prácticamente libre de toda interferencia.

A frecuencia predeterminada la muestra se alterna con dos patrones de amonio de concentración conocida, a fin de calibrar el instrumento, permitiendo la corrección en tiempo real de la deriva del potencial del electrodo.

Un programa ejecutado en ordenador externo en entorno Windows™, permite el control y la lectura de los resultados presentándolos de forma gráfica y tabular en pantalla generando paralelamente el fichero de resultados.

Aplicaciones

- monitorización de aguas residuales y potables
- piscifactorías
- monitorización de acuíferos
- industria química
- tratamiento de aguas residuales

Precio

Modelo 255	1.427.500 PTAS

Especificaciones

Rango	0.1- 1000 ppm
Resolución	0.2 %
Reproducibilidad	0,1 ppm + 3 % de lectura
Autonomía	1 mes
Calibración	30 minutos, frecuencia arbitraria
Frecuencia de lectura	cualquiera
Tiempo de respuesta	10 min
Muestra necesaria	1 mL / min
Reactivos necesarios	3 botellas (4 L) /mes
Dimensiones	45 x 54 x 60 cm
Comunicaciones	dos, RS-485 simplex
Alarmas	dos, TTL
Display	alfanumérico, 16 letras iluminadas
Salidas	0-5 V/4-20 mA, 2 relés (opcional)
Consumo eléctrico	0.5 A @ 220 VAC, 1 A @ 110 VAC

Opciones y Accesorios

Referencia	Descripción	Precio
opt -b	bomba interior de muestreo	110.000
opt -c	climatización completa	300.000
opt -u	alimentación 110 Vac	-0-
1219/420	tarjeta de salida, 0-5 V / 4-20 mA	30.000
1219/R	tarjeta relés, dos, 220 Vac, 2A	30.000

Repuestos

Referencia	Descripción	Precio
4750	patrón de 100 ppm	8.000
4751	patrón de 10 ppm	8.000
4752	reactivo	8.000
255/K	kit mant. mecánico 3 meses	12.000

Diseñado y fabricado en España.
Entrega inmediata.

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