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Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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March 1989

COAL COMPOSITION EFFECTS

DP/YUG/87/020

The Socialist Federal Republic of Yugoslavia

Report on*: Visit to UNIDO, Vienna (23-25 January 1989)
and subsequent information on the selection, installation and
application of the equipment at INKOS, Pristina, YUGOSLAVIA

Prepared for the Government of Yugoslavia
by the United Nations Industrial Development Organization
acting as executing agency for the United Nations Development Programme

Based on the work of Mr. S.C. Wallin,
Expert in the monitoring and control of atmospheric
emissions of SO2 from coal-fired power station boilers

Backstopping Officer: R.O. Williams, Chemical Industries Branch

United Nations Industrial Development Organization
Vienna

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CONTENTS

1. INTRODUCTION

With the aim of strengthening the facilities and expertise of the Kosovo Institute for Research and Development (INKOS), near Pristina two reports[1,2] have been prepared under the sponsorship of UNIDO.

As a follow-up to the recommendations made in the reports the equipment identified and specified had passed through the UNIDO purchase procedures and reached the final stage for placing the orders. The main purpose of my visit to Vienna from 23-25 January 1989 was to assist in resolving some of the issues raised during these procedures and to reconcile the technical requirements with the project financial constraints. Before placing the contracts the following issues were identified as highly relevant:

DP/YUG/87/019 - Equipment

- Evaluation of revised quotations from Perkin Elmer and Erba Science
- Response from H.P. re replacement of integrator with P.C.
- Selection of supplier(s) for GC and HPLC
- Technical justification for selection
- Final decision based on budget constraints

DP/YUG/87/020 - Equipment

- Evaluation of additional tenders received from Horiba and UPK
- Justification for choice of H & B analysers, particularly where they are most expensive. Resolution of outstanding issues, rack mounting? Questionnaire?
- Final decisions on items 7 (thermoelectron) and 5 (Monitor Labs). Answer questions raised by Monitor Labs

- Resolution outstanding questions re vehicle and selection of vehicle supplier

- Reconcile equipment selection with budget.

The philosophy of the approach up to final selection and purchase of the equipment will be given in the next chapter before dealing with the application of the equipment in the field and laboratory situations.

2. CRITERIA FOR THE SELECTION OF EQUIPMENT

The two project areas DP/YUG/87/019 and 87/020, although having separate objectives, do have some common interests especially in the measurement and analysis of particles and gases. Allocation of capital for 019 and 020 re $128K and $116K respectively and these have been the target figures within the total capital budget of $244K. The present selection of equipment is just within the total budget and within about 10% for the two project allocations which is considered acceptable.

2.1 87/019 Gasification Plant

On the basis of priority instruments and equipment within the cost ceiling, three essential items were selected:

(i) Apparatus for the determination of volatile organics.

(ii) Equipment for the analysis of polyaromatic hydrocarbons (PAH's).

(iii) Sampler for particulate and organic vapours.

The detailed specifications of these items took into account the need to sample and analyse aliphatic and aromatic HC's, N and S aromatic compounds, N heterocyclic HC's, phenols and mercaptans.

2.1.1 High Resolution GC with Thermal Desorption Unit

There were three candidate systems that met the specification, all produced by organisations with a very high reputation in the field of gas

chromatography. The systems are produced by Perkin Elmer, Hewlett-Packard and Carlo Erba (Erba Science).

Each potential sampler included a thermal desorption (TD) system suitable for the analysis of complex organic mixtures. The package includes the whole TD-GC-FID-data system approach which is specifically aimed at industrial organics such as very volatile species (BP 50°C); high molecular weight species (PAH's 3 ring, Dioxins, PCB's); very reactive species; hot wet stack gases. Analyses require correct interfacing between the thermal desorption, GC and data processing system. It should be noted that in the case of Hewlett Packard the TD is supplied by Bartelt and may require development work by one or both suppliers.

On the basis of least cost and meeting the specification the Elba Science system has been selected. The system is used widely in Europe and maintenance/ back-up support do not present logistic problems. Appendix A gives details of the Erba Science equipment.

2.1.2 High Performance Liquid Chromatography (HPLC) System

There were two systems, Hewlett Packard (HP) and Perkin-Elmer (PE) that met the specifications required.

The HP system was selected on the basis of least cost and its excellent performance in many laboratories throughout the world. Included in the system is a Programmable Fluorescence Detector with a large dynamic range to accommodate compounds giving large variations in emitted light. The Integrator is powerful, flexible and if required can be linked to a PC at a future date.

Details of the HP equipment are given in Appendix B.

2.1.3 Particulate and Organic Vapour Sampler

Andersen Hi-Vol samplers are already in use at INKOS and therefore a more sophisticated sampler manufactured by Andersen's and suitable for the subsequent analysis of high molecular weight organic particles and organic vapours has been selected.

2.2 87/020 Instruments/Equipment for the Measurement of Source Emissions Using a Mobile Laboratory

The provision of a mobile laboratory equipped to continuously measure source emissions (gases) has been identified as an essential facility for INKOS. Bearing in mind the high cost of fully equipped purpose designed emission laboratories a number of options were considered to provide the best option to meet the specifications and to be within the budget available. Two alternatives were examined in detail:

(i) to purchase the required instruments, valves, piping valves etc and a suitable panel van equipped with an air cooling system and carry out the installation and commissioning at INKOS;

(ii) to purchase a transportable package of instruments already piped and operational with span and calibration gas facility. The package would then be installed in a suitable panel van equipped with an air cooling system.

In the event three quotations were received for option (ii) that were all approximately at the budget limit including the purchase of a panel van. The organisations considered were: Horiba, Monitor Labs and UPK. Although in the case of the UPK quotation the oxygen analyser specification is for a zirconium oxide detector the Company's quotation was accepted because it provides for installation of equipment in the van including air conditioning and lightning protection. Details of the instruments are presented in Appendix C.

2.2.1 Measurement of Particulate Emissions - Discontinuous and Continuous

INKOS is already equipped with a Ströhlein 15 discontinuous extractive type particle sampler. As previously indicated to make continuous particle measurements for power plant emissions a double-pass transmissometer is recommended. Should the final total equipment costs permit an additional $10K an instrument to the following specification should be purchased.

- Transmissometer for the continuous determination of particle emissions in flue gases from combustion plant.

- To measure extinction in at least four ranges
- Suitable for duct widths of 0.5-10 metres
- Electrical output to be linearly proportional to the calibration values.

3. APPLICATION OF EQUIPMENT AND INSTRUMENTS

This chapter will deal with some specific applications for the equipment and indicate procedures and limitations where appropriate.

3.1 Application of High Resolution Gas Chromatography

It is the intention for the facilities to be installed at INKOS to use the GC without a mass spectrometer for the analyses of organic mixtures. In adopting this procedure it will be necessary, or at least advisable, to obtain a full GC-MS analysis for a typical mixture.

To use GC alone it is a requirement that each peak in the chromatogram corresponds to a peak in the GC-MS chromatogram which is due to a single substance. If a peak is clearly due to two or more components (from GC-MS evidence) then the area of that peak cannot be apportioned between the components, without considerable additional GC-MS work over a range of typical samples. Should the subsequent samples show considerable variations in the proportions of the individual species, then it would be impracticable to attempt to quantify any such unresolved components.

A further requirement is to conduct all analyses under, as closely as practicable, identical conditions to those used for the original GC-MS analyses. This requirement covers the following:

(i) sample introduction procedure (liquid injection or thermal desorption) should be same;

(ii) the chromatography column shall have the same diameter, length and contents;

(iii) the carrier gas and flowrate should correspond, and the column temperature should be programmed in the same manner.

Providing the above conditions are met the profile by GC can be used to identify and quantify peaks.

For calibration purposes the laboratory should have available standards for all the chemicals of interest. In addition these will provide confirmation of retention times and allow adjustments to be made if chromatography conditions have changed.

3.2 Thermal Desorption Autosampler (TDA)

The TDA is a stand-alone ancillary unit commonly used in conjunction with gas chromatography and for such purposes the absolute response of the detector to each analyte must be known. Analytical reproducibility is ensured by the provision of an in-line injector which allows the standard sample mixture to be vapourised directly into the cold trap used for the second stage desorption. Hence as the cold trap is heated the components will pass to the GC as if the cold trap had been loaded by primary desorption from the sampling tube. It is therefore possible to determine retention times, peak profiles and sample recovery from the cold trap before a sample tube is analysed. To calibrate the detector response a standard sample is injected.

3.3 Laboratory Requirements for GC Analysis

The laboratory where the equipment is to be used must have access to all compounds of interest for calibration purposes and the facilities and expertise for the safe handling of such chemicals. Regular supplies of pure helium, cylinder grade air, hydrogen should be available. The traps will require skilled preparation in a contamination free area and conditioning in a flow of helium at above desorption temperature before reuse.

Good laboratory practice is essential for maintaining the correct working environment for the operation of the instruments including the computers. In addition procedures for clearly identifying each individual sample and tracking it through the system to report stage are required.

3.4 Application of High Performance Liquid Chromatography

To obtain comprehensive data on the emissions of organics from processes it is necessary to representively sample the emission and analyse it to totally characterise all the organic components. This procedure is not always practicable nor cost effective and an alternative is to sample a known portion of the organic which can be analysed to give quantitative or semi-quantitative information on either:

(i) the total mass of material present and its bulk properties such as boiling point range, polarity etc using relatively simple and low-cost techniques, and/or

(ii) individual components or groups of similar components using high resolution 'state of the art' analytical techniques.

This approach is based on the United States EPA Environmental Assessment Methodologies for Fossil Energy Processes[3,4]. The protocol given by EPA for the analytical procedures at the initial stage (level 1) specifies a semi quantitative soxhlet extraction using dichloromethane solvent to determine the mass ratio of volatile to non-volatile compounds corresponding to the main activities of the process under investigation. The extract is then fractionated by polarity into seven subsamples on a silicon gel column. Compound Groups of interest resolved by this method are shown in Table 1.

By separating the compounds into broad groups of interest such as PAH's and phenols analytical procedures can then be applied to isolate and quantify them.

3.4.1 The Analysis of Polycyclic Aromatic Hydrocarbons in Gases

In recent years many reported methods for the determination of PAH's in gases and water have appeared. Liquid chromatography (LC) with ultraviolet (UV) absorption and/or fluorimetric detection and GC with flame ionization and mass spectrometry[5,6] detection have been used.

TABLE 1. - Fractionated Organic Categories

Category (Subcategory)	Most Probable LC fraction	Notes
Aliphatic hydrocarbons	1	Possible assignments. Fractions 4-5, 5-6, 6-7 generally overlap to a considerable extent. Also, additional components of a particular molecule may cause it to elute in an LC fraction other than expected. For example a short-chain ester would probably elute in LC fraction 5 or 6 whereas a long-chain ester would elute in fractions 3 or 4.
(Alkanes)	1	
(Alkenes)	1	
(Alkynes)	1	
Halogenated aliphatics	1,2	
(Saturated)	1,2	
(Unsaturated)	1,2	
Aromatic hydrocarbons	2,3	
(Benzenes)	2,3	
Halogenated aromatic hydrocarbons	2,3	
Nitro aromatic hydrocarbons	4,5	
Fused alternate, nonalternate hydrocarbons	2,3	
MW 216 (methyl pyrene)	2,3	
MW 216	2,3	
Ethers	4	
(Halogenated ethers)	4	
Epoxides	4	
Aldehydes	4	
Heteocyclic oxygen compounds	3,4	
Nitriles	4	
(Aliphatic)	4	
(Aromatic)	4	
Alcohols	6	
(Primary, secondary, tertiary	6	
(Glycols)	6	
Phenols	6	
(Alkyl, etc)	6	
(Halogenated phenols)	6	
(Nitrophenols)	6	
Esters	6	
(Phthalates)	6	
Ketones	6	
Amines	6	
(Primary, Secondary, tertiary)	6	
(Hydrazines, azo compounds)	6	
(Nitrosoamines)	6	
Heterocyclic nitrogen compounds		
(Indoles, carbazoles)	4	
(Quinolines, acridines)	6	
Alkyl sulfur compounds	6	
(Mercaptans)	6	
(Sulfides, disulfides)	6	
Heterocyclic sulfur compounds		
(Benzothiophenes)	4	
Sulphonic acids, sulfoxides	7	
Amides	6	
Carboxylic acids	6,7	
Silicones	2,3,4	
Phosphates	5,6,7	

LC with fluorescence detection is a sensitive method, but does always provide adequate selectivity in complex mixtures. However, the method has several advantages, and it is possible to improve selectivity as indicated in the following:

(i) Some isomers not easily separated by GC can be separated by LC with the correct choice of mobile phase and stationary phase e.g. benzofluoranthenes (b,j,k)[7].

(ii) Fluorescence detection of PAH's is very sensitive and lower limits of detection can be obtained than by GC/MS using selective ion monitoring[8].

(iii) Individual PAH's have characteristic fluorescence excitation and emission spectra and a degree of selectivity is possible if the facility to switch wavelengths is available during a run.

(iv) LC provides a useful preliminary clean-up/fractionation technique for the isolation of PAH's from complex mixtures[9,10].

Appendix D describes procedures for the determination of trace organic materials in the environmental samples.

3.5 Recommended Laboratory Layout for the Work-up and Measurement of Trace Organics Using HPLC

It is important that the information[11] and facilities necessary for the safe handling of chemical substances are provided for laboratory staff. An indication of some of the facilities and precautions required for work associated with HPLC are indicated in Sections 3.5.1-3.5.5.

3.5.1 Sample Extraction

Soxhlet extraction is self contained but common sense dictates that each - say 24 hour - extraction be carried out in a fume cupboard. Some means of monitoring throughout the period of extraction is also essential.

3.5.2 Concentration Process

This process has to be performed under very good extraction conditions as the objective is to remove solvent. Well designed and effective fume cupboards are essential.

3.5.3 Clean-up Stage

During manual open column clean-up fume cupboards are essential.

3.5.4 Analytical/Semi Preparative HPLC

The process is self contained with little opportunity for exposure to solvent fumes. However, the solvents used are volatile and therefore means to place the whole apparatus on drip trays and the provision of a fume hood above the apparatus and trays is recommended. During analysis helium sparging of solvents inevitably leads to solvent fumes and a fire hazard can exist unless suitable extraction is provided.

3.5.5 General Laboratory Layout for HPLC Analytical Work

The general layout should have 3-4 fume cupboards - one for each stage of the analytical procedure. The bench for the HPLC apparatus should be of a peninsular type (which facilitates maintenance work) with an overhead extraction hood.

The handling of chemical carcinogens especially standards in concentrated form, should be carried out in a glove box.

3.6 Use of a Source Emissions Mobile Laboratory

The mobile laboratory is basically a Mercedes-Benz 609D/3700 Van instrumented as specified in Appendix C. It is planned to locate the laboratory at a point near to where measurements are made, and to connect a probe - with a special sampling dilution system - to an umbilical sampling line presenting the process gases to the analysers. The linearised electrical output from the analysers is continuously monitored on a 6 channel recorder.

Calibration procedures are incorporated in the mobile laboratory so that at the site full checks can be made on the zero and span response for all the instruments.

The Laboratory is designed to ensure that during instrument operation and high ambient temperatures the air conditioning system will maintain a satisfactory working environment. For site trials at the process plants particulate sampling equipment and a range of ancillary items are likely to be required. Stowage of these, within and attached to the laboratory during transportation should be provided by INKOS.

The monitoring of source emissions is often time consuming and where possible spare items should be readily available to minimise any disruption to the work programme. Although the sample dilution system should avoid the presentation of aggressive gases to the analysers cosideration will need to be given to the provision of spare analysers at a future date.

4. CONCLUSIONS AND RECOMMENDATIONS

- The basis for the selection of equipment for the two project areas has been presented and the constraints, both technical and financial identified.

- Selection of a Carlo Erba-Mega Series HRGC 5360-00 high resolution gas chromatograph, a TDAS 5000 thermal desorption autosampler, other ancillary equipment and a data processing system gives a facility suitable for the analysis of complex mixtures. If required a mass spectrometer (MS) can be linked to the system thus enhancing the facility.

- Precautionary measures in the absence of MS are discussed, and the procedures required when operating the HRGC system to ensure valid data stated.

- Laboratory requirements for GC analysis are outlined together with safety requirements.

- A Hewlett Packard high performance liquid chromatograph HP 1050 series together with a HP 1046A programmable fluorescence detector, a HP 3396A integrator and other ancillary items have been ordered. The application of HPLC for the analysis of trace organics is discussed and the limitations and advantages of different methodologies presented.

- Detailed procedures for the determination of trace organic materials in environmental samples are described and critically appraised. The HPLC procedures include extraction/concentration; preliminary fractionation/ clean up and chromatographic separation, detection and quantification.

- Laboratory requirements for the installation of HPLC are given and include extraction, fume cupboards and safety measures.

- A UPK mobile source emissions laboratory for the continuous measurement of gaseous emissions has been selected. Initially data from the analysers will be monitored by means of a multi-channel chart recorder and it is recommended that a computer be installed when funds permit to facilitate data reduction.

- The measurement of particulate emissions will be carried out by an extractive discontinuous method - Ströhlein. It is strongly recommended that an "in-stack/or duct" transmissometer be purchased so that continuous measurements of particulate concentrations can be made.

5. REFERENCES

1. Wallin, S.C. Report of Visit (19 September-5 October 1988) to the Institute for Research and Development (INKOS) and the Electric Power Plants, near Pristina, Yugoslavia.

2. Wallin, S.C. Report of Visit (19 September-5 October 1988) to the Institute of Research and Development and Gasification Plant near Pristina, Yugoslavia.

3. Warren, J.L. Status of IERL-RTP Environmental Assessment Methodologies for Fossil Energy Processes. EPA Contract No. EPA/600/7-78/151 NTIS PB 287-210, 1978.

4. Lentzen, D.E. et al. EPA-IERL-RTP Procedures Manual - level 1 Environmental Assessment EPA 600/7-78-201, 1978.

5. Supelco Inc. GC/HPLC Bulletin 7730.

6. Bedding, N.D. et al. J of Chromatographic Science, Vol. 26, 1988, pp 597-605.

7. Wise, S.A. et al. J of Chromatographic Science, Vol. 19, 1981, pp 457-465.

8. Lawrence, J.F. Chromatographia, Vol. 24, 1987, pp 45-50.

9. Wise, S.A. et al. Anal. Chem., Vol. 58, 1986, pp 3067-3077.

10. May, W.E. and Wise, S.A. Anal. Chem., Vol. 56, 1984, pp 225-232.

11. Dornhoffer, M.K. Handling Chemical Carcinogens: A Safety Guide for the Laboratory Researcher, 1986. Chemsyn Science Laboratories, 13605 W 96th Terrace Lenexa, Kansas 66215 - 1297.

APPENDIX A

MEGA SERIES
HIGH RESOLUTION
GAS CHROMATOGRAPHS
5160-5300

ST MEGA 1-E
1st January 1986

The Mega Series high resolution gas chromatographs are a complete line of highly innovative instruments specifically designed to meet the very high criteria required by the modern, demanding chromatographic techniques.

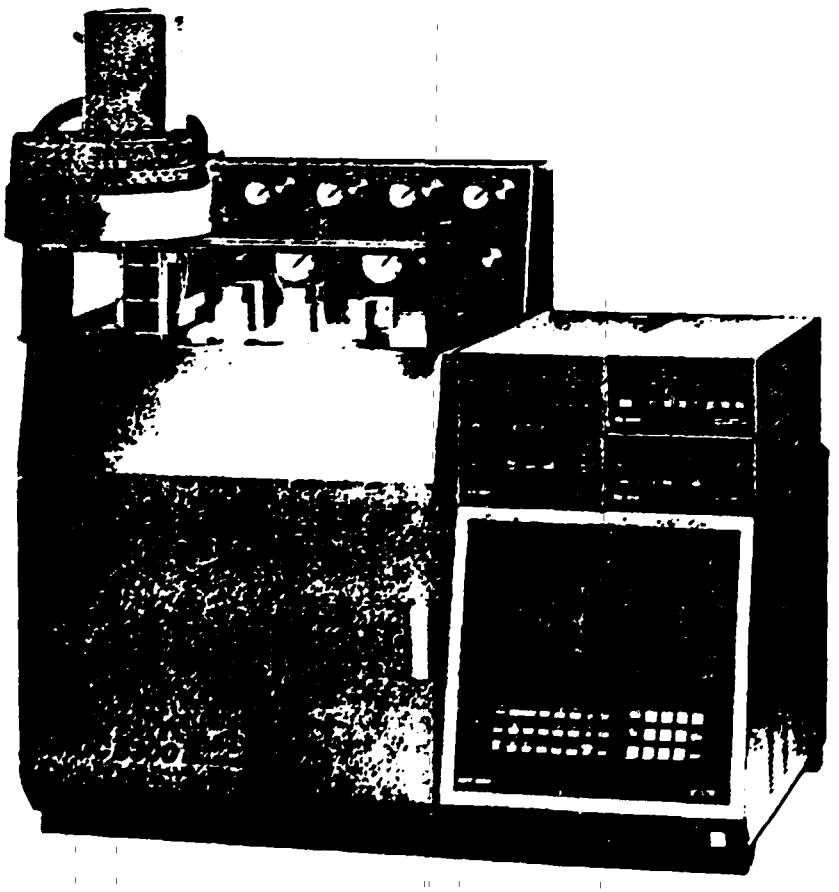
The new Mega Series offers the advantages of automation and modular construction, as well as a wide selection of easily interchangeable injection and detection systems.

The Mega Series features large column oven with high thermal stability and a keyboard operated Multi Function Controller (MFC 500) which includes a multi-ramp linear temperature programmer.

The Mega Series includes two main variants: the single column unit 5160 and the dual column units 5300.

They may be upgraded and automated at any time according to your analytical needs and budget through the widest array of dedicated accessories and purposely developed autosamplers including the unique cold on-column autosampler AS 550.

The line is completed by cost effective, highly efficient data systems and Maxima 820/Baseline 810 chromatography workstations.



Mega Series HRGC - Base Unit Specification

As reported before the Mega Series includes two main variants: the 5300 and 5160. These units feature the same column oven and keyboard operated Multi Function Controller MFC 500 and offer a wide choice of injection systems, pneumatic circuits and detection compartments. The detailed specifications of the individual parts forming the Base Units reported later are described hereunder.

Injection Systems

According to the different Base Unit configurations the following injection systems are available:

Dual capillary injection system (5160-00 and 5360-00)
It includes:
• Non-vaporizing, septumless cold on-column injector.
Based on the original design proposed by Grob, this injector is also fitted with a special secondary cooling system (patent No. 4269606) ensuring a complete sample transfer from the syringe to the capillary column.
This ensures peak area and relative peak area standard deviations below 1.5% and 0.5% respectively.
Besides this unsurpassed capabilities, the secondary cooling system also permits injection temperatures higher than the sample solvent boiling point therefore preventing the consequences of the flooding effect responsible for peak distortion.
The injection procedure can be automated by the OC 516 Module which, besides permitting automatic actuation of injector valve and secondary cooling by simple manual syringe insertion, also starts oven temperature programmer and computing integrator.
• Split-splitless injector
The design of this capillary injector is based strictly on Grob's original idea.
It finds its major field of application for samples which are undiluted or contain large amounts of heavy by-products.
It can be used for either split or splitless injection thus covering a large range of applications.
The injector accepts different sized glass liners to meet the requirements imposed by sample volume and to avoid sample-metal contact therefore preserving the nature of the sample.
Septum flushing and sample splitting is accomplished by two high precision micrometric valves located in a heated area.
These valves can be automated for unattended operations with autosamplers.
Temperature setting is via keyboard in the range 50°C to 450°C in 1°C increments.

Dual packed column injection system (5320-00 and 5340-00)
This system includes two heated injection ports designed to accept glass or metal packed columns from 4 to 6 mm OD.
It accepts metal or glass liners for conventional vaporization injection or alternatively the injectors may be used for direct sample injection into packed columns.
Glass and metal liners are readily removed for cleaning and removal of sample residues.
Special septum coolers are available to minimize bleeding and eliminate ghost peaks.
This injection system can be heated in the range 50°C to 450°C in 1°C increments.

Dual packed/capillary injection system (5330-00 and 5380-00)
This system includes one packed and one capillary column injector (split-splitless for 5330-00 and cold on-column for 5380-00).
Specification of these injectors have been previously reported.

Pneumatic Circuits

Different pneumatic circuits are available for carrier and auxiliary gases. Their composition is strictly related to the different configurations of injection systems and base body compartments fitted into the Base Units.

Carrier Gas
• Dual independent capillary-designed circuit (5160-00 and 5360-00)
This circuit features two separate lines for cold on-column and split-splitless injector. Each line includes:
A high precision bleed and diffusion-proof metal bellow pressure controller (PRV-20/3) for accurate carrier regulation in the range 0 to 2.5 Kg/sq cm.
The cold on-column injector line is prearranged for direct connection of CP/CF module for constant pressure/flow operations.
A metal shut-off valve, particularly useful for prompt leak check and easy flow rate measurement.
A 60 mm diameter pressure gauge.
• Dual independent packed-column designed circuit (5320-00 and 5340-00)
This circuit features two separate lines for packed column injectors.
Each line includes:
A high precision bleed and diffusion-proof metal bellow pressure controller (PRV-20/5) for accurate carrier gas regulations in the range 0 to 5 Kg/sq cm.
A high constancy flow controller.
A metal shut-off valve.
A 60 mm diameter pressure gauge.
• Dual independent packed and capillary-designed circuit (5330-00 and 5380-00)
This circuit features two separate lines for packed column and capillary split-splitless injector respectively.
The line for packed column injector is the same as reported before for 5320-00 and 5340-00 while that for the capillary injector was described for 5160-00 and 5360-00.

CODE	DESCRIPTION

Auxiliary gases
• Two different pneumatic plumbings are available
They consist of:
Three independent lines (5160-00) for hydrogen, air and make-up.
Five independent lines (5320-00, 5330-00, 5340-00, 5360-00 and 5380-00), two for hydrogen, two for air and a make-up.
Each line includes:
A high precision metal diaphragm pressure controller.
A 40 mm diameter pressure gauge.

Column Oven

The Mega Series column oven has been optimized to produce the best possible oven temperature stability and uniformity, fundamental parameters determining accuracy and precision of retention data.
Innovative patented solutions as a new concept in air circulation and a unique fan design permit the column to be immersed in an ideal, thermally quiet zone with a peak to peak temperature variation of less than 0.05% of actual temperature.
This permits low thermal mass capillary columns (flexible fused silica) to be used without any problem of peak distortion or splitting.
This column oven accepts true side by side column installation of both packed and capillary type while still providing a large usable space for different valving configurations.

Technical Data
Temperature range: from 8°C above ambient to 420 °C.
Subambient operations down to are possible through an optionally available N_2 cryogen unit.
Program rates: 0 to 49.9°C/min in 0.1°C/min through three-ramp programmer. Practical upper limit is 50°C/min during initial ballistic programming as may be required by splitless and cold on-column injections. Usable space: mm 320 (h) x 320 (w) x 160 (d).

Ionization Detector Base Body Compartments

Two types of ionization detector base body compartments are available according to the different Base Unit configurations.
This is mainly due to the fact the requirements imposed by capillary columns are basically more stringent and surely different from those needed by conventional packed columns. In this light the Mega Series base body compartments have been designed to fulfill these requirements.

Capillary-designed base body (5160-00, 5330-00, 5360-00 and 5380-00)
Engineered to accept all types of capillary columns (glass and fused silica). The base body design permits the capillary to enter directly the detector jet therefore eliminating any dead volume responsible for extra column band broadening effect.
The temperature of this compartment is finely controlled in the range 50°C to 450°C in 1°C increments.
Temperature uniformity is ensured by specially designed heaters eliminating any possible cold spot to avoid loss of efficiency.

Packed column-designed base body (5320-00 and 5340-00)
Accepts all types of glass and metal packed columns ranging from 4 to 6 mm OD without any modification.
Also in this case the column enters this compartment up to the detector jet therefore eliminating all problems previously described.
Temperature range and uniformity are the same mentioned above for the capillary-designed type.

A common feature for both types is the possibility to interchange ionization detectors in minutes without any modifications (except jet replacement).

Multi Function Controller MFC 500

The Multi Function Controller MFC 500 is the simple, easy to understand yet accurate keyboard operated control station of Mega Series.
It includes:

Address keyboard
This section contains all the addresses of the four zones the MFC 500 is divided into. They are: injector one, injector two, oven and detector base body compartments. It also includes "ACTUAL TEMP" and LIST keys for prompt visualization of the different temperatures and program parameters respectively.

Numeric keyboard
This keyboard is used to set the values of the individual operating parameters previously selected through the address keyboard.
It also includes "CHRONO" key to verify or re-adjust carrier gas or fuel gas flows through a digital stopwatch.

Large graphic array
It includes:
MEMORY display for all set parameters (°C, °K, MIN, °C/MIN); ACTUAL TEMP display for instant comparison with preset parameters.
TIME ELAPSED for the elapsed time of each program phase.
DATA/CHRONO display for monitoring each parameter entry and stopwatch.
Temperature program array with mobile cursor indicating actual phase in progress.
Trouble shooting and communication signals including "ready" and "alarms" lamps for system status indication or transmission to external devices.

Complete multi-program storage and recall
Facilities are provided to store up to 10 complete programs which can be recalled at any time.

CODE	DESCRIPTION

Battery back up
In case of total power failure a battery back up preserves operating parameters stored in memory for 30 days.

Column limit protection
Ensures that column maximum temperature will not be exceeded. Setting is independent from temperature program and is realized through digital thumbwheel switches for maximum safety.

Main power breaker
An automatic electromagnetic switch ensures protection of electric and electronic circuitry against current overloads.

General Base Unit Specifications

Physical size
Height: 677 mm, width 779 mm, depth 581 mm

Power requirements
15 amp. dedicated line.
220 VAC ± 10%; 50/60 Hz.
Maximum power consumption: 2200 VA (including injectors and detector base body) during full power heat-up.

Mega Series HRGC - Base Units

113 11100-50

Mega Series HRGC 5160-00

complete with:
Dual capillary injection system including cold on-column and split-splitless injectors.
Dual independent capillary-designed pneumatic circuit for carrier gas (one for each injector).
Three independent line aux. gas plumbing.
High stability large column oven specially designed for fused silica capillary columns.
Capillary-designed base body for ionization detectors.
Keyboard operated Multi Function Controller MFC 500 including multi-ramp temperature programmer and large graphic array.
Installation Kit and standard outfit.

113 11101-50

Mega Series HRGC 5320-00

complete with:
Dual packed column injection system accepting 4 and 6 mm OD glass and metal columns without any modifications.
Dual independent packed column-designed pneumatic circuit for carrier gas (one for each injector).
Five independent lines aux. gas plumbing.
High stability large column oven permitting true side by side column installation.
Dual packed column-designed base body for ionization detectors.
Keyboard operated Multi Function Controller MFC 500 including multi-ramp temperature programmer and large graphic array.
Installation kit and standard outfit.

113 11102-50

Mega Series HRGC 5330-00

complete with:
Dual injection system including one packed column injector and one capillary split-splitless injector.
Dual independent packed and capillary-designed pneumatic circuit (one for each injector).
Five independent line aux. gas plumbing.
High stability large column oven permitting true side-by-side packed and capillary column installation. Specially designed for fused silica capillary columns.
Dual packed/capillary designed base body for ionization detectors.
Keyboard operated Multi Function Controller MFC 500 including multi-ramp temperature programmer and large graphic array.
Installation kit and standard outfit.

113 11103-50

Mega Series HRGC 5340-00

Same as Mega Series HRGC 5320-00 Base Unit but also including a high sensitivity, high stability hot wire thermal conductivity detector to be piloted by HWD 430 (not included as standard with the instrument).

113 11104-50

Mega Series HRGC 5360-00

complete with:
Dual capillary injection system including cold on-column and split-splitless injectors.
Dual independent capillary-designed pneumatic circuit for carrier gas (one for each injector).
Five independent line aux. gas plumbing.
High stability large column oven specially designed for fused silica capillary columns.
Dual capillary-designed base body for ionization detectors.
Keyboard operated Multi Function Controller MFC 500 including multi-ramp temperature programmer and large graphic array.
Installation Kit and standard outfit.

113 11105-50

Mega Series HRGC 5380-00

Same as Mega Series HRGC 5330-00 but with cold on-column injector instead split-splitless injector.

CODE	DESCRIPTION

Detection Systems for Mega Series

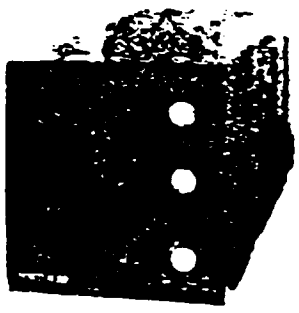
Thermal Conductivity Detector

418 10600-50

Hot Wire Thermal Conductivity Detector type HWD-45
Complete with sensing elements type WX (2")
This detector can be connected to HWD 430 Control Module. Relevant technical data are reported below.

432 09803-50

HWD 430 Control Module
coupled to HWD 45 detector, it permits Constant Mean Temperature operations to be performed.
This ensures high filament protection, while enhancing wide linear dynamic range and high sensitivity.
The module incorporates separate controls for digital setting of detector and filament temperature in steps of 10°C and status lights for prompt visualization of the system.
Safeties are also provided for safety cut off and carrier pressure failure.
Output signal section includes binary steps attenuator (1 to 1024 plus shunt) amplifier gain by a factor of 10, polarity switch and fine and coarse zero controls.
This module can operate : cal mode only.



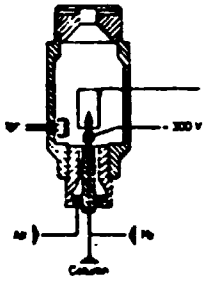
Minimum detectable amount: 1×10^{-10} g/ml (based on neon), equivalent to 0.4 vpm neon in 1.5 cc of air using 20 ml/min helium carrier with detector temperature 100°C and filament temperature 200°C and a molecular sieve column 5 m x 2 mm ID at ambient temperature.
Sensitivity: 2×10^{8} mV x ml/mg (based on neon).
Linearity: ±2% for heptane over a dynamic range of $>10^{4}$.
Noise: ±2% at highest sensitivity (x 1 x 10).
Nominal temperature setting for detector: ambient to 390°C.
Nominal temperature setting for filaments: ambient to 490°C.
Output for recorder: 1-10 mV.
Output for computer: 1-10 V.
Power Supply: 220 V; 50/60 Hz.

Flame Ionization Detector

418 10620-50

Flame Ionization Detector type FID-40*
Specially designed for high dynamic range.
Sensitivity: 0.012 coulombs/gram.
Linear range: better than 10^{6}.
Noise: 2×10^{-14} A at max sensitivity.
Minimum detectable amount: 3×10^{-12} g/sec (pentane).
Operating temperature limits: 330°C with flame jet FID-4 (404 01800-50); 450°C with ceramic flame jet (404 04300-50).

* This detector includes one flame jet FID-4 as standard. For high temperature operations the ceramic flame jet should be ordered extra.



432 09717-50

EL 580 Electrometer Module
The Electrometer Control Module EL-580 is a single channel amplifier for FID-40 and NPD-40 detectors which provides excellent performance of sensitivity and linearity. It consists of a solid state amplifying circuit, JFET pre-amplifier stage, signal attenuators, full scale calibrator, back-off suppressor as Autozero and stabilized power supply.
Operation modes: single or differential*
Input range: 0 to 10^{-6}A
Input attenuation: 4 steps (10^{0}, 10^{1}, 10^{2}, 10^{3})
Zero compensation: 5×10^{-7}A through digital type autozero. Remote control can be activated
Output attenuation: 11 binary steps from 2^{0} to 2^{10}
Recorder output: Potentiometric Recorder 10-1 mV f.s.
Computer output range: 0 to 10V (1V)DC
* For differential mode an input cord adapter required.

432 09825-50

Input cord adapter for EL 480 and 580
Permits EL 480 and 580 to operate in differential mode.

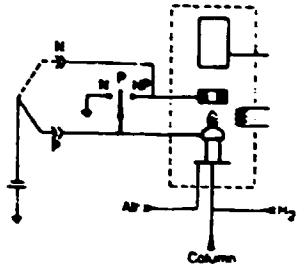
CODE	DESCRIPTION

Thermionic Detector

419 10540-50

Nitrogen Phosphorus Detector type NPD-40*
High sensitivity, high stability wide linear dynamic range detector for the determination of nitrogen and phosphorus containing compounds at a flip of a switch.

Minimum detectable amount: 5×10^{-14} g/sec as methyl parathion; 2×10^{-13} g/sec as atrazine.
Linearity range: better than 10^6.
Noise: 2×10^{-14} A in «N mode».
Selectivity: N/C = 10^6:1; P/C = 10^3:1.
Operating temperature limits: 330°C with flame jet FID-4 (404 01800-50); 450°C with ceramic flame jet (404 04300-50).



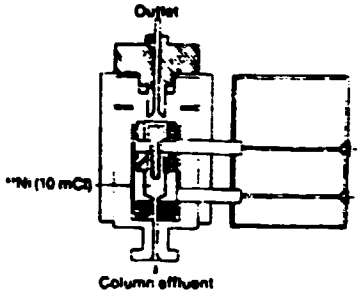
* This detector includes one flame jet FID-4 as standard. For high temperature operations the ceramic flame jet should be ordered extra.

Electron Capture Detector

419 10550-50

Electron Capture Detector type ECD-40*
complete with ionization chamber, Ni^{63} source**, low voltage heater and Pt wire sensor.

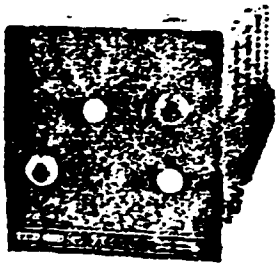
Linear dynamic range: higher than $1:10^6$ (constant current mode and nitrogen carrier gas).
Minimum detectable amount: less than 0.1 pg of lindane.
Ionization chamber volume: 400µl.
Source activity: 10 mCi.
Operating temperature limits: 300°C with jet 404 02000-50; 400°C with metal jet 404 04401-50.



* This detector includes one jet 404 02000-50 as standard. For high temperature operations (> 280-300 °C) the metal jet 404 04401-50 should be ordered extra.
** Subject to local rules concerning radioactive materials

432 09593-50

ECD 400 Control Module
complete with electrometer, temperature controller, digital frequencymeter with display and detector overheating protection.
Operates according to: constant current and constant frequency modes.



Constant Current Mode
Reference current: 0 to 5×10^{-9} A continuously adjustable.
Pulse amplitude: 5 to 50 V pk (negative) continuously adjustable.
Pulse width: 0.1 µs (argon/methane) - 1 µs (nitrogen).
Frequency range: 0 to 2.5 MHz @ 0.1 µs; 0 to 500 KHz @ 1 µs.
Computer Output*
Range: 0 to 10 V DC
Sensitivity: 4 µV/Hz @ 0.1 µs; 20 µV/Hz @ 1 µs
Recorder output**: strip chart potentiometric recorder 10 mV, 0.5 s f.s.
Attenuation: 13 binary steps from 1 to 4096 plus ∞ (shunt)
Sensitivity x 1: 16 µV/Hz @ 0.1 µs; 80 µV/Hz @ 1 µs

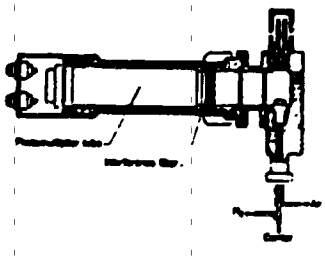
Constant Frequency Mode
Input range: 0 to 5×10^{-9} A.
Pulse amplitude: 5 to 50 V pk (negative) continuously adjustable.
Pulse width: 0.1 µs (argon/methane) - 1 µs (nitrogen)
Frequency setting: 0 to 50 KHz continuously adjustable
Computer output*
Range: 0 to 10 V DC
Sensitivity: 0.1 mV/10^{-12} A
Recorder output**: strip chart potentiometric recorder 10 mV, 0.5 s f.s.
Attenuation: 13 binary steps from 1 to 4096 plus ∞ (shunt)
Sensitivity: 0.4 mV/10^{-12} A

Flame Photometric Detector

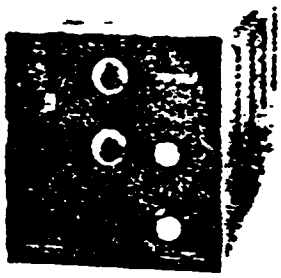
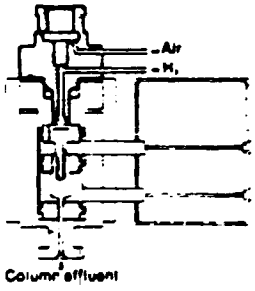
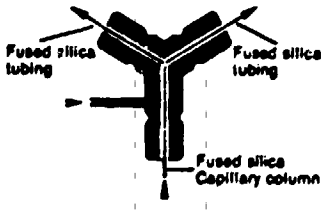
419 06700-50

Flame Photometric Detector type SSD 250
complete with photomultiplier, 394 nm filter (sulphur), cartridge heater and connection cable.

Linear dynamic range: Sulphur 5×10^3 (with linearizer); Phosphorus: 10^3.
Minimum detectable amount (diazinon): 2×10^{-11} g S/sec; 1×10^{-12} g P/sec.
Selectivity: S/hydrocarbon: 10^4; P/hydrocarbon: 10^3.
Operating temperature limit: 250°C.



* 0 to 1 V DC output is also available
** 0 to 1 mV DC output is also available

CODE	DESCRIPTION
432 00630-50	**SSD 250 Control Module** complete with electrometer, autozero and temperature controller. Operates according to direct and linearizing mode. Input range: 1 - 10. Input current: 10^{-6} - 10^{-5} - 10^{-4} A f.s. Photomultiplier tube excitation: 600 to 1200 V (negative) continuously adjustable. Backing off: continuously adjustable. Zero suppression: 0 to 10^{-9} A continuously adjustable. Automatic zero: through sample/hold memory with resetting read-out meter. *Direct Mode* Computer output* Range: 0 to 10 V DC @ 1 mA max. Output impedance: ≤ 1 Ω. Resolution: 20 μV. Sensitivity: 100 μV/10^{-9}A. Linear dynamic range: $1:5 \times 10^3$. Recorder output**: potentiometric type 10 mV, 0.5 sec f.s. Attenuation: 11 binary steps from 1 to 1024 plus ∞ (shunt). Resolution: 20 μV. Sensitivity x 1: 100 μV/10^{-9} A. Linear Dynamic range: $1:5 \times 10^3$. *Linearizing Mode* As direct mode but with output through linearizing system without attenuation. Equation $V = K \cdot [S]^n$. Exponent: 1.3 to 2.13 continuously adjustable. Computer output* Range: 0.5 to 10 V DC @ 1 mA max. Output impedance: ≤ 1 Ω. Resolution max: 20 μV. Recorder output**: potentiometric type 10 mV; 0.5 sec. f.s. Resolution max: 20 μV. Detector temperature range: 50 to 250°C in 25°C steps. Power supply: 220V ± 10%, 50/60 Hz; 100 VA. * 0 to 1 V DC output is also available ** 0 to 1 mV DC output is also available
	
	Multidetector Configurations
190 04518-50	Adaption kit for ECD/FID or ECD/SSD series configuration (for ECD-40 only) Complete with two separate lines for auxiliary gases.
222 04710-50	Heater for FID-40 arranged in series with ECD-40 Complete with cable and plug for connection into the ECD 400 Control Module.
233 00510-50	Thermal insulating cap for FID
190 04521-50	Effluent splitter for fused silica columns Complete with fittings, ferrules and two metres each persilanized fused silica capillary tubings (0.32 and 0.22 mm ID respectively).
260 80363-50	Persilanized fused silica capillary tubing, 0.32 mm ID, two metres
260 80364-50	Persilanized fused silica capillary tubing, 0.22 mm ID, two metres
	
	Spares and Consumable Parts for Detection Systems
404 01800-50	Flame jet FID-4 for FID-40 and NPD-40 (set of 2)
404 04300-50	Ceramic flame jet for FID-40 and NPD-40 (set of 2)
404 02000-50	Jet for SSD 250 and ECD-40
290 30903-50	PTFE O-ring for SSD-250 and ECD-40 (set of 10)
404 04401-50	Metal jet for high temperature operations with ECD-40 (set of 2) Requires washer 290 23609-50
290 23609-50	Washer, metal for jet 404 04401-50
338 70000-50	Calibration mixture for NPD-40
465 01000-50	Alkali source for NPD-40 (set of 2)
281 07100-50	Narrow bandpass filter for phosphorus (526 nm) for SSD-250
281 07000-50	Narrow bandpass filter for sulfur (394 nm) for SSD-250
276 02800-50	Water cooler for SSD-250
190 04519-50	Maintenance kit for SSD-250
	

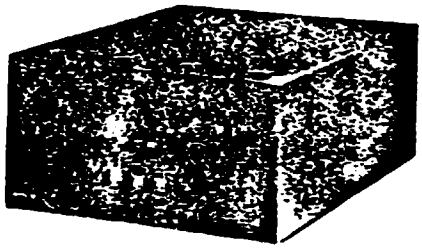
Multinjector™ Universal Cold Injector for HRGC

The new Multinjector results from the combination of a cold on-column injector with an easily retrofittable cold split/splitless (PTV) module.
Two such modules are available (see below 299 02030/299 02031).
Both are compatible with Autosampler AS 550.

299 02030-50 — **Cold split/splitless (PTV) module Mod. 516**
Complete with one splitline and automatic valve for splitless mode controlled by MFA 515 Module.

299 02031-50 — **Cold split/splitless (PTV) module Mod. 516**
Complete with split and back-flush lines.
Includes automatic valves for splitless and back-flush modes.
Both valves are controlled by MFA 515 module.
Requires purged cold on-column injector OC 61 (299 02110) for manual or semiautomatic injections and OC 65 (299 02092), which is already included in Autosampler AS 550 (251 05073), for fully automated injections.

432 09720-50 — **MFA Multi Function Actuator**
The MFA 515 is the control module for cold split/splitless (PTV) modules (299 02030/299 02031).
It includes a large variety of programs so that the operator need only key a figure to obtain the desired mode of operation. All parameters are readily available on digital displays and can be altered at any time by soft keys.
This version is also suitable for the automatic control of the Cold Trap System used in conjunction with TDAS 5000.



432 09721-50 — **MFA 515 Multi Function Actuator**
This control module offers the same performance of the previous one (432 09720) but also include an automatic actuator for the cold on-column injector.
This will highly facilitate injection procedure and enhance reproducibility.

Spares and Consumables for cold split/splitless (PTV) modules

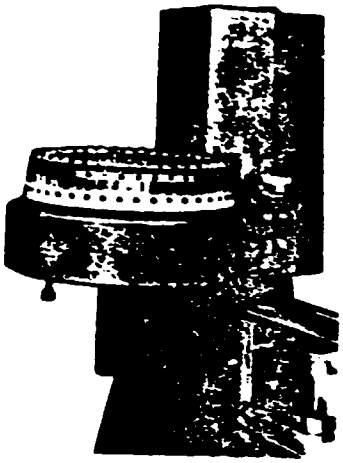
290 30301-50 — O-ring viton 2007. Set of 10. Ensures tightness between bottom of cold on-column injector and top of PTV module

290 13485-50 — Graphpack ferrule 1 mm I.D. Set of 2
290 13486-50 — Graphpack ferrule 0.8 mm I.D. Set of 2
290 13487-50 — Graphpack ferrule 0.45 mm I.D. Set of 2
290 13488-50 — Graphpack ferrule 0.35 mm I.D. Set of 2
290 13489-50 — Graphpack ferrule 0.25 mm I.D. Set of 2
453 20052-50 — Glass liner. Set of 2
290 13495-50 — Graphpack ferrule for glass liner. Set of 2
290 33458-50 — Graphitized vespel ferrule OD 1 for split and back-flush line tightness. Set of 10
290 34204-50 — Washer s.s. OD 1.6 for ferrule 290 33458. Set of 10
347 15436-50 — Adapter 8-4 complete with silver washer. Convert capillary detector base body to accept graphpack ferrules
290 37100-50 — Washer, silver, for adapter 347 15436. Set of 10

CODE	DESCRIPTION

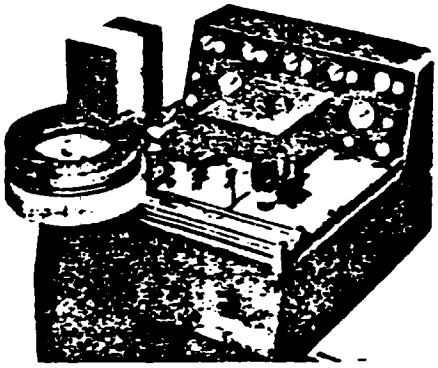
Automatic Samplers for Mega Series

Autosamplers for liquids



251 05072-50

AS 550 Autosampler for cold on-column injection of liquids ranging from 0.2 to 250 microlitres.
Also suitable for vaporizing injectors with optional kit.
Complete with:
42 position sample tray
3 µl syringe for on-column injection
Waste bottle
Mounting brackets
Adaption kit containing specially designed cold on-column injector (type OC 55) provided with automatic actuator for rotative valve and wide bore fused silica precolumn mounted on a special holder.
This kit also includes a zero dead volume connector with make-up line and ferrules for connection of precolumn to 0.32 mm I.D. fused silica capillaries.
It DOES NOT INCLUDE sample vials, relevant septa and hand crimpers which have to be ordered separately.
Equipped with BCD output.
Requires connection to AS 550 Programmer for automatic operations.
Tray capacity: 42 vials/1.5 ml; 60 vials/0.8 ml (optional).
Vial sizes: 1.5 ml/12 x 32 mm crimp top, 11 mm finish; 0.8 ml/8.5 x 30 mm crimp top, 8 mm finish (optional).
Sample size reproducibility: typically 1%.
Cross contamination: typically less than 0.3%.

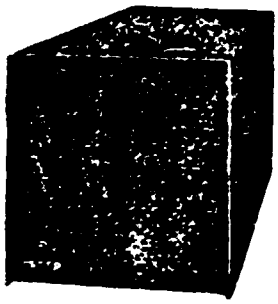


251 05073-50

AS 550 Autosampler for cold on-column injection
Same as 251 05072-50 but including OC 65 instead of OC 55.
To be used with cold split/splitless (PTV) module with back-flush capability (299 02031-50).

251 05063-50

AS-V 570 Autosampler for liquids with 42 sample tray
Suitable for vaporizing capillary and packed column injectors.
Uses 1.5 ml, 12 x 32 mm crimp-top vials and comes complete with automatic splitless valve,3 µl syringe, waste bottle and mounting brackets. It DOES NOT INCLUDE sample vials, relevant septa and hand crimpers which have to be ordered separately.
Equipped with BCD output.
Requires connection to AS 550 Programmer for automatic operations.
Tray capacity: 42 vials/1.5 ml; 60 vials/0.8 ml (optional).
Vial sizes: 1.5 ml/12 x 32 mm crimp top, 11 mm finish; 0.8 ml/8.5 x 30 mm crimp top, 8 mm finish (optional).
Sample size reproducibility: typically 1%.
Cross contamination: typically less than 0.3%.



251 05077-50

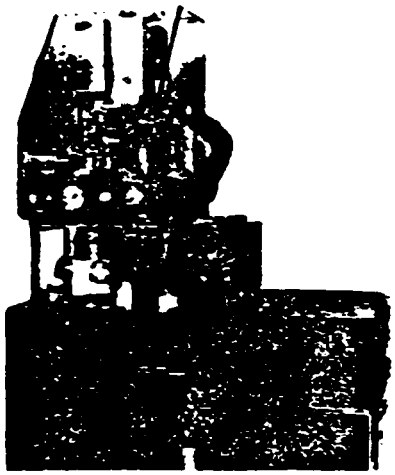
AS 550 Microprocessor controlled programmer for Autosampler AS 550 and AS - V 570
Provides complete control of injection sequence, flush sequence and tray movements.
Operates according to LOCAL and REMOTE modes.
Parameter settings is through dedicated keys and display and includes all functions of AS 550 and AS-V 570 with the addition of the control of secondary cooling time for cold on-column injector and splitless time for splitless injection.

Utilities
Power supply: 220V ± 10%; 50/60 Hz
Servo air: 5 Kg/sq. cm
Nitrogen: 2 Kg/sq. cm

CODE	DESCRIPTION
	Options for AS 550 Autosampler
190 04529-50	Adaption kit for operations with vaporizing injectors
190 04530-50	Adaption kit for operations with glass capillary columns
190 04541-50	Kit for manual injections through on-column injector (OC 56)
	Accessories and consumables for AS 550/AS-V 570
240 74003-50	Crimp-top vials, 1.5 ml, 12 x 32 mm, 11 mm finish (pkg of 100)
240 74005-50	Crimp-top vials, 0.8 ml, 8 mm finish (pkg of 100)
453 80800-50	Conical glass insert 0.15 ml for 1.5 ml vial (pkg of 100)
386 08100-50	Aluminium seals, 11 mm with teflon faced septa (pkg of 100)
386 08300-50	Aluminium seals, 8 mm with teflon faced septa (pkg of 100)
190 04557-50	Sample tray for 60 vials (requires 0.8 ml capacity vials)
425 07500-50	Self-standing unit for pressurizing gas
	Required for servo-gas control on AS 550/AS-V 570
206 11000-50	Hand-crimper (11 mm)
206 11001-50	Hand-crimper (8 mm)
313 04800-50	Diverter valve septa (pkg of 24)
313 04700-50	Septum, teflon faced, for diverter valve for AS 550 only (pkg of 10)
	Syringes and needles for AS 550
365 01101-50	Syringe 3 µl with needle 0.47 x 0.12 mm for OC
365 01201-50	Syringe 5 µl with needle 0.47 x 0.12 mm for OC
365 01301-50	Syringe 10 µl with needle 0.47 x 0.12 mm for OC
365 01400-50	Syringe 3 µl with needle 0.57 x 0.12 mm for vaporising injectors
365 01500-50	Syringe 5 µl with needle 0.57x0.12 mm for vaporising injectors
365 01600-50	Syringe 10 µl with needle 0.57 x 0.12 mm for vaporising injectors
365 50006-50	Needle 3 µl (0.47/0.12 mm)
365 60006-50	Needle as above (set of 5)
365 50007-50	Needle 5 µl (0.47/0.12 mm)
365 60007-50	Needle as above (set of 5)
365 50008-50	Needle 10 µl (0.47/0.12 mm)
365 60008-50	Needle as above (set of 5)
	Syringes and needles for AS-V 570
365 00800-50	Syringe 3 µl with needle 0.57x0.13 mm
365 00900-50	Syringe 5 µl with needle 0.57x0.13 mm
365 01000-50	Syringe 10 µl with needle 0.57x0.13 mm
365 50000-50	Needle 3 µl (0.57/0.13 mm)
365 50001-50	Needle 5 µl (0.57/0.13 mm)
365 50002-50	Needle 10 µl (0.57/0.13 mm)
345 08535-50	**Suggested spares kit for AS 550**
403 50000-50	Sampling probe
365 01101-50	Syringe 3 µl
365 60006-50	Needle for 3 µl syringe (set of 5)
313 04800-50	Diverter valve septa (set of 24)
313 04700-50	Septum teflon faced (set of 10)
240 14536-50	Waste bottle 50 ml, 2 off
205 09003-50	Septum penetrating tool
345 08515-50	**Suggested spares kit for AS-V 570**
403 50000-50	Sampling probe
365 00800-50	Syringe 3 µl
365 50000-50	Needle 3 µl
313 04600-50	Diverter valve septa (pkg of 24)
420 19002-50	Teflon waste lines (2 off)
240 14536-50	Waste bottle, 50 ml (2 off)
205 09003-50	Septum penetrating tool

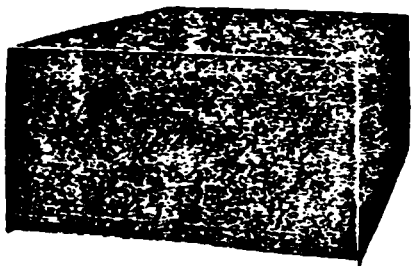
CODE	DESCRIPTION

Thermal Desorption Technique



251 02005-50 **TDAS 5000 Thermal Desorption Autosampler**
Sampling Unit complete with:
Automatic sample magazine for 30 adsorption tubes (expandable to 50 tubes).
Adjustable temperature furnace for tube desorption.
Automatic collection unit for desorbed tubes.
Advanced electro-pneumatic system for autosampling.
Dead volume-free injection valve for partial or total sample transfer into the GC.
Thermally insulated fused silica sample transfer interface.
Mounting brackets.
Transparent plastic safety cover.
Standard outfit including metal tubings and fittings for compressed air supply. Requires connection to TDAS 5000 Control Unit for automatic operations.

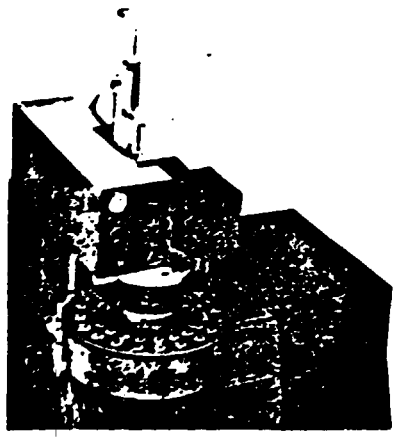
432 09700-50 **TDAS 5000 Control Unit**
The built-in microprocessor allows stand alone operations as an intelligent satellite module also capable of controlling GC parameters and integrator start-stop (master mode) as well as to receive commands from the GC and integrator and/or computer (slave mode).
The module includes three independent temperature controllers to provide precise heating regulation of injection valve, desorption tube furnace and sample transfer interface to GC. Digital set points and digital temperature displays in the range 0-399°C.
In case of failure or after all tubes have been desorbed (sample magazine "empty" status) the autosampler TDAS 5000 is reset to a "stand-by" condition and relevant messages are promptly indicated to the operator by a series of colored LED's on the front panel



Accessories and consumables for TDAS 5000

432 09687-50	Cold trap system 515 for TDAS 5000 (Requires MFA 51· Control Module 432 09720)
240 10038-50	Closed sample tray
468 01901-50	Adsorption tube 6 x 2 mm, unpacked (set of 10)
468 01906-50	Adsorption tube 6 x 3 mm, packed with Tenax (set of 10)
468 01911-50	Adsorption tube 6 x 3 mm, unpacked (set of 10)
468 01921-50	Adsorption tube 6 x 4 mm, unpacked (set of 10)
290 31702-50	O-ring Viton (set of 10) for operations up to 260 °C
290 03703-50	O-ring Kalrez (one off) for operations up to 300 °C
290 13471-50	Graphitized Vespel ferrule for 0.70 mm OD f.s. capillary (set of 2)
432 09725-50	Heated interface
405 12671-50	Filling device for 6 mm OD tubes

Head Space Technique

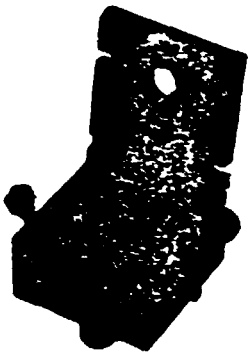


251 01110-50 **HS 250 Automatic Sampler**
for the headspace analysis complete with:
Thermostatted turntable for 40 vials.
Headspace gas sampling module.
Control module.
Headspace gas sampling syringe type Hamilton 1002 LTSN, 2.5 ml capacity.
Support for the assembly of the sampler on Mega Series gas chromatographs.
Standard outfit including 5 and 10 ml glass vials, rubber and teflon coated septa for vials, tubes and fittings for compressed air supply.
Power supply: 220V; 50/60 Hz.
Servo air: 4 Kg/sq. cm.

Spares and Accessories for Automatic Sampler mod. HS 250

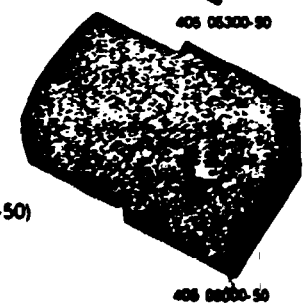
180 04506-50	Kit BCD output
240 10031-50	Accessory for syringe needle sweeping
206 00700-50	Hand crimper for glass vial sealing (not included as standard with the HS 250 sampler)
206 00710-50	Decapping tool for septum removal from glass vials (not included as standard with the HS 250 sampler)
365 00530-50	Gas sampling syringe type Hamilton 1750 LTSN, 0.5 ml capacity (not included as standard with the HS 250 sampler)
365 00540-50	Gas sampling syringe type, Hamilton 1002 LTSN, 2.5 ml capacity (one off included as standard with the HS 250 sampler)
240 06300-50	Vial-glass 10 ml (set of 50)
240 06200-50	Vial-glass 5 ml (set of 50)
286 02600-50	Septum, teflon coated rubber, for vials 5 ml and 10 ml with aluminium seals (set of 100)

CODE	DESCRIPTION
	Autosampler for Solids
251 02700-50	**Solid sample injector mod. 952** Can be automated by commands from Mega integrator via a suitable valve driver (code 039 31095) and relating solenoid valve assembly (code 405 21040-50) to be fitted in GC Base Unit. Sample capacity: 23 samples.
	Spares and Accessories for 952 solid sample injector
378 00700-80	Heat exchanger for mod. 952 solid sampler
245 04900-50	Glass microcontainers (capillary) for code 251 02700-50 (set of 50)
	Gas Sampling Valves
405 03600-50	**Pneumatic gas sampling valve with 3 ml loop** Automation of this valve requires suitable valve driver (code 039 31095) and relating solenoid valve assembly (code 405 21040-50 or 405 21050-50) piloted by Mega integrator with time functions.
405 04200-50	**Manual gas sampling valve with 3 ml loop**
	Stainless steel loops (for valves code 405 04200-50 and 405 03600-50)
245 00900-50	Stainless steel loop, 0.5 ml capacity
245 01300-50	Ditto, 1.5 ml capacity
245 01400-50	Ditto, 3 ml capacity
245 01200-50	Ditto, 6 ml capacity
245 01100-50	Ditto, 12 ml capacity
245 01000-50	Ditto, 25 ml capacity
245 01500-50	Ditto, 50 ml capacity
245 01600-50	Ditto, 100 ml capacity
245 01700-50	Ditto, 200 ml capacity
	Devices and Accessories for Column Switching
405 03100-50	**Device for mounting an external auxiliary column complete with a 50 cm chromatographic column packed with molecular sieves (to be used with valves code 405 04200-50 and 405 03600-50).**
405 05300-50	**Multicolumn switching valve type Bimatic GM** for mounting more chromatographic columns to be switched according to different configurations. Max. operating temperature: 120°C
405 06000-50	**Multicolumn switching valve type Bimatic GR** for mounting more chromatographic columns to be switched according to different configurations. Max. operating temperature: 180°C Both switching valves Bimatic GM and GR can be automated by commands from Mega integrator with time functions and a suitable valve driver (code 039 31095) and relating solenoid valve assembly (code 405 21040-50 or 405 21050-50)
	Spares and Accessories for switching valves
313 02100-50	Diaphragms for above (set of 10)
272 00500-50	PTFE Rotating disc for GR
350 07500-50	Kit of tube and fittings for column installation on Bimatic GM/GR
405 10700-50	Needle-valve column pressure balance, stainless steel execution
405 08700-50	Switching valve, 2-steps and 4 ways, for manual control of multicolumn valves type Bimatic, complete with support and fittings
039 31095	**Valve driver module for automatic actuation of solenoid valves** Provides control for up to four double timed events.
405 21040-50	**Solenoid valve assembly for two double timed events (four solenoid valves)** To be piloted by valve driver (code 039 31095).
405 21050-50	**Solenoid valve assembly for four double timed events (eight solenoid valves)** To be piloted by valve driver (code 039 31095).



405 03600-50

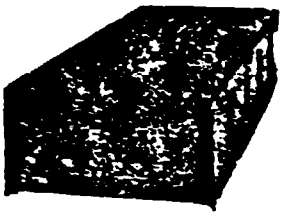
405 05300-50



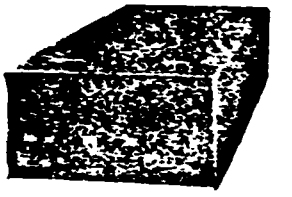
405 06000-50

CODE	DESCRIPTION

Accessories for Injection System Automation



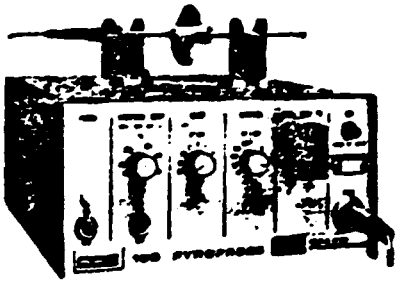
432 08680-50 — **SL 516 Control Module**
for the automatic actuation of split-splitless injector valves. Facilities are provided for direct command by the operator or external modules (temperature programmers and/or autosamplers) for a fully automatic synchronized sequence.
Individual septum flush and splitless time is settable from 0 to 99 min 99 sec through dedicated keys and display. This display also provide continuous monitoring of elapsed time. Color coded Led's show status of both valves.
Connection of this module to Mega Series does not require any modification except the easy replacement of the standard manual valves of the injector with the interchangeable automatic ones provided as outfit.
Power supply: 220V ± 10%; 50/60 Hz.
Servo-air: 3 Kg/sq cm.



432 08710-50 — **OC 516 Control Module**
for the automatic actuation of the non-vaporizing septum-less cold on-column injector.
Simplifies the injection procedure by automatically actuating, via a common bus, the injector valve, secondary cooling, temperature programmer and computing integrator.
The high degree of automation is made possible by simply introducing and withdrawing the syringe through the injector.
A direct result of this automation is unsurpassed standard deviation in terms of retention times and peak areas.
The system consists of an on-column actuator, mountable in less than one minute on the standard on-column injector body and a separate control module. Self-checking mechanisms are fitted to prevent syringe insertion in case of failure.
Power supply: 220V ± 10%; 50/60 Hz.

Devices and Accessories for Special Techniques

432 03000-50 — **Device mod. 125**
for the analysis of solvent residues in foodstuff packings, complete with extraction chamber and control module.

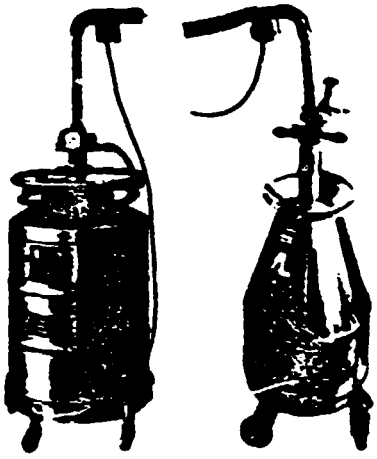


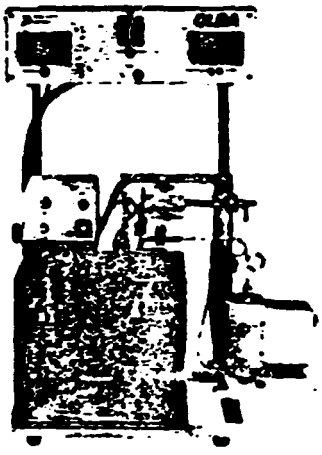
432 06100-50 — **Pyroprobe 100 Solids Pyrolizer**
complete with probes (coil and ribbon type).
Final temperature range continuously adjustable from ambient to 1000°C.
Heating rates: eight linear rates between 0.1 and 20°C/sec. With the linear control off, 600°C is reached in 8 msec and 1000°C in 17 msec when the ribbon element is used.
Pyrolysis intervals: ten intervals between 20 msec and 20 sec.
Power supply: 220 V ± 10%; 50/60 Hz.

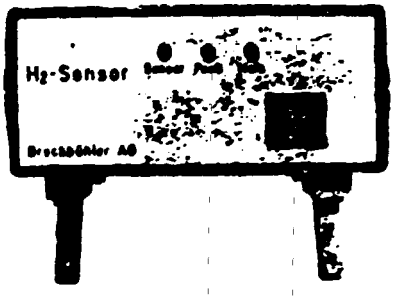
403 07400-50 — Coil probe
403 07500-50 — Ribbon probe
382 02900-50 — Quartz tube for coil probe (set of 20)
290 33508-50 — Graphite ferrule for interface (set of 10)
290 41707-50 — Viton O-ring for interface (set of 20)
290 43507-50 — Probe seal (set of 25)

432 08680-50 — **Cryo 520 Control Module**
Connected to the proper kit it permits the oven of the Mega Series to be programmed from a temperature of —50°C and —99°C using carbon dioxide and liquid nitrogen respectively.
According to the coolant to be used the corresponding kits have to be ordered separately.
Power supply: 220 V ± 10%; 50/60 Hz

CODE	DESCRIPTION
	Sub-ambient temperature kits for Cryo 520 The following kits include all parts for direct connection to carbon dioxide bottle and following liquid nitrogen reservoirs (not included): Air liquide type TC 50 with plug BN3. Messer Griesheim type Jupiter, 50 l capacity.
190 04527-50	Kit for operations with CO_2 (50 Hz)
190 54529-80	Kit for operations with CO_2 (60 Hz)
190 04528-50	Kit for operations with liquid N_2
	Warning: For safety reasons when the GC oven is kept at low temperature (below water dew point) for extended period an isolation transformer MUST BE USED. This is also available from Carlo Erba Strumentazione. See under code no 413 12057-50 for description and specification.
	Recommended options for Cryo 520
425 08100-50	**Back pressure regulator** This is particularly recommended for keeping the pressure inside the Air Liquide nitrogen reservoir constant in order to ensure the utmost reproducibility of coolant intake.
413 12057-50	**Isolation transformer** Output power: 2200 VA. Frequency: 50/60 Hz. Primary voltage: According to country voltage. Secondary voltage: 220 V AC. Insulating voltage: 5000 V. Static shield.
251 07000-50	**CLSA Closed Loop Stripping Apparatus** Based on Grob method the CLSA is the system of choice for the determination of organic substances in water. Organic substances are liberated from potable water and transferred to a very small amount of charcoal in a hermetically closed circuit system, in which the carrier may be air or an inert gas. The organic substances are dissolved from the charcoal, separated by capillary gas-liquid chromatography and identified by gas-liquid chromatography-mass spectrometry. In unpolluted water, hundreds of substances up to C_{24} are detected at concentrations down to 1 in 10^{13} (w/w). The CLSA comes complete with Control Unit, waterbath thermostat, waterbath glass container, waterbottle bracket, metal bellow pump, glass retainer for charcoal filter and heater (condenser). Power requirements: 220V; 50/60Hz.
	Consumable parts for CLSA
281 13070-50	Charcoal filter (1.5 mg charcoal)
281 13080-50	Charcoal filter (5 mg charcoal)
240 14002-50	Sample vial with PTFE stopper (for extraction of 1,5 mg charcoal filter)
240 14004-50	Sample vial with PTFE stopper (for extraction of 5 mg charcoal filter)
240 11623-50	Water bath glass container
240 14535-50	Glass bottle 1 litre (sample bottle)
386 10000-50	Glass bottle inlet/outlet glass assy with 2 Rotulex connections
276 05000-50	**Hydrogen sensor** complete with sensor head and control module. Continuously monitors hydrogen in column oven and, in case of an hydrogen concentration exceeding 1%, provides signals for heater cut off and oven cooling. Power requirements: 220V; 50/60 Hz.
276 05010-50	**Hydrogen/nitrogen switching unit** In case of alarm provides switching from hydrogen to nitrogen in the carrier line.
276 05020-50	**Alarm sound** (available with H_2/N_2 switching unit only). Provides an audible alarm sound alerting the operator. Alarm goes out only on manual reset by the operator. Reset is therefore only possible when hydrogen concentration has dropped to normal values.



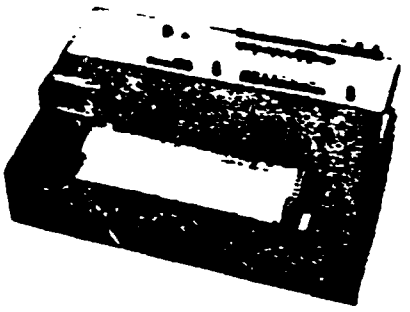




CODE	DESCRIPTION

Recorders and Spare Parts

Single-pen Recorder



352 08040-50 — **Strip chart potentiometric recorder type BD 40** prearranged for connection to gas chromatograph.
Spans: 1 - 2 - 5 - 10 - 20 - 50 mV f.s. and (x 100) adjustable spans between selected range (40 to 100%).
Response: 0.5 sec. full scale.
Zero adjustment: pen reset all over the scale.
Chart speed: 14 speeds electronically selected by push button switches 0.1 - 0.2 - 0.5 - 1 - 2 -5 - 10 mm/min or mm/sec.
Scale width: 200 mm

Double-pen Recorder

352 08035-50 — **Strip chart potentiometric recorder type BD 41**
Specifications as BD 40 but with two pens.

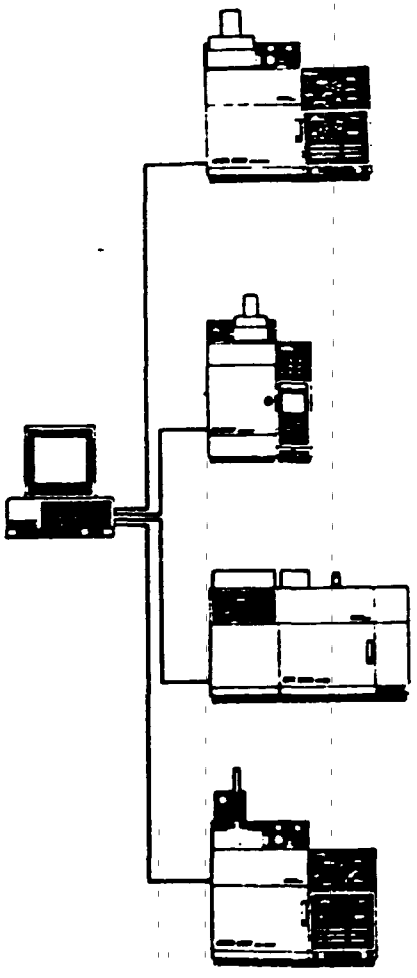
Spare Parts and Consumables for Recorders

352 75100-50 — Black fibre pen for recorder type BD 40 and channel 1 of BD 41 (set of 6)
352 75101-50 — Red fibre pen for channel 2 of recorder BD 41 (set of 6)
352 75000-50 — Chart rolls for recorders types BD 40/41 (set of 10 diagrammed type)
352 75001-50 — Chart rolls for recorders types BD 40/41 (set of 10 plain white type)

352 75200-50 — **Consumable parts for recorder type BD 40**
Black fibre pen (2 sets of 6)
Chart rolls (2 sets of 10)

352 75201-50 — **Consumable parts for recorder type BD 41**
Black fibre pen (2 sets of 6)
Red fibre pen (2 sets of 6)
Chart rolls (2 sets of 10)

Gas Chromatography Workstations: Maxima 820/Baseline 810



039 00001 — **Erbacard-Maxima 820/HRGC**
This hardware and software package is to be used with NEC Computers (or equivalent genuine IBM/AT) and includes:

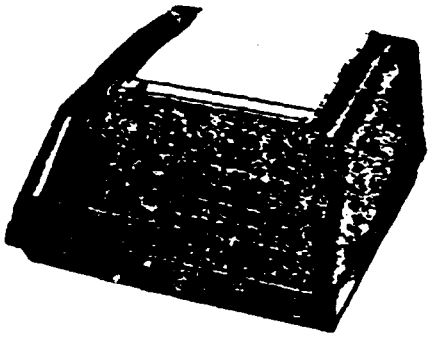
- TD 83 Multifunction board with 1 MB on-board RAM
- WD 24 interface with 256 KB RAM and V/F dual slope A/D converter with 22 bits of resolution. Enables data acquisition, data processing and instrument control for two independent GC's with two detectors each (four channel max.). Expansion to four independent GC's with two detectors each (8 channels max) requires an extra WD 24 interface (039 00002).
- Maxima 820/HRGC Software enabling:
  - Data acquisition, data processing, and instrument control for up to four independent chromatographs with 8 detectors.
  - Multitasking for background acquisition and control
  - On-screen real-time display of incoming chromatograms with adjustable expansion
  - Automated or manual analyses for area %, internal or external standardization.
  - Multiple-point linear, quadratic, cubic, or geometric calibration curves with regression statistics, weighting, and on-screen display and interactive editing.
  - Built-in database manager for generation of summary reports and QC/trend plotting.
  - Direct file compatibility with dBase III.
  - Archival and batch reprocessing of chromatograms and results from disk.
  - Writing of raw chromatograms to ASCII disk files for use with other software.
  - Automatic calculation of all peak integration and noise rejection parameters.
  - Grouping of non consecutive peaks.
  - Manual adjustment/reconstruction of peaks and baselines.
  - Chromatogram addition, subtraction, ratioing, differentiation (derivatives), rescaling, stacking, overlaying, offsetting and comparing (with retention time interpolation).
  - Automatic fill-in of component identification table
  - Automatic retention time adjustment for drift

CODE	DESCRIPTION
039 00002	**WD 24 Interface** to expand Maxima 820 to four independent GC's with 2 detectors each (8 channels max.)
039 00020	**Erbacard - Baseline 810/HRGC** This software and hardware package is to be used with NEC Computers (or equivalent genuine IBM/AT) and includes: • WD 22 interface with 256 KB RAM and V/F dual slope A/D converter with 22 bits of resolution. Enables data acquisition, data processing and instrument control from a single GC with 2 detectors max. No further expansion possible. • Memory expansion board (1MB). • Baseline 810/HRGC Software enabling: - Data acquisition, data processing, and accessory control for a single chromatograph with one or two detectors. - Multitasking for background acquisition and control. - On-screen real-time display of incoming chromatograms with adjustable expansion. - Automated or manual analyses for area % internal or external standardization. - Multiple-point linear, quadratic, cubic, or geometric calibration curves with regression statistics, screen display, and on-screen interactive editing. - Archival and batch reprocessing of chromatograms from disk. Automatic calculation of all peak integration and noise rejection parameters. - Manual adjustment/reconstruction of peaks and baselines. - Chromatogram overlays. - Automatic fill-in of component identification table. - Automatic retention time updating for drift This software can be expanded by BLAO Advanced Analysis Option (039 00006) and BLRO Advanced Reporting and Plotting Option (039 00007)
039 00006	**BLAO Baseline Advanced Analysis Option*** - Chromatogram addition, subtraction, ratioing, differentiation (derivatives), rescaling, and offsetting. - On-screen comparison of chromatograms with stretch/compress adjustment of the time axis (interpolation) to line up peaks - Useful for comparing, subtracting, or ratioing chromatograms acquired under different column conditions. - Calibration curve weighting for improving results quality.
039 00007	**BLRO Baseline Advanced Reporting and Plotting Option** - Operator customization of sample report content and layout for printout or storage as ASCII text or DIF files (for use with other spreadsheet, statistical, word processing, or data management software). - Database manager for summarizing and generating user-designed summary reports, and QC and trend plots. - Direct file compatibility with dBASE III file format.
274 50001	**Erbanet Software** This software enables the complete control of Mega GC and Mega Integrator parameters connected to a personal Computer. Analytical conditions and results can be stored on disc and recalled whenever required. The software is mouse or key-board driven and includes a synoptic editor for a GC parameters. Compatible with Labnet, Erbacard-Maxima 820 and Baseline 810.
432 09730	**RS 500 Communication and additional memory interface for Mega HRGC's** RS 500 is a microprocessor based (Z 80) communication and additional memory module including a 64K RAM and 32 K Eprom and a two RS 232 c ports. RS 500 is fully BASIC programmable and is therefore the ideal interface for the control of Mega HRGC's, and external devices or valves from Maxima 820 or Baseline 810 Workstations. RS 500 is also the ideal interface between Mega Integrator and Mega HRGC's to provide, through a very cost-competitive alternative, the following unique capabilities: • generation of a single report including all analytical and integration parameters • print-out of the programmed temperature profile on the chromatogram • print-out of analytical bulletin complete with elution temperature of each peak • random access to AS 550 autosampler tray with automatic file change-over RS 500 is complete with cables to Mega Integrator and Computer. In case of a multi-instrument configuration requiring more RS 500 modules to be interconnected, an equivalent number of Erbanet cables (230 34096) must be ordered separately.
230 39072	Erbanet cable for the connection between Mega Integrator and Computer
230 34096	Erbanet cable for the interconnections between RS 500 modules in a multi-instrument configuration
039 00050	**NEC Color Computer** The NEC Computer runs the same software as the IBM AT at the fast processing speed of 8MHz. And it comes fully equipped to support Maxima 820/HRGC in color. Also compatible with Baseline 810/HRGC. As a fundation for your workstation, this package includes the NEC Base Unit with 640K RAM, DOS (latest version), 20 megabyte hard disk, 1,2 megabyte floppy disk drive, EGA graphics adapter, EGA color monitor, mouse, math coprocessor, printer (200 cps), and printer cable.
039 00051	**NEC Monochrome Computer** The NEC Computer runs the same software as the IBM AT at the fast processing speed of 8MHz. And it comes fully equipped to support Baseline 810 HRGC in monochrome. Also compatible with Maxima 820/HRGC. As a fundation for your workstation, this package includes the NEC Base Unit with 640K RAM, DOS (latest version), 20 megabyte hard disk, 1,2 megabyte floppy disk drive, Hercules compatible graphics adapter, high resolution monochrome, mouse, math coprocessor, printer (200 cps), and printer cable.

*This option is a must when Baseline 810/HRGC is used with a color computer

CODE	DESCRIPTION

Data Handling Systems



039 31000 **Mega Series Computing Integrator**
The Mega Series Computing Integrator is a single channel/low cost instrument which can be expanded to a dual channel or multi-channel system for use in either GC or HPLC.
Its capabilities match those of large and expensive data systems, yet it is easy to use.
Besides the processor, a separate microprocessor controls the printer plotter, which operates at 40 characters per second.
The calculations most frequently used in chromatography (area %, area normalizing using response factors, external standard and internal standard) are programmed.
In addition, multilevel calibrations can be made with or without internal standardization using either linear or non linear least-squares fit to calibrate data.
Statistical calculations are also built-in, giving reports of averages, % relative standard deviations, standard deviations and variances of component concentrations or response factors.
Furthermore BASIC programmability adds flexibility for customized calculations and bulletin formats.
With its fast sampling rate (20 ms) the Mega Integrator is extremely suitable for operations with capillary column.
Power requirements: 220 VAC; 50/60 Hz.

039 32000 **Mega Series Computing Integrator**
same as above but without BASIC programmability.

Accessories and Spares for Mega Integrators

039 31041 Plotter thermal paper for Mega Integrator (set of 10 rolls)
039 83000 Printing head for Mega Integrator
039 31010 Plug-in second channel module for Mega Integrator
039 31020 Plug-in RS 232c interface module for Mega Integrator
039 31030 Plug-in time functions module for Mega Integrator

CODE	DESCRIPTION

Chromatographic Columns for Mega Series

A wide range of high quality chromatographic column is available for Mega Series gas chromatographs.
They include packed and/or unpacked glass and/or metal columns of different length and size whose standard dimensions are given below.
Columns do not include fittings and ferrules which have to be ordered separately as shown in the section Fittings and Accessories for Packed Columns.
When ordering please specify length, support type and mesh, stationary phase and concentration.

Packed Metal Columns
These columns are available in any length required.

280 08610-52	Column, stainless steel, 4 x 2 mm Ø
280 08710-52	Column, stainless steel, 6 x 4 mm Ø
280 08810-52	Column, stainless steel, 6 x 5 mm Ø
280 08910-52	Pair of matched columns, stainless steel, 4 x 2 mm Ø
280 09010-52	Pair of matched columns, stainless steel, 6 x 4 mm Ø
280 09110-52	Pair of matched columns, stainless steel, 6 x 5 mm Ø

Packed Glass Columns

280 50410-50	Glass column, standard type*
280 51110-50	Pair of matched glass columns, standard type*

Unpacked Glass Columns and internally treated empty tubings for column preparation

280 52010-50	Glass column, 1 m long
280 52011-50	Glass column, 1.5 m long
280 52012-50	Glass column, 2 m long
280 52013-50	Glass column, 2.5 m long
280 52014-50	Glass column, 3 m long
280 02400-52	Tube, stainless steel, 5 m long, 4 x 2 mm Ø
280 02500-52	Tube, stainless steel, 5 m long, 6 x 4 mm Ø
280 02300-50	Tube, stainless steel, 5 m long, 6 x 5 mm Ø
420 05600-50	Tube, PTFE, 10 m long, 6 x 4 mm Ø

* Available length: 1 - 1.5 - 2 - 3 m; diameter: 6 x 3 mm.

Fitting and Accessories for Packed Columns

350 20119-50	Pair of terminals for 6 mm OD columns, complete, O-rings tightness
350 20117-50	Ditto, metallic tightness
350 20118-50	Pair of terminals for 4 mm OD columns, metallic tightness
347 14402-50	Intermediate connection fitting, of stainless steel, for 6 mm OD
210 00300-50	Electromagnetic vibrator for chromatographic column packing (220 V)
290 50304-50	Tightness O-rings for 4 mm OD columns (set of 50)
290 50306-50	Tightness O-rings for 6 mm OD columns (set of 50)
290 34571-50	Low bleeding ferrules for operations up to 250°C with 6 mm OD glass columns (set of 10). Particularly advisable for electron capture detector
290 34137-50	Metallic ferrules (front and back) for 6 mm OD columns (set of 10)
290 34136-50	Metallic ferrules (front and back) for 4 mm OD columns (set of 10)
281 08900-50	Stainless steel wire gauze discs (set of 50)
313 03200-50	Injection port septa (set of 50)
381 02500-50	Stainless steel tube, 2 x 1 mm Ø (3 m long)
281 08700-50	Depurating filter for gas (unpacked)
281 08701-50	Depurating filter for gas (packed)
350 21436-50	Cool septum holder for packed column injector (set of 2)

CODE	DESCRIPTION

Capillary Columns

The Mega range of fused silica capillary columns.
Based on an intensive research into column technology, the Mega range of fused silica capillary columns have been developed to offer the utmost advantages in terms of precision, inertness, reliability and reproducibility.
All columns are certified by a Grob test chromatogram which implies a constant quality control not possible on large production in series.
Most columns of both types feature an unsurpassable degree of thermal stability permitting very high temperature operations (eg OV1 may be used up to 370°C).
Standard columns available are listed here.
Other phases and/or length or film thickness are available on request (see section custom tailored capillary columns).
Columns do not include fittings and ferrules which have to be ordered separately as shown in the section Fittings and Accessories for Capillary Columns.
Additional information on Mega capillary columns is available through a separate dedicated catalog.

Standard Capillary Columns

Apolar Crossbond™ Fused Silica Capillary Columns (0.32 mm ID)
Immobilized phase

	Stationary Phase	Film thickness (µm)	Length (m)
280 80400-52	OV1, dimethyl silicone gum	0.10-0.15	15
280 80401-52	As above	0.10-0.15	25
280 80402-52	As above	0.40-0.45	15
280 80403-52	As above	0.40-0.45	25
280 80410-52	SE 52, 5% phenyl, methyl silicone gum	0.10-0.15	15
280 80411-52	As above	0.10-0.15	25
280 80412-52	As above	0.40-0.45	15
280 80413-52	As above	0.40-0.45	25
280 80420-52	SE 54, 1% vinyl, 5% phenyl methyl silicone gum	0.10-0.15	15
280 80421-52	As above	0.10-0.15	25
280 80422-52	As above	0.40-0.45	15
280 80423-52	As above	0.40-0.45	25

Polar Fused Silica Capillary Columns (0.32 mm ID)
Immobilized phase

	Stationary Phase	Film thickness (µm)	Length (m)
280 80430-52	Carbowax 20M, polyethylene glycol	0.10-0.15	15
280 80431-52	As above	0.10-0.15	25
280 80432-52	As above	0.40-0.45	15
280 80433-52	As above	0.40-0.45	25

Megabond™ Wide Bore Fused Silica Capillary Columns (0.53 mm ID)
Immobilized phase

	Station Phase	Film thickness (µm)	Length (m)
280 80440-52	OV1, dimethyl silicone gum	1.5	10
280 80441-52	As above	3.5	10
280 80442-52	SE 52, 5% phenil, methil silicone gum	1.5	10
280 80443-52	As above	3.5	10
280 80444-52	SE 54, 1% vinyl, 5% phenyl methyl silicone gum	1.5	10
280 80445-52	As above	3.5	10
280 80446-52	Megawax, polyethylene glycol 20 M	1	10

Custom Tailored Capillary Columns

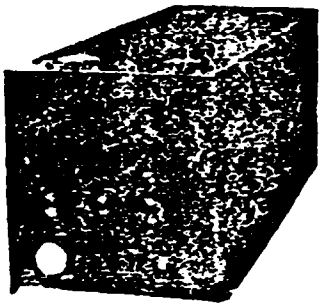
The standard range of Mega fused silica capillary columns, by virtue of the different phases, lengths and film thicknesses available, virtually covers almost the whole range of HRGC applications.
However to satisfy particular requirements a large range of custom tailored capillaries can be supplied on demand. These columns include phases such as SE30, OV101, J x R, OV17, OV1701, OV73, OV225, OV275, Ucon, FFAP, Silar and Chiral which can be prepared according to your requirements in lengths up to 50 m and film thickness ranging from 0.02 to 5 mm or higher whenever possible.
Should you be in doubt about the best column to fit your application we invite you to contact our extensive network of HRGC application laboratories based in our Headquarters in Italy and throughout Europe and USA. In these laboratories our experienced chromatographers will help you with suggestions, scientific literature and all the analytical back-up necessary for the solution of your problems.
When ordering these special columns please specify coating, film thickness and choose length and column material according to the following specifications:

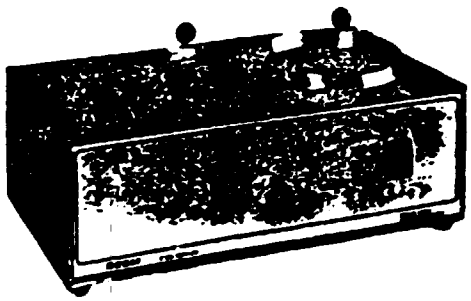
280 80460-52	Fused silica capillary column, 15 m long, 0.32 mm ID
280 80461-52	Fused silica capillary column, 25 m long, 0.32 mm ID
280 80462-52	Fused silica capillary column, 50 m long, 0.32 mm ID
280 80450-52	Wide bore fused silica capillary column, 25 m long, 0.53 mm ID

CODE	DESCRIPTION
	Fittings and Accessories for Capillary Columns
290 32958-50	Viton ferrule OD 1 for 1 mm OD max glass capillary columns (set of 10)
290 33461-50	Graphitized Vespel ferrule OD 0.35 for 0.25 mm ID fused silica capillary columns (set of 10) Recommended for high temperature operations and for applications requiring electron capture detector
290 33460-50	Graphitized Vespel ferrule OD 0.45 for 0.32 mm ID fused silica capillary columns (set of 10) Recommended for high temperature operations and for applications requiring electron capture detector
290 13471-50	Graphitized vespel ferrule OD 7 for 0.70 mm OD fused silica capillary column (set of 2)
290 33458-50	Graphitized Vespel ferrule OD 1 for 1 mm OD max. glass capillary columns (set of 10) Recommended for high temperature operations and for applications requiring electron capture detector
290 34609-50	Kalrez ferrule for 1 mm CD max. glass capillary columns (set of 10) Stand a higher temperature than Viton and maintain elasticity under higher temperature. Also do not stick easily to glass capillary column. Being a perfluoroelastomer Kalrez is not advisable for ECD operations.
350 20421-50	Stainless steel locking nut with lateral cut (set of 2) For column connection to split-splitless injector and outlet compartment-base body.
290 34203-50	Conically engraved s.s. washer for Viton and Kalrez ferrules type OD 1 (set of 10) For column connection to split-splitless injector and outlet compartment-base body.
290 34204-50	Conically engraved s.s. washer for graphitized Vespel ferrules type OD 1, OD 0.35 and OD 0.45 (set of 10) For column connection to split-splitless injector and outlet compartment-base body.
452 10001-50	Column fitting for on-column injector, complete with nut and washer
452 00001-50	Back washer/coolant jet for on-column injector
350 30423-50	Locking nut 8MB for on-column injector (set of 5)
347 19470-50	Flexible sleeve for fused silica columns (optional)
360 07507-50	Pair of terminals for glass capillary columns Tightness with Viton ferrule OD 1 (for split-splitless injector)
350 07508-50	Pair of terminals for glass capillary columns Tightness with graphitized Vespel ferrule OD 1 (for split-splitless injector)
205 09004-50	Ferrule drilling device (reamer) complete with the following drills (one of each): 0.35, 0.40, 0.45, 0.50, 0.75, 0.9 mm
347 19487-50	Adapter for connecting capillary columns to a packed column base body
453 00400-50	Glass liner for split-splitless injector, volume 1 ml (set of 2)
453 00300-50	Glass liner for split-splitless injector, volume 0.25 ml (set of 2)
405 27030-50	Micrometric manual valve for split-splitless injector
405 27000-50	Micrometric automatic valves for split-splitless injector Requires SL 516 Control Module for the automatic actuation
281 23020-50	Filter, s.s., for manual and automatic micrometric valve (code 405 27030-50 and 405 27000-50), unpacked* (set of 2)
338 01700-52	Activated charcoal 40/50 mesh (flask of 100 g)
299 02070-50	Interchangeable s.s. head for on-column injector This head provides a 0.20 mm ID channel suitable for 701 RNFS syringe (code 086 85510)
313 03200-50	Injection port septum for split-splitless injector (set of 50)
404 01900-50	Blind jet for ionization detector leak-check (set of 2)
205 01900-50	Extraction and locking spanner for jet type FID-4
350 46101-50	Blind nut for ionization detector leak-check (set of 10)
360 44107-50	Rubber holder fitting for FID (set of 10)
368 14112-50	Glass capillary column holder, 140 mm wide for HRGC 5330-00, 5360-00 and 5380 (not included as standard)

* This filter should be packed with activated charcoal (ranging 30-80 mesh) and fitted between the split line of the vaporizing injector and the micrometric valve to improve splitter performance and prevent valve contamination.

CODE	DESCRIPTION
190 04500-50	**Kit for on-column injector** (not included as outfit with the instrument) Particularly recommended for a correct preparation of the glass capillary column and an accurate injection mode. The kit consists of:
205 09000-50	Diamond contact file and engraving diamond
365 00500-50	0.5 microlitre syringe with repeating dispenser and 75 mm removable needle
086 00740	Microsyringe 701 SN, G A 32, needle length 75 mm (set of 2)
290 32958-50	Viton ferrule OD1 (two sets of ten ferrules each)
290 33458-50	Graphitized Vespel ferrule OD1 (two sets of ten ferrules each)
276 05050-50	**High Oven Temperature Cold On-Column Accessory 516** Enables injection of a large variety of samples at oven temperature much higher than solvent boiling point eliminating sample return and loss even under these critical conditions. Ideal for samples containing medium and high molecular weight components dissolved in volatile samples.
190 04555-50	**Kit for direct vaporizing injection with wide-bore capillary columns** This kit permits a standard packed column injector to be used for on-column vaporizing injections with wide-bore fused silica capillary columns. *The kit includes:*
453 00045-50	Glass liner, 2 mm ID
453 00046-50	Glass liner, 4 mm ID
290 03490-50	Vespel ferrule for glass liner
347 09493-50	Adapter for connecting capillary columns to packed columns injector
347 19487-50	Adapter for connecting capillary columns to packed columns base body
290 13471-50	Vespel ferrule OD 7 (set of 2)
432 09615-50	**CP-CF 516 Constant Pressure-Constant Flow Control Module** This module allows the carrier gas to be supplied in the constant pressure or constant flow modes. Vaporizing or cold split-splitless injectors are compatible only with constant pressure mode because they have an open line with constant flow restriction to atmosphere (split line). Cold on-column and direct vaporizing injectors are compatible with both constant pressure and constant flow modes. The CP-CF unit overcomes the difficulties of adjusting the flow rates under very low pressure drops (e.g. 5 kPa) when using wide bore capillary columns with capillary-like carrier flow rates (3-6 ml/min). When used with conventional capillary columns (0.2-0.3 mm I.D.), the CP-CF 516 keep the flow rate constant even during extended temperature programs e.g. 50°C to 350-400°C. The resulting advantages are better separation efficiency, shorter analysis time and constant detector response. In addition CP-CF 516 is also recommended for large volume injection and GC/HPLC coupling. The unit is supplied with two flow cells: 0-35 ml/min (built-in) and 0-5 ml/min (standard outfit). Both are easily interchangeable. Power supply: 220V ± 10%; 50/60 Hz.
415 00300-50	Glass end straightening machine GESM 102-20
354 60000-50	Straightening miniature furnace for GESM 102-20 (for 1 mm OD tube)
354 60005-50	Straightening miniature furnace for GESM 102-20 (for 1.35 mm OD tube)
425 07500-50	Self-standing pneumatic module for GESM 102-20



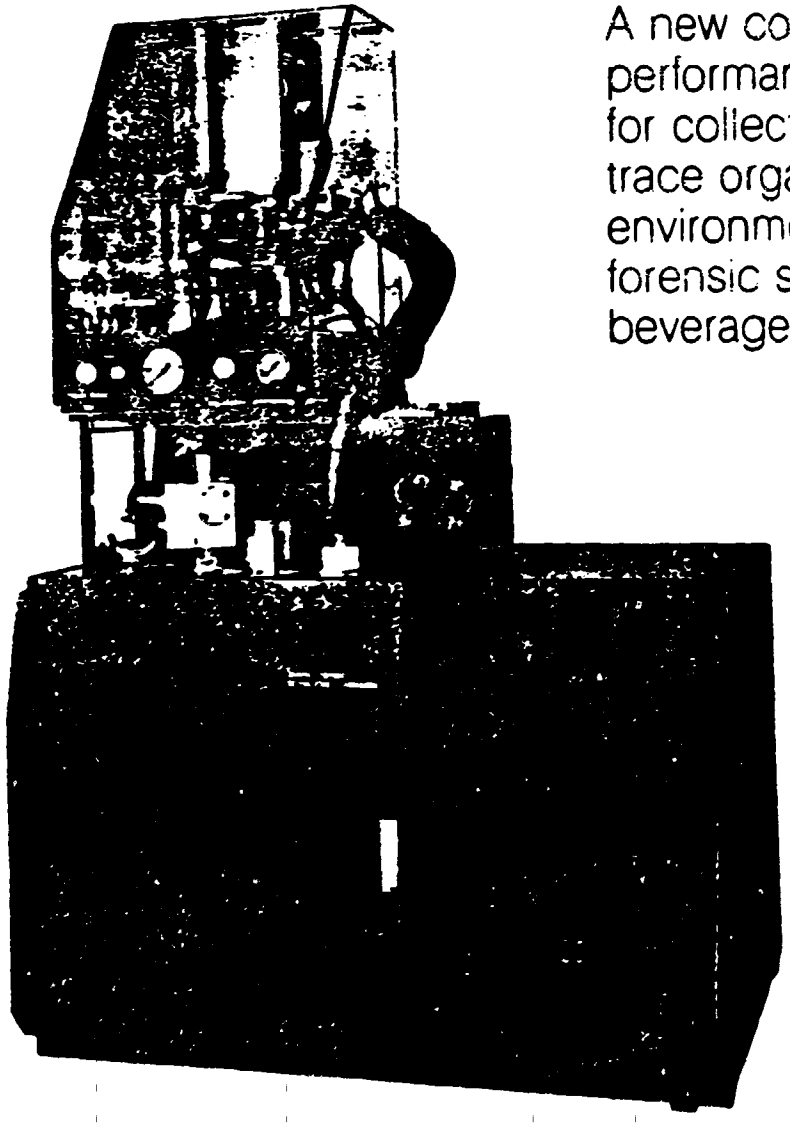


CODE	DESCRIPTION
	Microsyringes for Packed Columns
	Hamilton 700 Series Two types are available: N and RN. N type denotes an epoxy-cemented stainless steel needle while RN denotes a removable needle. Both types have plunger in the barrel. Unless otherwise specified these syringes are fitted as standard with a 51 mm long needle, point style 1 (17° bevel). Needle and point styles other than standard are available on demand.
365 02000-50	Microsyringe 75 [illegible] capacity, gauge 26 S
365 02001-50	Microsyringe 701 [illegible] µl capacity, gauge 26 S
086 80366	Microsyringe 701 N, 10 µl capacity, gauge 26 S. Package of six
086 87930	Microsyringe 75 RN, 5 µl capacity, gauge 26 S
086 80330	Microsyringe 701 RN, 10 µl capacity, gauge 26 S
	Needles for 700 RN Syringes
086 80427	Needle for 75 RN and 701 RN microsyringe (package of three)
	Hamilton 7000 Series The total syringe capacity of 7000 series is in the needle. The volume contained in the needle is read from the teflon-coated outer sleeve against the 6 cm graduated barrel scale. Unless otherwise specified these syringes are fitted as standard with a 70 mm long needle, point style 1 (17° bevel).
086 86250	Microsyringe 7000 SN, 0.5 µl capacity (point style 3)
365 00101-50	Microsyringe 7001 N, 1 µl capacity
365 00102-50	Microsyringe 7002 N, 2 µl capacity
086 80002	Microsyringe 7005 N, 5 µl capacity
086 00306	Microsyringe 7110 N, 10 µl capacity (point style 3)
	Microsyringes for Capillary Columns
365 00500-50	0.5 microlitre syringe with repeating dispenser and 75 mm long removable s.s. needle (for on-column injector)*
365 00510-50	5 microlitre syringe with repeating dispenser and 75 mm long removable s.s. needle (for on-column injector)*
365 00520-50	10 microlitre syringe with repeating dispenser and 75 mm long removable s.s. needle (for on-column injector)*
365 00600-50	Do it yourself repair kit consisting of one needle and one plunger for 0.5 microlitre syringe (code 365 00500-50)
365 00700-50	Set of needles for 5 and 10 microlitre syringes (code 365 00510-50 and code 365 00520-50)
365 02002-50	10 microlitre syringe 701 RNFS with 75 mm long, O.17 mm OD removable fused silica needle (for on-column injector)**
365 50031-50	Fused silica needle, 75 mm long, 0.17 mm OD for 701 RNFS syringe**
365 20001-50	Teflon ferrule 0.17 mm bore (for f.s. needle 0.17 mm OD)
365 02007-50	10 microlitre syringe 701 SN, GA 32, 75 mm long cemented s.s. needle (for on-column injector)*
365 00610-50	Microsyringe box for on-column injector. The box contains:
365 00500-50	Two 0.5 microlitre syringe
365 00510-50	One 5 microlitre syringe
365 00520-50	One 10 microlitre syringe
365 00600-50	Two 0.5 microlitre syringe repair kits
365 00700-50	Set of needles for 5 and 10 microlitre syringes
365 00103-50	10 microlitre syringe 701 SN, point style 1, GA 26 S, 70 mm long cemented s.s. needle (for split-splitless injector - splitless mode)
365 02001-50	10 microlitre syringe 701 N, point style 1, 50 mm long cemented s.s. needle (for split-splitless injector - split mode)

* Suitable for 0.32 mm ID glass and fused silica capillary columns.
** Suitable for 0.20 mm ID fused silica capillary columns. This 0.17 mm OD f.s. needle requires replacement of the standard upper part of the on-column injector with a suitable one (code 269 02070-50).

TDAS 5000

THERMAL DESORPTION AUTOSAMPLER



A new cost effective, high performance automated system for collection and analysis of trace organic compounds in environmental monitoring, forensic science, and food and beverage chemistry

TDAS 5000
THERMAL DESORPTION AUTOSAMPLER

Main features

Complete, flexible automation

The standard configuration provides facilities for fully automatic thermal desorption of up to 30 tubes (optionally expandable to 50).

The complete automation is achieved by the use of a powerful microprocessor which enables the control unit to control the gas chromatograph and integrator functions (master mode) or to accept commands from the gas chromatograph, integrator and computer (slave mode).

Enhanced modularity

Being a stand-alone ancillary unit the TDAS 5000 can be connected to virtually any GC system at any time.

The TDAS 5000 is designed to be installed on top of any 4000 or Mega series GC saving bench space and permitting free access for the mass spectrometer interface from the left or right side.

This is of utmost importance when a mass spectrometer is used to positively identify sample constituents, which have proven or potential carcinogenic implications, as is often the case in personal monitoring.

Reproducibility

Analytical reproducibility is ensured by the advanced design and precise construction of the electro-pneumatic system and by the accurate temperature control of the switching valve, vapor adsorption tube heater and sample transfer interface.

This specially designed thermostatted, deactivated fused silica transfer interface permits the desorbed gas to be injected into the gas chromatograph without any risk of catalytic or adsorptive process.

The zero dead volume switching valve, which permits a precise, predetermined amount of sample to be transferred to the GC is microprocessor-controlled for extreme accuracy.

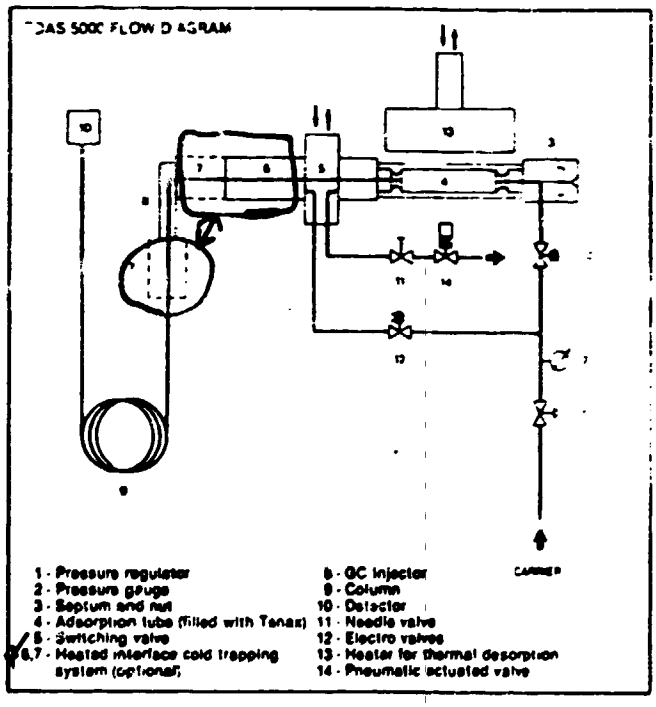
Rugged, dependable hardware

The TDAS 5000 has been designed following the concept of rugged and reliable construction, traditional to our instrumentation. The combination of the finely machined mechanical parts (many of which have proven their reliability in other instruments over several years of continuous and perfect field operation) and advanced, dependable electronic components assure long term, trouble-free performance. All components are readily accessible for quick, efficient field service resulting in low running costs and minimum down-times.

Description

Adsorption followed by thermal desorption is a rapidly expanding area of interest for many analysts - not just the environmental scientist but also the forensic scientist and the food and beverage chemist.

The schematic below illustrates the principles involved.



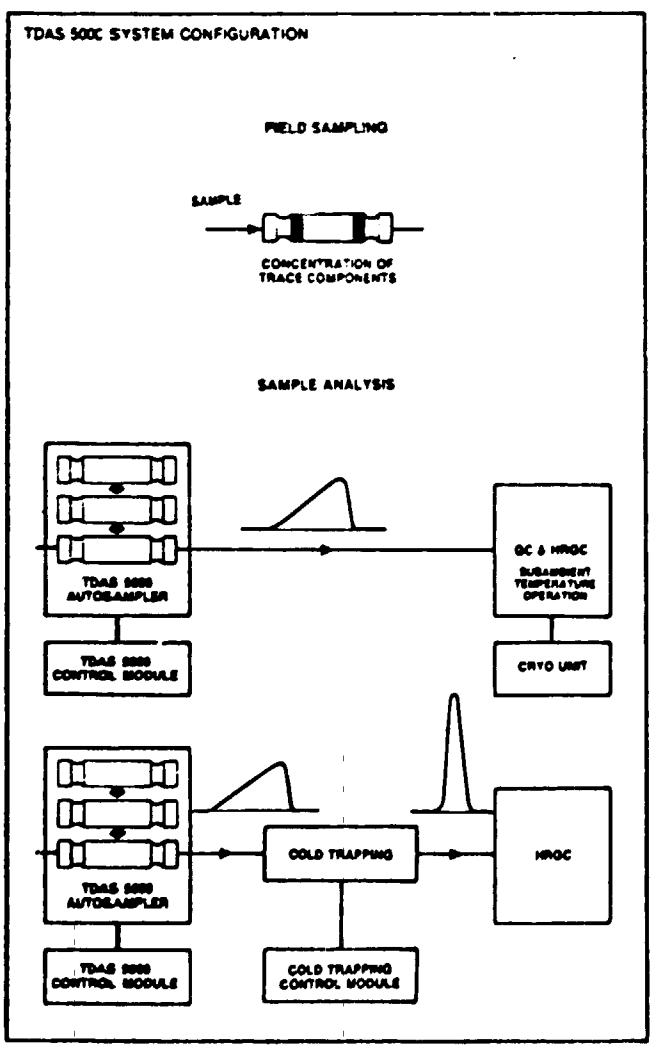
The tube (4) holding the trapped components of interest is inserted into the sampling position by the automatic loading mechanism and is heated to the desired temperature by the heater (13). Carrier gas flowing through tube (1) transports the components of interest through the switching valve and low volume heated interface (6) into the injector of the analytical GC (8).

Three innovative features of the TDAS 5000 contribute to the excellent chromatographic results obtainable from this system:

— Very fast rise time of the tube temperature

The heater (13) is maintained at a constant preset temperature and is applied to the Tenax tube in such a manner that the trapped components are rapidly desorbed thus ensuring that the sample "plug" being transported to the GC is kept as small as possible.

— Very inert, low volume interface
The low volume and the inert nature of interface, made of specially treated fused silica, ensure that any deterioration of the sample "plug" is kept to a minimum whether due to excessive dead volume or active site effects.
— "Focussing" of the sample components
When the sample "plug" enters the column inlet it encounters a very cold area which concentrates the components into an even smaller "plug" and assures the utmost efficiency of the columns, particularly in the case of capillaries.



The TDAS 5000 although designed for operation with both glass and fused silica capillary columns is equally compatible with packed columns allowing existing methodologies to be readily transferred to this new instrument.
Carlo Erba's extensive experience in high resolution gas chromatography has been utilised to ensure contamination-free gas supplies. Stainless steel and non-polimeric materials are used throughout. The design of the TDAS 5000 was evolved so that the fitting of the unit to a Carlo Erba GC would not preclude the addition of any accessories e.g. a mass spectrometer output on the left or right side is still possible, as is the use of multiple detectors whether in series or in parallel.
The control module controls the temperatures of the heater, switching valve and the interface as well as providing a complete handshake with Carlo Erba 4000 and Mega series of gas chromatographs. In addition if the Mega GC is coupled to the HEC 960 Computer then the computer may be used to set the TDAS 5000 parameters and to operate it according to methodologies which can be stored on a disc.
The TDAS 5000 may be used by the environmental chemist to monitor the exposure levels of employees working in areas of risk. It may also be used by forensic scientists in the investigation of fire sites where arson is suspect. Chemists involved in the examination of low level contamination or flavors in food and drink industries will find a use for the TDAS 5000 in concentrating components to the level where they may be analysed by gas chromatography.

TDAS 5000 application fields

— Identification and determination of pollutants in air previously adsorbed on Tenax trapping tubes (in active or passive modes).
— Determination of organic pollutants in water (hydrophobic characteristics of Tenax permit elution of water at ambient temperature).
— Direct analysis of dirty samples using tubes filled with adsorbing or supporting materials for retention of by-products.
— Direct determination of volatile or medium volatile components in very high boiling point matrices (example: hydrocarbons in lubricating oils, monomers in polymers, etc).
— Direct reconcentration of diluted solutions of organic compounds and automatic injection into the GC (using selected solvents and tubes filled with special packing materials).

Specification and ordering information

The TDAS 5000 consists of two separate units - the Sampling Unit and the Control Module which are described below.

Sampling Unit

complete with:

— Automatic sample magazine for 30 vapor adsorption tubes
— Adjustable heater for tube desorption
— Automatic collection unit for desorbed tubes
— Electro-pneumatic system for autosampling including zero dead volume switching valve
— Thermally insulated, temperature controlled, deactivated fused silica sample transfer interface
— Mounting brackets
— Transparent plastic safety cover
— Standard outfit

Dimensions (w/o support): 455 x 315 x 470 mm (h x w x d)
Power: 220V AC ± 10%, 50/60 Hz.
Code no. 251 02005-50

Control Module

This microprocessor-based unit has three precise and independent temperature controllers for:

— The heater for tube desorption
— Desorbed sample gas switching valve
— Sample transfer interface

The temperature can be individually set and displayed in the range of 0-399°C.
The following analysis parameters can be individually set using a soft-key/display combination:
Purge time (sec)
Preheating (sec)
Desorption (sec)
Cleaning (min)
Analysis (min)
These parameters can be recalled and displayed at any time for confirmation or alteration, as required.
Dimensions: 160 x 315 x 500 mm (h x w x d)
Power: 220V AC ± 10%, 50/60 Hz.
Code no. 432 09700-50

TDAS 5000 CONTROL MODULE

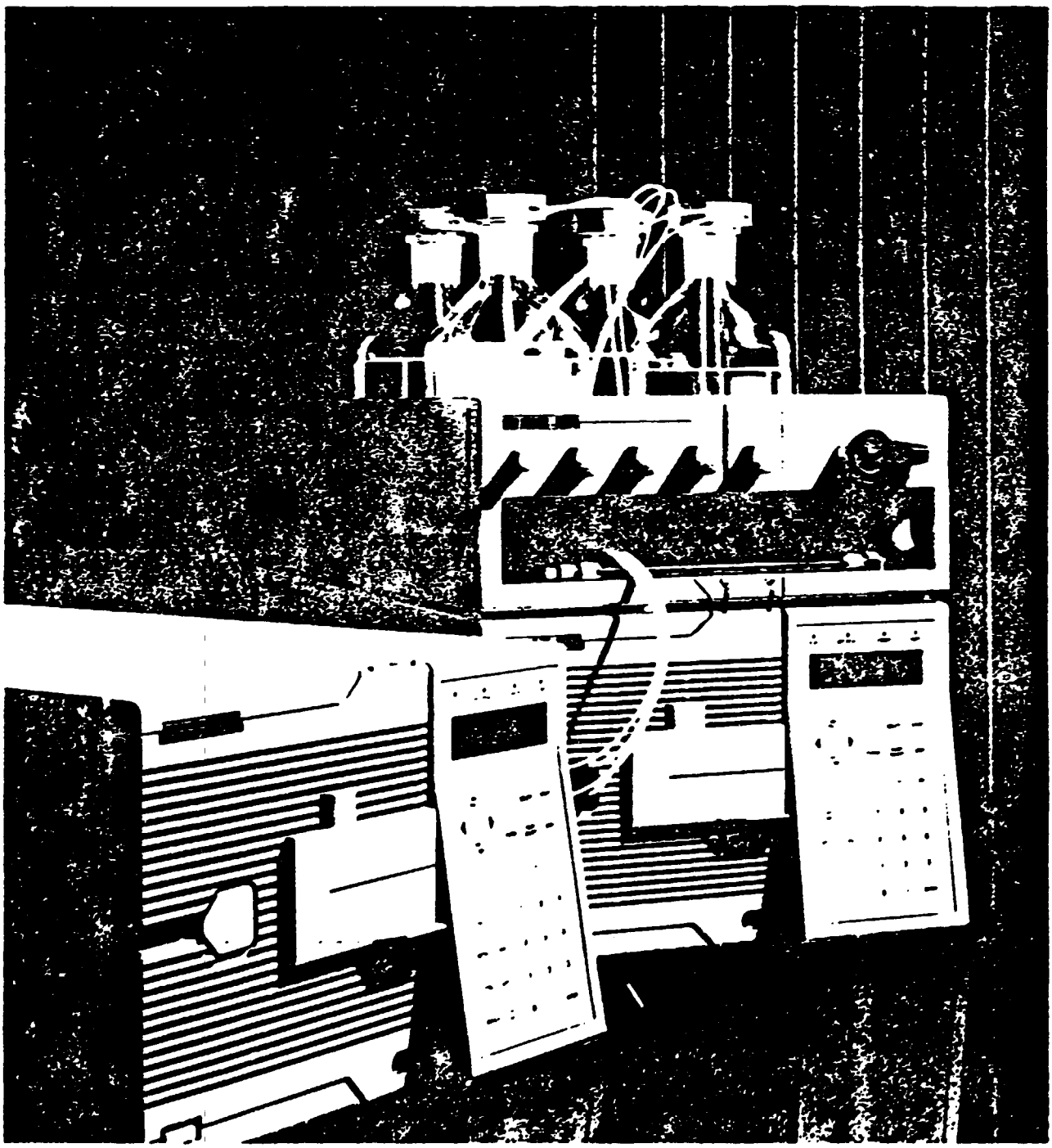
CARLO ERBA STRUMENTAZIONE

STRADA RIVOLTANA - 20090 RODANO (MILAN) - ITALY - CABLE ERBADAS MILAN
TELEPHONE (2) 950591/9568161 - TELEX 340449 CEST I

The HP 1050 Series Pumping Systems

HEWLETT PACKARD

APPENDIX B

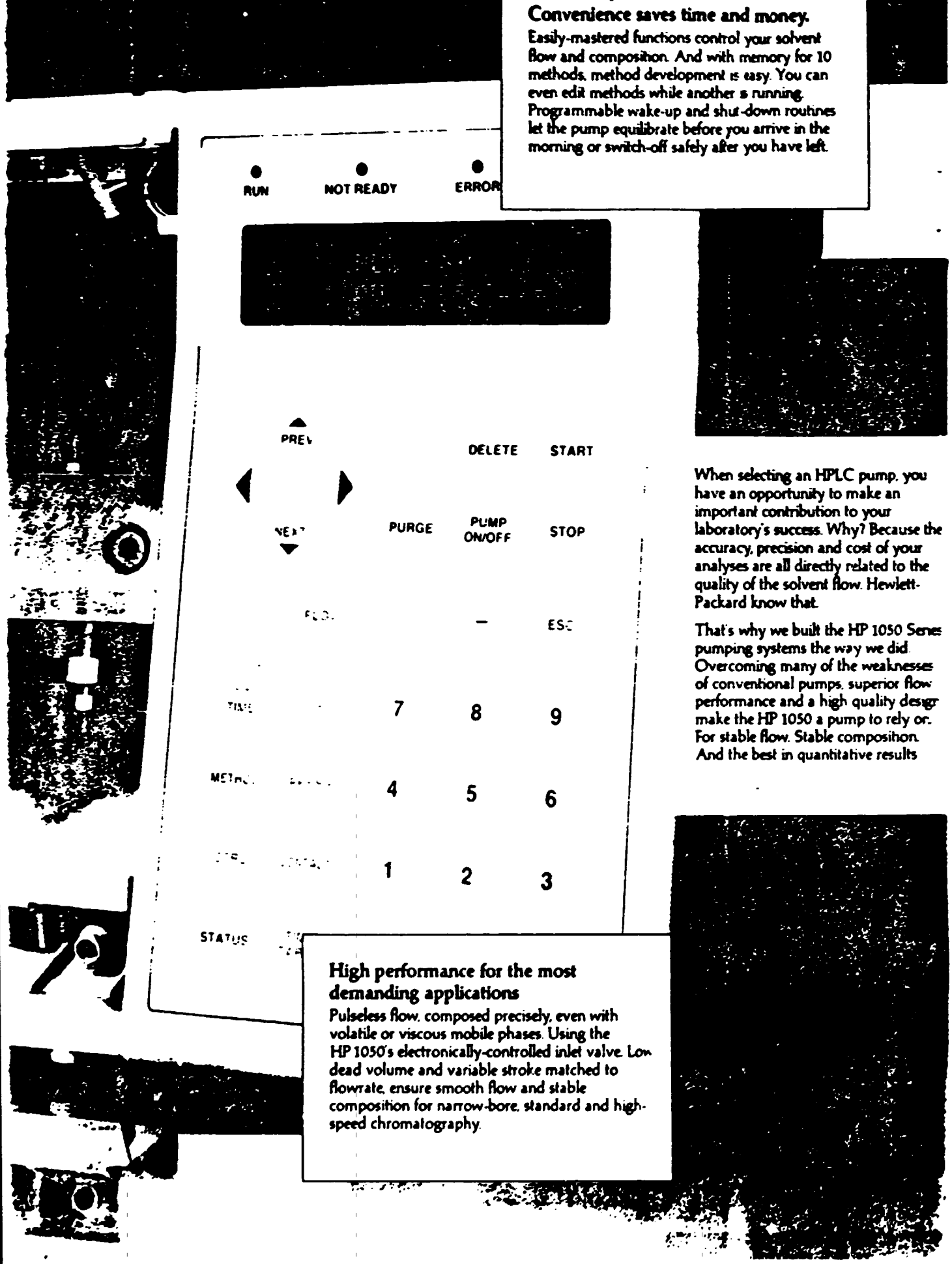


Keep future options open

Designed for easy upgrading as your needs change. Adapt for aggressive solvents if necessary. Or add quaternary solvent mixing to the isocratic pump, installed in minutes yourself. Match purchases to your budget, without compromising investment for the future. With Hewlett-Packard, you're backed by our commitment to the pursuit of new trends.

Maximum uptime for high throughput

Unattended, the pump remains bubble-free. And with only two valves, there's a lower risk of blockages hindering flow. Smart diagnostics recognize problems before samples are wasted – the 2-line messages guide you directly to the problem. And since everything is so easy to reach from the front, operators need no special maintenance training.



Convenience saves time and money.

Easily-mastered functions control your solvent flow and composition. And with memory for 10 methods, method development is easy. You can even edit methods while another is running. Programmable wake-up and shut-down routines let the pump equilibrate before you arrive in the morning or switch-off safely after you have left.

When selecting an HPLC pump, you have an opportunity to make an important contribution to your laboratory's success. Why? Because the accuracy, precision and cost of your analyses are all directly related to the quality of the solvent flow. Hewlett-Packard know that.

That's why we built the HP 1050 Series pumping systems the way we did. Overcoming many of the weaknesses of conventional pumps, superior flow performance and a high quality design make the HP 1050 a pump to rely on. For stable flow. Stable composition. And the best in quantitative results.

High performance for the most demanding applications

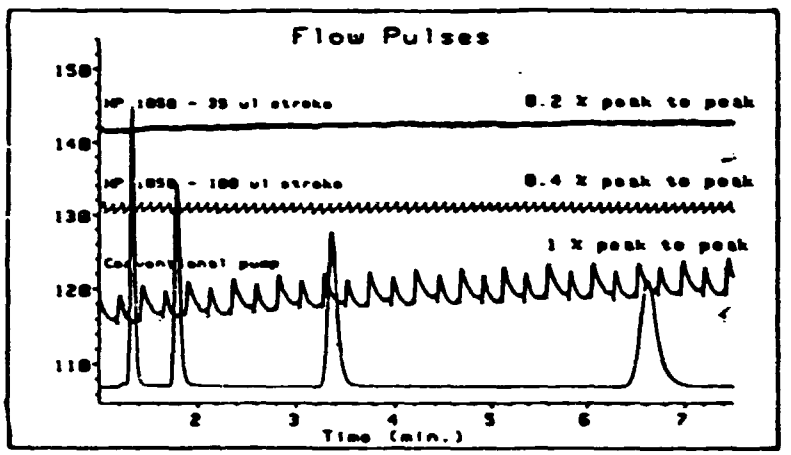
Pulseless flow, composed precisely, even with volatile or viscous mobile phases. Using the HP 1050's electronically-controlled inlet valve. Low dead volume and variable stroke matched to flowrate, ensure smooth flow and stable composition for narrow-bore, standard and high-speed chromatography.

An isocratic pum

Self-centering pistons lengthen seal life. They're self-retracting too, preventing expensive breakages.

Have you ever been confronted with irregular results – an inexplicable variance which prevents reliable quantitation? The injector is deli... ng precisely, retention times are reproducible and yet you cannot repeat peak areas. The problem may be unstable flow.

Flow fluctuations cause changes in the rate at which components move through the detector. And for concentration-sensitive detectors, of course, a component's area response is inversely proportional to its rate of movement through the flow cell. So when flow varies, especially at intervals similar to the component's peakwidth, peak areas vary.



Decreasing stroke volume not stroke frequency for low flow rates (here just 1 ml/min) reduces flow ripple.

That's why Hewlett-Packard have designed a pump which reduces the stroke volume, not the stroke frequency, to lower flowrate. And why such care has been taken to minimize the amplitude of high-frequency flow ripples. Improving quantitative measurements. And lowering detection limits when using flow sensitive detectors.

The design for stable flow

Flow is delivered by two sapphire pistons in series. Just two valves control the solvent's progress: an inlet valve electronically synchronized to the piston stroke and a spring-loaded outlet valve. Since the inlet is electronic, it can't cause vapor bubbles with volatile solvents. And the spring keeps the outlet operating properly even at low pressure.

As the first piston draws up the solvent, the second is propelling it onwards. On the return stroke, the first piston delivers that solvent into the expanding chamber of the second. Half of the volume flows straight through onto the column, the other half fills the chamber. Between the pistons, a damper smooths the transition between intake and delivery.

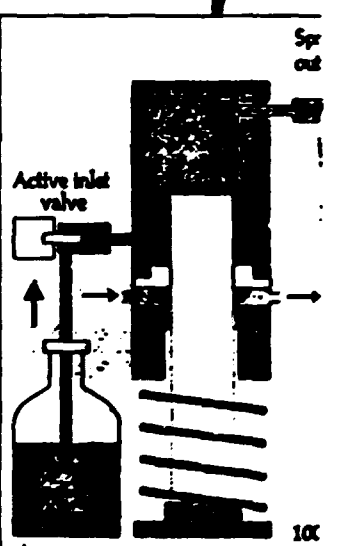
By controlling the volume of the strokes – frequent large strokes at high flowrates; smaller, yet just as frequent strokes at low flowrates – the impact of each stroke on flow fluctuations is kept to an absolute minimum.

The self-priming pump

With such a direct flow path, bubbles have nowhere to hide. First-in, first-out, solvent flow sweeps the b... les out – it's self-priming. Even with gas-saturated solvents, you can start the pump without having to open bypass valves or suck solvent through the pumphead by hand first.

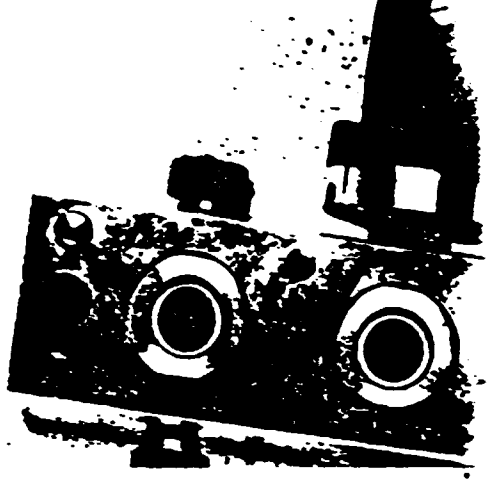
Rel... le quality – by clever design

With only two valves there's much less risk of the pump bringing the system down. Even when contaminated with unfiltered



...with low dead volumes and head-to-t... optimized for bubble-free flow.

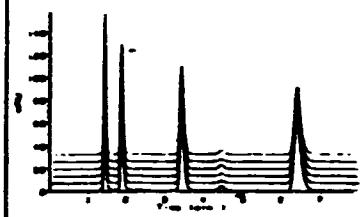
ıp built to rely on



Active inlet valve keeps solvent flow smooth – even with volatile solvents.

Peak	$\overline{RT}$	σ (%) RT	Area
1	1.408	0.10	0.17
2	1.863	0.09	0.33
3	3.395	0.05	0.08
4	6.371	0.03	0.15

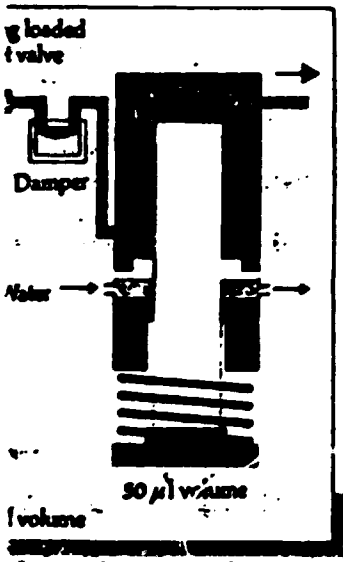
Average of 6 runs



Column: 100 x 4.6 mm, 5 µm Hypersil ODS (order number HP 79916OD-554)
Flow: 1.0 ml/min
Stroke: 35 µl
Inj. vol: 10 µl

Reproducibility of both retention times and areas demonstrate really stable flow.

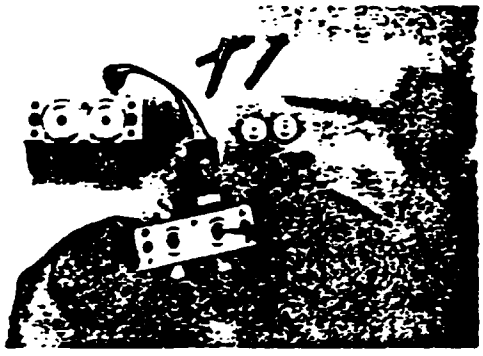
solvents, the active inlet valve can carry on opening and closing. And the outlet valve is easy to maintain – it can be dissassembled, cleaned and re-inserted.



flow over the pistons, the flow path is

Piston seals at high pressure are prone to wear. By clever engineering that mechanical wear can be minimized, lengthening the seal's life, and reducing costs. The self-centering pistons find their own way through the seal, on the path of least resistance. That means much less abrasion than with fixed pistons. And the optional rinse-reservoir attachment keeps the rear of the seal constantly wet – preventing damaging salts from crystalizing out.

Since the pistons are self-retracting, even untrained users cannot damage them while changing seals. There is no need for adjustments, no special tools and no added expense.



And to make sure you only change seals or clean the outlet valve when it's absolutely necessary, not based on a hunch – the HP 1050's smart electronic diagnostics keep you informed on flow stability. Even suggesting when certain maintenance is required. That means no time wasted troubleshooting or reading repair instructions. You can solve the problem yourself in minutes. Increasing your sample throughput.

The HP 1050 also understands changes in the backpressure recorded during damping. Noticing how pressure drops when solvent bottles are empty and quickly shutting down the system if you choose. Or braking the flow when pressure rises too high or too rapidly, protecting the column from damage.

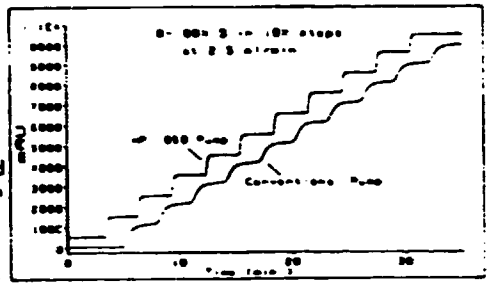
Here to stay, even when needs change

Compared to most HPLC pumps, the HP 1050 Series really is the more flexible. Not simply because it is modular. Or genuinely stackable, easy to install, operate and maintain. The HP 1050 pump is upgradeable.

The single pump isocratic HP 1050 becomes a single pump quaternary gradient HP 1050 with just one additional circuit board, Hewlett-Packard's own high-speed proportioning valve, and the solvent conditioning cabinet. Turn the page to see what that can mean for your laboratory.

Adapt immediately w

A pump that can deliver four solvents isn't merely a necessary tool for complex gradient separations. It's also a time-saving tool when your work requires frequent solvent changes. And a convenient way to mix solvents accurately for isocratic analyses, removing the risk of mistakes in solvent preparation.



Flow geometry optimized for excellent composition precision. Ensuring superior reproducibility
A Water
B Water + 0.5% acetone

Four solvents always available

With optimized flow geometries, customized control of stroke volume, and its own exclusive high-speed proportioning valve, the HP 1050 Series pump blends any combination of 4 solvents so smoothly that you may even choose to use it in your isocratic analyses. And since solvent changeover is so easy with a self-priming pump, switching to another mobile phase is just a matter of selecting one of the 10 methods stored in memory. Simply push the key to load.

The high-performance difference

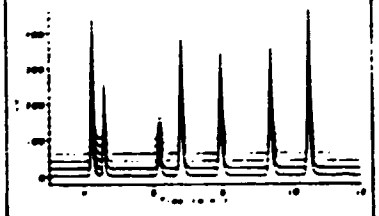
Not just any multi-solvent pump can deliver precise mixtures at the extremes. Especially when working with small solvent percentages, or very low or very high flowrates, the engineering must be the finest to ensure accurate, well-mixed, and reproducible compositions. And reproducibility in your separations.

Whether you are identifying peaks, quantifying sample components, or collecting the separated material, stable composition and reproducible gradients are a must.

Three criteria determine the success of low-pressure gradient formation:

		0 %	
Peak	$\overline{RT}$	RT	Area
1	4.203	0.26	0.31
2	4.551	0.19	0.31
3	6.142	0.11	0.13
4	6.766	0.11	0.13
5	7.911	0.10	0.18
6	9.340	0.08	0.13
7	10.445	0.08	0.12

Average of 6 runs



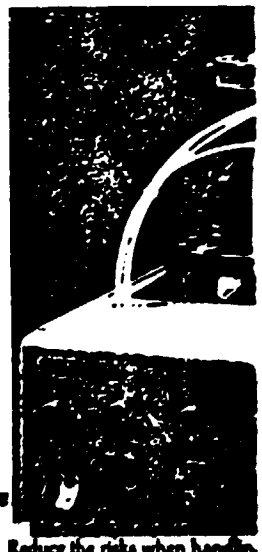
Sample: 4 µl of aromatic compounds
Column: 100 x 4.6 mm, 5 µm Hypersil ODS (order number: HP 79916OD-554)
Flow: 2 ml/min
Eluant: Channel A: water
Channel B: acetonitrile
Gradient: 0 to 100 % in 10 mins
Detector: HP 1050 Series multiple wavelength detector

HP 1050 flow and composition stability demonstrated by reproducibility of retention times and areas

adequate mixing, reasonably small delay volume and reliable operation even with solvent mixtures that release gas. Here, the differences between pumps become apparent. Through clever design and versatile features, the HP 1050 distinguishes itself clearly.

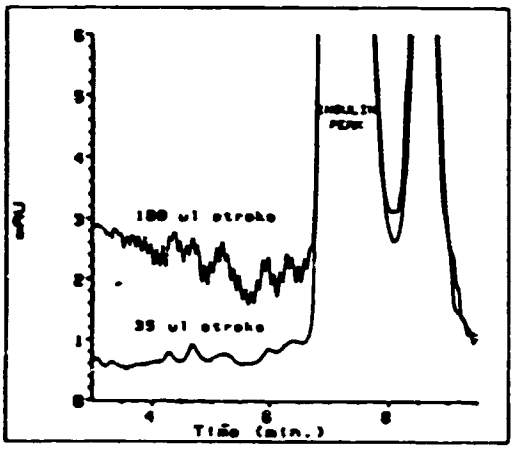
Precision mixing for the most subtle separations

By proportioning the solvents at low pressure through a 4-way valve, the contributions for a certain mixture enter the pump one after another. Most pumps use a fixed stroke



Reduce the risks when handling connections for polluting fluids

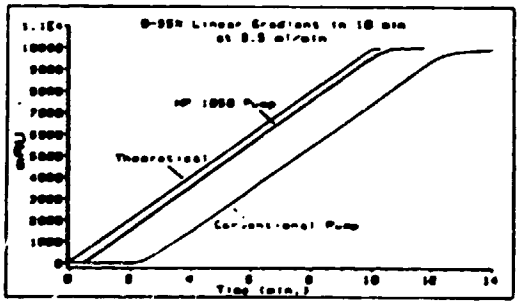
quaternary flexibility



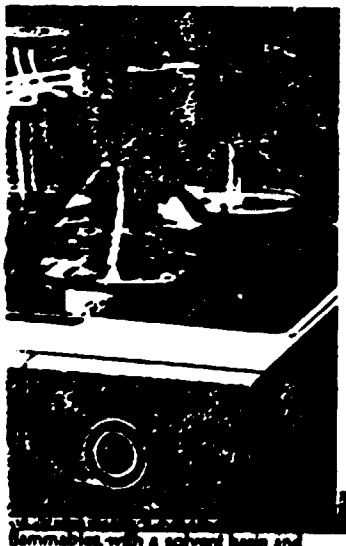
Stable composition is a must for trace level detection when mixing UV absorbing solvents.
A: Water + 0.1 % TFA
B: Acetonitrile + 0.1% TFA

which is large enough to achieve the pump's maximum flow. But large pump strokes require a proportionally large volume mixer before the column to achieve an homogenous blend. Reducing the stroke volume would allow for a smaller mixing volume, but that's only possible if the proportioning valve can switch rapidly enough between the channels.

The HP 1050 uses both shorter strokes matched to flowrate and a high-speed valve. No additional hardware is needed for mixing. That means a very low 800 µl delay volume before gradient changes



HP 1050 gradients, fine-tuned with variable stroke, are truely linear. And reach the column even sooner.
A: Water
B: Water + 0.5 % acetone



flammables, with a solvent basin and with leak sensors and safe leak drainage.

reach the column, comparable to many high-pressure mixing pumps. So now you can perform subtle changes in your gradients, and be confident that they are reproducible.

The HP 1050 is the pump to choose for high performance, versatile and convenient chromatography. With the confidence of Hewlett-Packard quality and guaranteed 99% uptime service.

Sensible and safe

When developing quaternary methods, you'll want to keep track of them. There's space for up to 10 methods in the HP 1050's memory, and while you are giving one gradient a try you can modify others. Since the memory is permanent, there's fast error-free recall even after a power fail. And you can prevent unauthorized changes by locking the keyboard by keystroke.

Designed for smart synchronization with the rest of the LC, the remote communication lines can automatically shutdown the pump after errors anywhere in the LC system. Intelligent messages on a full 2 lines of display keep you informed. Saving time, solvents and those critical samples.

Specifications

Hydraulic system	Dual-piston series pump with proprietary servo-controlled variable stroke drive, floating piston design and active inlet valve.
Flow range	Settable from 0.001 to 9.999 ml/min, in 0.001 ml/min increments
Piston displacement	20 to 100 µl, automatically matched to flowrate or user-selectable
Flow precision	< 0.3 % RSD (typically < 0.15 %), based on retention time, at 0.5 ml/min and 2.5 ml/min.
Pressure	Operating range from 0 to 400 bar (5880 psi) up to 5 ml/min, from 0 to 200 bar (2950 psi) up to 10 ml/min. Programmable upper and lower limits. Real-time display in bar, psi or MPa
Pressure pulsation	< 2 % amplitude (typically < 1 %), 1 ml/min propanol, at all pressures > 10 bar
Compressibility compensation	User-selectable, based on mobile phase compressibility.
Recommended pH range	1.0 to 12.5. Solvents with pH below 2.3 should not contain acids which attack stainless steel
Materials in contact with solvents	Stainless steel, titanium, gold, sapphire, ruby, filled TEFLON®, TEFLON®, ceramic

Quaternary pumping system

Gradient formation	Low pressure quaternary mixing/gradient capability using proprietary high-speed proportioning valve
Composition range	0 to 100 %, in 0.1 % increments, from 4 independent channels
Composition precision	± 0.25 % absolute (typically ± 0.15 %), peak to peak, binary mixture of water:acetonitrile, from 0.5 ml/min to 5.0 ml/min, without mixer.
Delay volume	500 to 1000 µl, dependent on backpressure.
Solvent preparation	Four 1 liter bottles, each with cap, filter and individually-regulated helium sparger.

Display	2 line by 16 character fluorescent display with real-time display of operating parameters and pressure.
Control	Integrated keyboard with function keys; parameter editing during run possible; keyboard lock.
Parameters	Flowrate, compressibility, stroke volume, upper and lower pressure limits, 2 external contacts; % B, % C, % D (for quaternary pump).
Time-programmable	Flowrate, upper pressure limit, external contacts, % B, % C, % D.
Methods	Battery-backed storage of up to 10 methods (depending on length), including time-programming. Automatic startup and shutdown methods. Editing of stored methods possible during run.
Analog output	2 mV/bar for pressure monitoring.
Communications	Outputs: Ready, 2 external contacts (one 24 V relay and one 100 V max. contact closure, both with 0.1 A). In- and outputs: Start, Stop, Shutdown.
Safety aids	Extensive diagnostics, error detection and display via front-panel LED's and status logbook. User-definable shutdown method activated in case of error. Leak detection and safe leak handling. Low voltages in major maintenance areas. Column pressure protection with maximum rate of pressure change of < 20 bar/sec after a setpoint change
Environment	10° C to 55° C with < 95 % humidity (non-condensing).
AC power requirements	Line voltage: 100 - 120 or 220 - 240 V ± 10 %, 48 66 Hz, max. 120 VA. Meets EMC requirements of IEC 801.
Dimensions (h x w x d)	208 mm (8.2") x 325 mm (12.8") x 560 mm (22")
Weight	19 kg (42 lb)

For complete description of test conditions used to obtain specifications, see Owner's manual. Teflon is a US registered trademark of EI Du Pont de Nemours & Co.

For more information call your local Hewlett-Packard sales office and ask for an Analytical Product Representative. Or write to Hewlett-Packard: U.S.A. - P.O.Box 10301, Palo Alto, CA 94303-0890; Europe - P.O.Box 667, NL-1180 AR Amstelveen, The Netherlands; Canada - 6877 Goreway Drive, Mississauga, L4V 1M8, Ontario; Japan: Yokogawa Electric Corporation, P.O.Box 6044, Shinjuku-NS Bldg 10F, 4-1 Nishi-Shinjuku 2-Chome, Shinjuku-ku, Tokyo 163; Elsewhere in the world, write to Hewlett-Packard Intercontinental, 3495 Deer Creek Road, Palo Alto, CA 94304, U.S.A.

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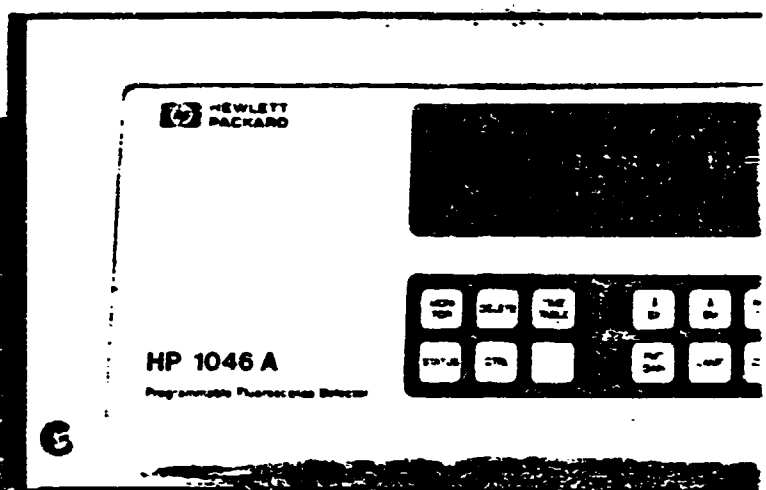
HP 1046A

Programmable Fluorescence Detector

HEWLETT PACKARD

Increase your detection options...



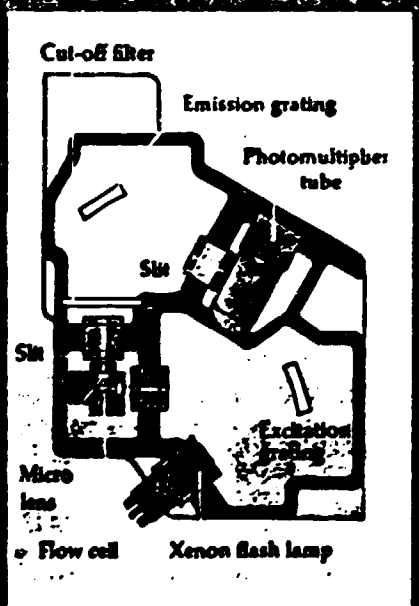
Luminescence to fit the application

Stay ahead in HPLC – obtain extra sensitivity and selectivity with programmed fluorescence detection. Explore the compound-specificity of phosphorescence detection. Investigate chemiluminescence detection for new analytical methodologies.

For increased detectability in HPLC, the HP 1046A provides all three luminescence options. You get a high-performance grating/grating fluorescence detector plus phosphorescence and chemiluminescence capabilities at no extra cost.

Take full advantage of compound luminescence

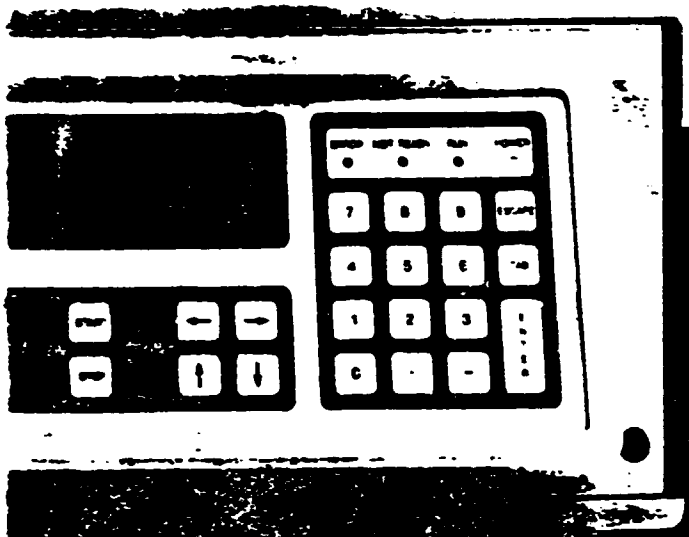
With the HP 1046A you time-program detector parameters for the optimal detection of each peak. To utilize fully the luminescence of each compound, time-program the excitation wavelength as well as the emission wavelength. You choose the best wavelength pair for each peak. The result: outstanding selectivity and sensitivity!



HP 1046A optical design

The intensity of the emitted light for the compounds in your sample may vary by several orders of magnitude during one analysis. Conventional detectors do not offer the required dynamic range. With the HP 1046A there isn't a problem: you see all the fluorescing compounds in a single chromatogram by time-programming the PMT (photomultiplier tube) gain. In a single run, you can detect and accurately quantitate all major compounds and trace impurities.

...then program for optimum detectability

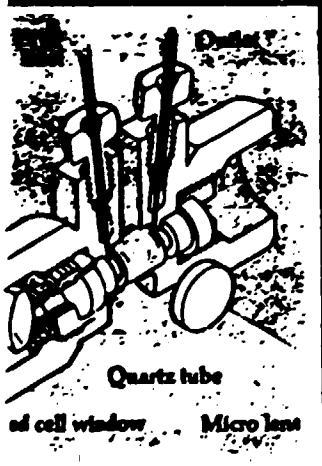


Meets all the requirements of an LDLC system

Low-dispersion Liquid Chromatography (LDLC) uses columns with low internal volumes, packed with small particles. The resulting peaks require a detector that has a low cell volume and fast response.

To minimize peak dispersion in the HP 1046A, we used computer aided design to develop a low volume flow cell (5 µl) with optimum flow geometry. The entire cell volume is illuminated and used in luminescence measurements. This is achieved by using stepped cell windows. An advance that gives high sensitivity and low peak dispersion in fluorescence detection. Optimize the signal to noise ratio by varying the response time to fit your chromatography. The fast response gives undistorted peak shapes when doing high-speed LC.

HP 1046A flow cell design



So easy to operate

Switch on and use the HP 1046A immediately. Enter operating parameters and time-programmed events through function keys – it's all self-explanatory.

Get all important detector information at a glance: the four LED's and large 32-character display always provide a clear view of the excitation and emission wavelengths, photomultiplier response and instrument status.

Rapid transfer from one LC to another

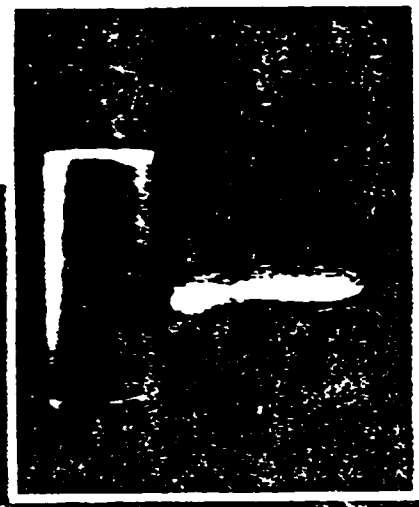
The HP 1046A is a single, compact unit requiring very little bench space. Its low weight makes it easy to move. Use it on any of your liquid chromato-graphs.

Enhance your ap

The demands on trace analysis in a wide variety of matrices, including environmental, food, pharmaceutical and pathological samples are rapidly increasing. The need for lower detection limits and increased selectivity can only be met by improvements in detector technologies.

Fluorescence detection is known to be extremely sensitive and selective. Many compounds fluoresce naturally, others may be derivatized by pre or post-column reactions to form highly fluorescent compounds. The benefits offered by phosphorescence and chemiluminescence detection are also becoming evident in an increasing number of applications.

Take full advantage of the exceptional sensitivity and selectivity offered by luminescence detection by adding the HP 1046A programmable fluorescence detector to your liquid chromatograph.

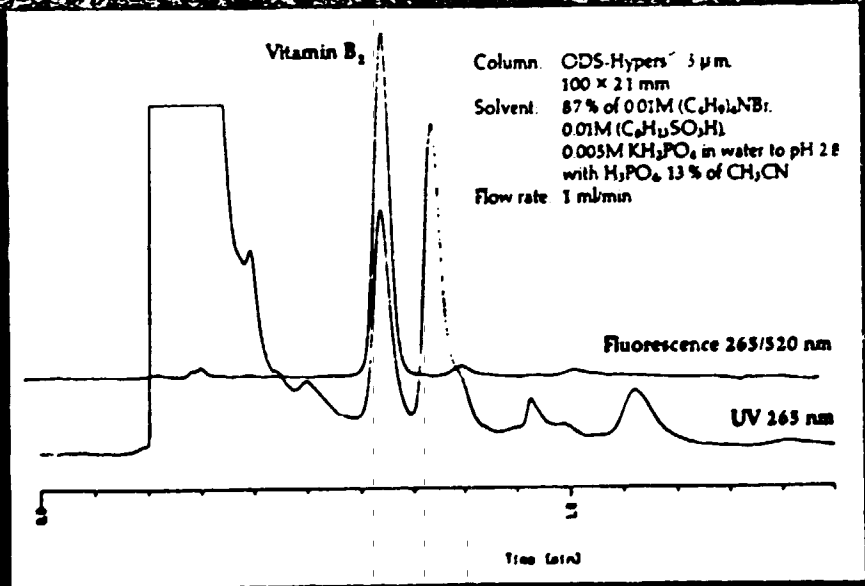


The measurement of vitamin B2 in milk

The natural fluorescence of vitamin B_2 can be used to determine this compound in complex matrices without the need for sophisticated and time consuming sample preparation techniques.

Proteins and lipids were removed from a milk sample by precipitation with Carrez-reagent, followed by centrifugation and filtration. Twenty microliters of the supernatant was injected onto the column.

The comparison between UV-detection at 265 nm and fluorescence detection showed the extra selectivity that can be obtained when using an excitation wavelength of 265 nm and an emission wavelength of 520 nm, respectively. A fast response time of 0.5 seconds was used to prevent distortion of the rapidly eluting peaks.



Comparison of UV- and fluorescence detection for the analysis of vitamin B_2 in milk

The desired measuring ranges can be achieved, however, it is recommendable not to measure high concentrations directly with the instruments, but to use a dilating system together with analyzers of lower range. The advantages are the following:

- No need to use heat traced sample lines, since the dew point is lowered.

- No need to use high temperature measuring cells in the instrument. Lowering the temperature will drastically increase the life time of many components (like solenoid valves).

- Measuring high concentrations with one instrument will cause a "memory effect" in the instrument's components in the low ranges, that means many hours of stabilization may be required to measure very low concentrations after the instrument has "seen" a very high concentration. This effect will not occur if too big differences in the ranges are avoided.

For dilution a diluting sample probe is proposed, that eliminates the need for a separate heater, since the dilution is performed directly in the hot stack.

2.1 SULPHUR DIOXIDE ANALYZER

MODEL:	UNOR 6 N
MEASURED COMPONENT:	SO_2
TYPE OF DETECTOR:	Gas Filter-Correlation-Infrared (NDIR)
RANGE:	0...50, 0-500 vpm SO_2 switchable
PRECISION:	better than +/-2 ppm
RESPONSE TIME:	<30s to 95% of full scale deflection
RESOLUTION:	better than 1% fsd
HEATED CELL:	47°C
OUTPUT SIGNALS:	0-1 V, linearized
LINE SUPPLY:	240 V/50 Hz
STANDARD ACCESSORIES INCLUDED WITH ANALYZER:	Sample pump, Filter and Maintenance Manual
SIZE:	483 (19") x 134 (3HU) x 306 mm (WxHxD)
WEIGHT:	approx. 12 kg

2.2 NITROGEN OXIDE MEASURING UNIT WITH ACCESSORIES

MODEL:	8101
a) MEASURED COMPONENT:	NO, NO_2, NO_x
b) TYPE OF DETECTOR:	Chemiluminescence
c) RANGE:	0-10/20/50/100/200 ppm
d) PRECISION:	0,2 ppm
e) NOISE:	0,1 ppm
f) ACCURACY:	2 % of range or better
g) LAG TIME:	30 seconds
h) RISE TIME:	60 sec 95 % of full scale
i) FALL TIME:	60 sec 95 % of full scale
j) ZERO DRIFT:	+/- 1 % in 8 hours
k) SPAN DRIFT:	+/- 1 % in 8 hours

OPERATION TEMPERATURE RANGE: $5^{\circ}C$ to $45^{\circ}C$

OUTPUT SIGNALS:	0 - 1 V or 0-10 mV linearised
LINE SUPPLY:	240 V/50 Hz
POWER REQUIREMENT:	350 Watts start-up
STANDARD ACCESSORIES INCLUDED WITH ANALYZER:	Sample pump, Teflon Sample filter and maintenance manual
SIZE:	19" rack, 22 cm high
WEIGHT:	27 kg
GAS FOR CALIBRATION:	see item 8

2.3 CARBONDIOXIDE ANALYZER WITH ACCESSORIES

MODEL:	UNOR 6 N
MEASURED COMPONENT:	CO_2
TYPE OF DETECTOR:	Infrared (NDIR)
RANGES:	0-0,5%, 0-5 %
PRECISION:	+/-1% of range
ACCURACY:	+/-2% of range
MINIMUM DETECTABLE SENSITIVITY:	10 ppm
ZERO DRIFT:	1 % of full scale per week
SPAN DRIFT:	1 % of full scale per week
NOISE:	5 ppm
LAG TIME:	20 s
FALL TIME:	30 sec for 90% of scale
RISE TIME:	30 sec for 90% of scale
OPERATION TEMPERATURE RANGE:	+5°C to 40°C
OUTPUT SIGNALS:	0-10 mV or 0-1 V linearised
LINE SUPPLY:	240 V/50 Hz
POWER REQUIREMENT:	150 VA
STANDARD ACCESSORIES INCLUDED WITH ANALYZER:	Sample pump, Filter and Maintenance Manual
SIZE:	483 (19") x 134 (3HU) x 306 mm (WxHxD)
WEIGHT:	approx. 12 kg
PRICE:	see price list

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2.4 CARBONMONOXIDE ANALYZER WITH ACCESSORIES

MODEL:	UNOR 6 N
MEASURED COMPONENT:	CO
TYPE OF DETECTOR:	Gas Filter-Correlation-Infrared (NDIR)
RANGES:	0-100 ppm, 0-500 ppm
ACCURACY:	+/- 1% of range
LINEARITY:	+/- 1%
PRECISION:	+/- 1% of range
ZERO DRIFT:	+/- 0,2 ppm/24 h
SPAN DRIFT:	1 % of full scale per day
NOISE:	0,1 ppm
RESPONSE TIME:	10 s at 95 % fsd
CROSS SENSITIVITY:	not appreciable for CO_2 and H_2O
OPERATION TEMPERATURE RANGE:	+5°C to 45°C
OUTPUT SIGNALS:	0-10 mV or 0 - 1 V linearised selectable 1 each output for momentary or integrated 1 h value
LINE SUPPLY:	240 V/50 Hz
POWER REQUIREMENT:	100 VA
STANDARD ACCESSORIES INCLUDED WITH ANALYZER:	Sample pump, Filter and Maintenance Manual
SIZE:	483 (19") x 134 (3HU) x 306 mm (WxHxD)
WEIGHT:	approx. 12 kg

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2.5.a PROBE FOR STACK SAMPLING

Sampling probe with integral ejector for sampling and sample dilution. The diluting probe allows for measurement of stack gases with analyzers for low concentration - like ambient analyzers.
Because of the dilution directly in the stack, also the dew-point is lowered, so that no heat tracing of the sample line has to be done to avoid condensation.

Blow-back prefilter

Gas tight holder for critical orifice equiped with critical orifice 250 ml/min (dilution rate 20:1 to 30:1)

Material highly corrosion restistant

two stage ejector

Connections for all control lines

Maximum temperature 400°C

Length 304 mm

Diameter 27 mm

Weight 5 kg

No power supply required

* EXTENSION OF THE SAMPLE PROBE,

  for stacks with bigger diameter

  additional extension per meter

* Umbilical with all required tubing (2 x PE, 2 x Teflon) including all the fittings

  4 m
  10 m
  20 m

  Several pieces can be coupled together up to a length of 100 m

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- CONTROL UNIT FOR DILUTING PROBE

  Pressure reducer and gauge for diluting air

  Vacuum gauge

  Blow-back unit

  Zero air switching

  Span gas switching

  Size: 483 x 224 x 330 mm (WxHxT)

  Weight: 10 kg

  No power supply required

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2.5.b CENTRAL CLEAN AIR SUPPLY WITH ACCESSORIES

Central Air Supply:	Model NK 355
Max. gas flow:	7 - 8 l/min free of sulfur components, Nitrogen Oxide, Carbonmonoxide and Carbondioxide
Max. pressure:	5 - 6 bar
Power requirement:	220 V/50 Hz/ 1,2 KVA

Parts mounted on a plate,

Compressor with 80 l storage tank separate.

The NK 355 is mounted in the cabin in a separate room.

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2.1 OXYGEN ANALYZER

MODEL:	OXOR 6 N
MEASURED COMPONENT:	O_2
TYPE OF DETECTOR:	paramagnetic
RANGE:	0-2,5/5/10/25 %
ACCURACY:	better than +/-1% F.S.
PRECISION:	better than +/-1% F.S.
RESPONSE TIME:	<10s to 90% of full scale deflection
ZERO DRIFT:	<1% F.S. in 8 h
SPAN DRIFT:	<1% F.S. in 8 h
OUTPUT SIGNALS:	0-1 V, linearized
LINE SUPPLY:	240 V/50 Hz
STANDARD ACCESSORIES INCLUDED WITH ANALYZER:	Sample pump, Filter and Maintenance Manual
SIZE:	483 (19") x 134 (3HU) x 306 mm (WxHxD)
WEIGHT:	approx. 12 kg

The Oxygen Analyzer cannot use the sample from the dilution probe, but needs a separate probe. This probe can also be used for the other compounds in case that only low concentrations are to be measured that require no dilution.

A. Sampling

- Sampling Probe Ga 54 c

  V4A-steel with coated Teflon tube

  max. temperature 250°C

  external filter

  length of probe tube 1000 mm

- Heating Collar Hei 56

- heated sample gas line
  with exchangeable teflon tube 6 x 8 mm

  max. temperature 200°C

  length 20 m

- Teperature regulator WFD 125 D
  with digital display

- Solid State Relais 45 A

B. Gas handling and preparation

- Vacuum switch D2S - M3SS
  for status signal "probe filter plugged"

- Electric gas cooler ECS-4G

  4 heat exchanges of Duran-Glass

  high and low temperature alarm

  power 240 V/50 Hz

- Automatic condensate drain, consisting of

  peristaltic pump Gf 46A

  condensate collector Fi 07C
  with level switch for pump

- Diaphragm pump Gf 53
  240 V/50 Hz

- Fine regulating valve

- Flow tube 25-250 l/h
  for monitoring bypass flow

- Condensate monitor MK-1
  for switching off sample pump
  in case of condensate break-through.

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2.7 RECORDER

6-channel recorder

MODEL:	GICA 6000
TYPE:	flat bed
ACCURACY:	+/-0,25 %
NUMBER OF CHANNELS:	6
SPEED:	0,5 s
PENS:	felt tip
PAPER:	250 mm width
PAPER ADVANCE:	3/6/12/15/30/60/120/150/ 300/600 mm/min, switchable to mm/h
INPUTS:	0-10/20/50/100/200 mV 0-1/2/5/10/20 V
POWER:	240 V/50 Hz/60 VA
DIMENSIONS:	500 x 570 x 70 x 165 mm ($WxDxH_1xH_2$)
WEIGHT:	14 kg

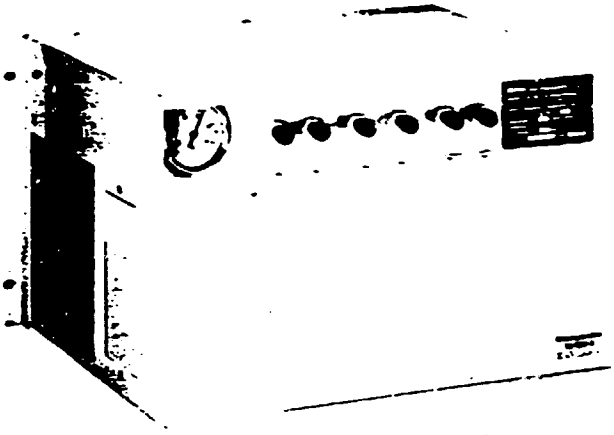
Including 2 spare sets of pens
6 rolls of paper

Sample Gas Cooler

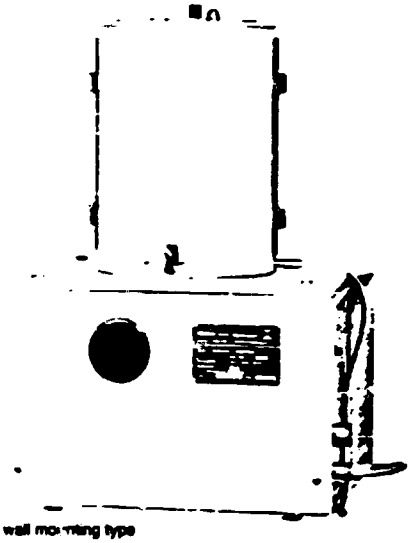
Fi 57

for wall mounting, or 19"-6 PU rack or Ex-version

43.001 E/85



19"-6 PU rack type



wall mounting type

Fi 57

- constant low dew point of +4 °C ± 0.5 °C over entire performance range,
- gas inlet temperature max. +120 °C,
- max. 3 separate heat exchangers in one cooler,
- corrosion-resistant gas paths of PTFE or stainless steel 1.4571,
- max. flow 150 l/h per heat exchanger,
- Ex-version – Ex is d 3n G4,
- 19" chassis,
- safe cooling circuit by pressure control.

Application

Sample gas coolers are essential components of gs sampling and conditioning systems. These units are used whenever wet sample gases have to be cooled down so that the gas will always be above the dew point in the following section of the analyser system.

The dew point or partial pressure of condensable components of the sample gas is kept low and constant in order to eliminate the influence of residual water vapour on the measurement result or to have such influence considered during calibration of the analyser by a constant value.

Description

The unit operates like a compressor type refrigerator. The cooling element is a cooling dome of stainless steel tube with a surface temperature kept constant by a thermostat. The spiral-wound heat exchangers of stainless steel tube or PTFE of 6 x 1 mm dia. are arranged close to the cooling dome and provide fror optimum and fast cooling of the sample gas flow.

One or more condensate separators (depending on the number of incorporated heat exchangers) at the outlet of the heat exchanger provide for the connection of condensate collectors, automatic float-type condensate drains or condensate draining pumps. These devices are not included in the standard supply, will however be installed or attached if desired.

The gas inlets and outlets of the heat exchangers are arranged on the top of the unit and are identified by arrows.

The cooler can be equipped with a dial-type contact thermometer for functional control.

The standard version is connected to the mains by a 2 m cable with plug. For connecting the Ex-version, the front wall must be removed after loosening 4 screws. The connecting cable is introduced through side cable glands and connected to the Ex-proof connection box.

The cooler is ready for operating about one hour after switching on.

All moving parts of the compressor are running in an oil bath to ensure long life.

The standard and the 19" rack version can be supplied with the following options:

- functional control with dial-type contact thermometer,
- one potential-free change contact each, minimum contact at +2 °C, maximum contact at +10 °C.

The sample gas cooler is available in 3 versions:

standard version for wall mounting and installation in analyser cabinets,

19" version for installation in 19" cabinets and racks,

Ex-version in protection Ex is d3n G4.

Specifications Fi 57

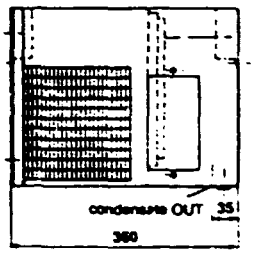
43.001 E/85.01

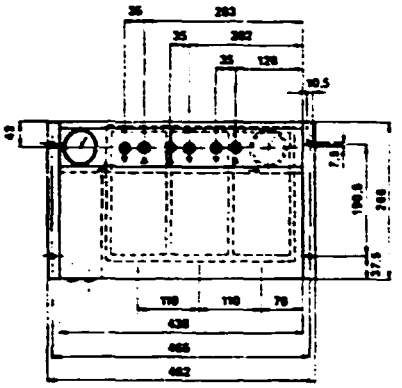
Principle of operating:	compressor-type sample gas cooler
Gas inlet temperature:	max. +120 °C, water vapour saturation, dew point +65 °C at 150 l/h flow
Gas outlet temperature:	+4 °C
Dew point variations:	±0.5 °C
Allowable gas inlet pressure:	120 bar for stst tube heat exchangers 2 bar for PTFE heat exchanger 1 bar for 19" version with PTFE heat exchanger
Number of heat exchangers:	max. 3 separate gas circuits
Cooling performance:	830 KJ/h at +25 °C ambient temperature and +4 °C cooling vapour temperature
Material of gas-contacted parts:	PTFE or stainless steel 1.4571, 6 x 4 mm dia.
Power supply:	220 V ± 10%, 50 . . . 60 Hz, 300 VA
Electrical connections:	2 m mains cable with plug; 19" and Ex-version: terminal connection box PG 16
Sample gas connections:	screw connectors for tube/hose 6 x 4 mm dia.
Condensate connection:	tube, 12 mm dia., external
Warm-up time:	approx. 1 h
Ambient temperature range:	+5 . . . +50 °C; Ex- and 19" version: +5 . . . +40 °C
Transport and storage temperature:	−20 . . . +70 °C
Protection (DIN 40050):	IP 20; Ex-version: IP 20 – Ex is d3n G4
Case:	varnished sheet steel, plastic cover with fast lock
Dimensions (h x b x d):	standard vers.: see dimensioned drawing 19" version: 6PU; 266 x 482 x 360 mm Ex version: 550 x 430 x 420 mm
Mounting:	standard vers.: wall mounting or free-standing Ex version: wall mounting or free-standing within hazardous zones 19" version: 19" cabinet or rack
Weight:	standard vers.: 23 kg 19" version: 23 kg Ex version: 33 kg

Subject to technical modifications!

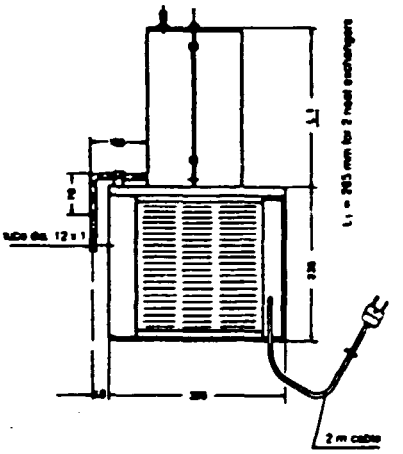
Dimensions

19"-6 PU type



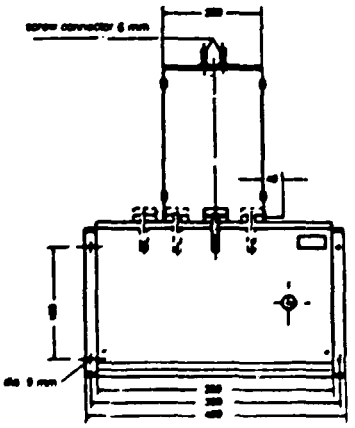


wall-mounting type



Quoting/Ordering information

Sample gas cooler version:	☐ wall mounting ☐ 19" rack ☐ Ex version
Number of heat exchangers:	☐ 1 ☐ 2 ☐ 3
Material of heat exchangers:	☐ PTFE ☐ stainless steel 1.4571
Contact thermometer:	☐
Error output signal:	☐ min. contact, +2 °C ☐ max. contact, +10 °C potential-free change contacts rated for 250 V/10 A/300 W



UPK

UPK GmbH
D-6350 Bad Nauheim
Hauptstraße 95
Postfach 1223
Bundesrepublik Deutschland

Telefon (0 60 32) 3 19 71
Telex 4 15 535 upk d
Telegramme UMPRO

Vertreten durch:

Gas Sampling Probes

Ga 33
Ga 53
Ga 54 C
Ga 54 D

41.001 E/...

Introduction

Gas sampling probes are used where the gas analyser system cannot be connected directly to the gas stream to be measured (for example: pressurized lines). They are also used to sample gas from enclosed and relatively inaccessible spaces, and to take the gas at the relevant point of the line cross-section in case of large diameter lines. A gas sampling probe can bridge large wall thicknesses (on stacks) and allows to take the sample from the hot zone of the gases. The gas filter of the probe retains a major portion of the dust particles so that the following gas lines are not exposed to coarse solids.

The proper gas sampling probe is selected according to

- gas temperature
- corrosiveness of gas
- necessary installation depth (streaks in the gas stream)
- structural conditions of the installation place.

Most of the problems are usually caused by the corrosive condensate. Even corrosion-resisting stainless steel can be attacked by the synergism of corrosiveness and high temperature. In such a case condensate in the gas sampling system must be avoided: parts in contact with the gas are heated or heat-insulated and the condensate is removed in a following sample gas cooler of particularly resistant material.

Ga 53
Gas sampling probe with inside filter for dust-laden gases up to 500 °C
+
Ga 51
Sampling sleeve with stuffing box to allow variable installation depth.

An inside filter has the advantage that even wet gases with condensable portions would not require heating of the filter element with consequent saving of installation work and cost. An inspection of the filter is still possible relatively fast by the 2-bolt flange.

Contration streaks in the gas stream can be detected by the Ga 53/Ga 51 probe by varying the installation depth to find the optimum sampling point.

The probe should be installed with a downward slope to the outside of about 15° to allow draining of the condensate forming in the probe tube.

The sampling sleeve Ga 51 can be used as support also for other probes,such as temperature sensors.

Application example

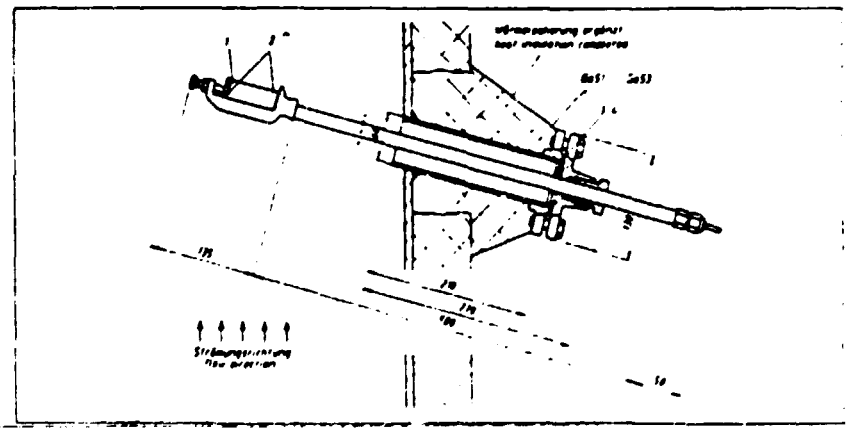
Stack gas measurement (CO, CO_2, O_2) on gas or oil-fired combustion systems or engines

Ordering code

☐ 400056 gas sampling tube Ga 53
☐ 400054 gas sampling sleeve Ga 51

Spare parts

1: 015690 filter cartridge Ker 03
2: 404324 sealing ring Gid 28
3: 400092 sealing ring Gid 13
4: 011361 ceramic fibre cord
din. 6/0.5 m



For specifications of the gas sampling probes refer to page 4. All dimensions in mm.

UPK GmbH
D-6350 Bad Nauheim
Hauptstraße 95
Postfach 1223
Bundesrepublik Deutschland

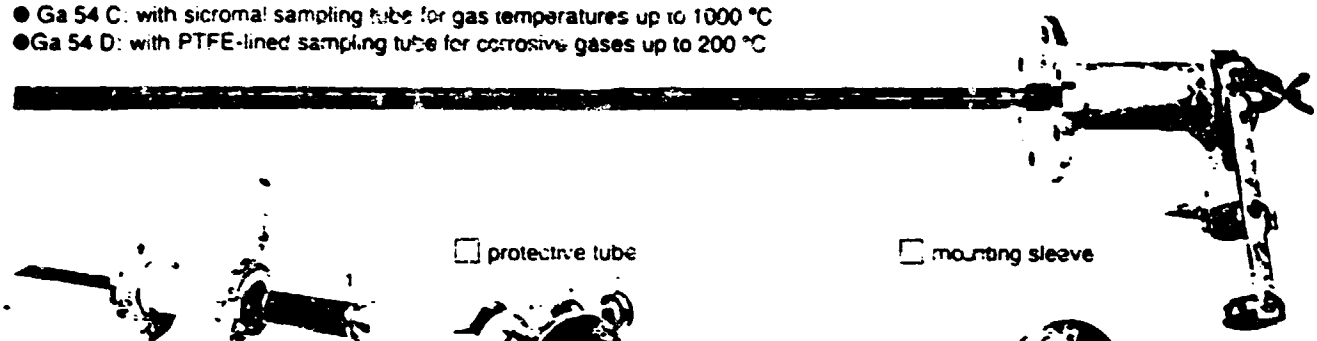
Telefon (06032) 31971
Telex 415535 upk d
Telegramme UMPRO

Vertreten durch:

Ga 54 C/D

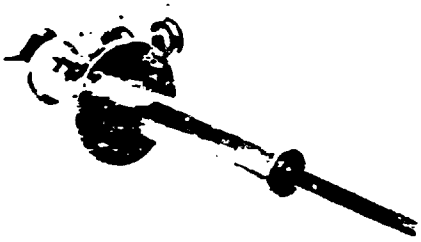
Universal probe with heatable outside filter for dust-laden wet gases

- Ga 54 C: with sicromal sampling tube for gas temperatures up to 1000 °C
- Ga 54 D: with PTFE-lined sampling tube for corrosive gases up to 200 °C



- ceramic filter element (1)
- support for heated gas line (2)

☐ protective tube



The protetive tube is required for large wall thickness (such as brickwork stacks) if the gas temperature is below 500 °C. This tube prevents cooling of the probe below the dew-point of the sample gas and therefore corosion which could be caused by corrosive condensate on the inside and outside surfaces of the tube. This protective tube is not required for thin walls. It must not be used for temperatures above 500 °C.

Material: stainless steel 1.4571
Insulation: ceramic fibres
Weight: 1.7 kg

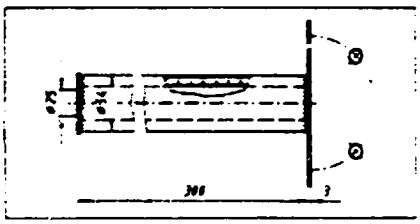
☐ mounting sleeve

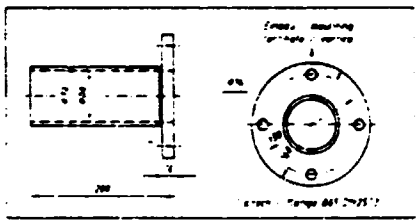
A tubular sleeve with matching flange is available for firm installation in the gas line. The sleeve can take one Ga 54 probe with or without protective tube. This sleeve should be installed as shown.

Materials: steel St 35 (1.0308)
and St 37 (1.0114)
nickel-plated
Weight: 3.5 kg

The gas sampling probe Ga 54 covers a wide range of applications:

- Model Ga 54 C covers a wide range of temperature.
- Model Ga 54 D having a sampling tube internally and externally lined with PTFE is suitable for particularly corrosive gases.
- The outside filter can be cleaned rapidly and by simple means; usually, compressed air blowing is sufficient.
- The filter can be heated. The heating can be installed also at a later date.
- If the probe has to be installed with the sampling tube sloping upwards, the ceramic filter element can be omitted.
- A heated sample gas line can be mounted directly on the probe.





Application example:

Sampling of wet corrosive stack gases in power plants and refuse incinerators.

Accessory

The following accesory is available to adapt the sampling probe to various structural and technical requirements.

☐ protective hood

This protective hood covers the probe case on 4 sides and is used as weather or contact protection. It is mounted on the flange of the probe by 2 wing screws.

Dimensions(hxbxd): 280 x 160 x130
Material: stainless steal 1.4301 (exept small parts
Weight: 2,9 kg

☐ test head

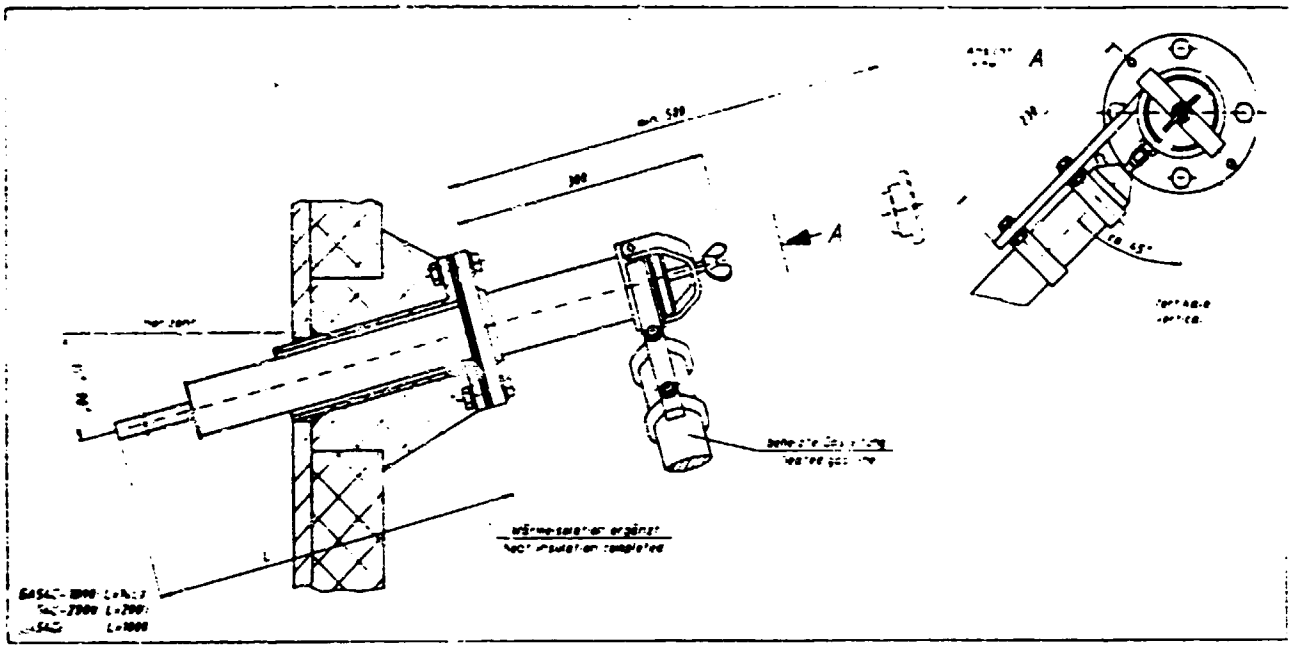
The test head is used to connect a test gas line to the probe. It is placed into the probe case instead of a filter insert and allows to test and calibrate the analyser system including the entire sample gas line downstream of the sampling probe.

Gas connection: clamp ring screwing stainless steel 1.4571 for tube Ø8 mm
Material: stainless steel 1.4104

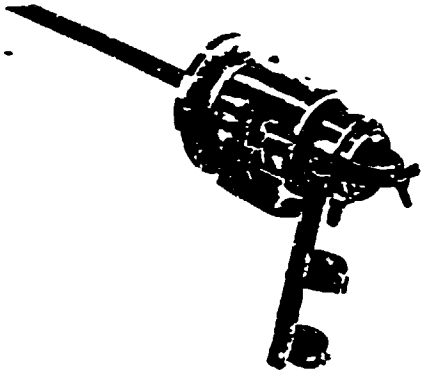
UPK GmbH
D-6350 Bad Nauheim
Hauptstraße 95
Postfach 1223
Bundesrepublik Deutschland

Telefon (06032) 31971
Telex 415535 upk d
Telegramme UMPRO

Vertreten durch:



☐ heating jacket

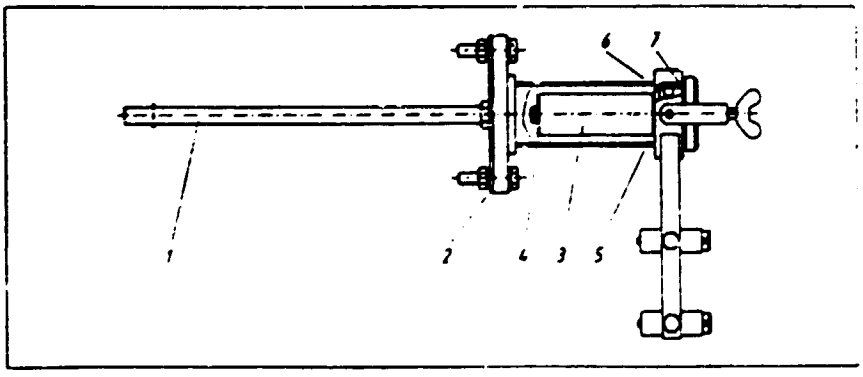


The heating jacket is used to heat the filter case of the Ga 54 probe in order to avoid condensation on the ceramic filter. Condensate would block the filter pores by dust sludge so that the filter would be very hard to clean. This arrangement is essential for SO_2 and NO_x measurements where already small volumes of condensate in the filter would falsify the measuring result (by absorption of the component to be measured). Therefore, this filter always has to be heated for SO_2 and NO_x measurements.

The heating jacket contains 2 heater windings with separate connections. Therefore, 3 different heating powers can be obtained:

- 200 W with parallel connection of both windings;
- 100 W with only one winding connected;
- 50 W with series connection of windings.

Power supply:	200 V, 50/60 Hz, 2x 100 W
Electrical connection:	terminal screws through cable glands PG 13.5 (use heat resistant cable
Max. ambient temperature:	328 K (55 °C)
Protection:	IP 50 (DIN 40050)
Weight:	1.6 kg



Quoting/Ordering codes

☐ 404599 gas sampling probe Ga 54 C - 1000

☐ 300540 gas sampling probe Ga 54 C - 2000

☐ 404570 gas sampling probe Ga 54 D gas sampling probes Ga 54 each including 1 flange gasket and 4x hex. screws M 12 x 55 + hex. nuts, washer and spring ring of stainless steel 1.4571.

☐ 404524 protective tube Ga 57 (including 1 flange gasket)

☐ 300541 protective hood Hi 55

☐ 405080 mounting flange Ga 56

☐ 404578 test head Ga 58

☐ 405032 heating jacket Hei 56

☐ 404527 adapter flange Ga 59 (incl. mounting parts) – for mounting on existing standard flange

Spare parts

1: 35820 gas sampling tube 1000 mm lang
305824 gas sampling tube 2000 mm lang
401235 PTFE-lined sampling tube 1000 mm long
2: 303951 flange gasket Gid 87
3: 017477 filter cartridge Ker 31
4: 404327 sealing ring I
5: 404328 sealing ring II
6: 017888 O-ring silicon 45.7 x 2.6
7: 017989 O-ring Silicon 53.6 x 2.6

Probe with ceramic sampling tube for gas temperatures up to 1500 °C.

The gas sampling tube Ga 33 is used for gas temperatures above 1000 °C since materials of steel cannot be used for such temperatures. The sampling tube of the Ga 33 consists of a ceramic material and is mechanically supported by an additional ceramic tube. Both tubes are replaceable.

The sampling tube can be inspected and cleaned without disasembly. The tube is accessible after removing the dummy plug on the outside.

Application examples

Gas measurements on tunnel kilns (the flange tubes of the probe fits the usual inspection holes); gas sampling on glass-melting furnaces and cupola furnaces.

Installation notes

The probe Ga 33 should be installed when the plant is cool, i.e. at temperatures below 100 °C. If this is not possible, the probe must be introduced in the installation hole SLOWLY to become adapted to the gas temperature as otherwise the ceramic tubes of the probe could be destroyed by thermal stresses.

Ordering codes

☐ 400627 ceramic gas probe Ga 33
L = 800 mm

☐ 400628 ceramic gas probe Ga 33
L = 1000 mm

☐ 400629 ceramic gas probe Ga 33
L = 1400 mm

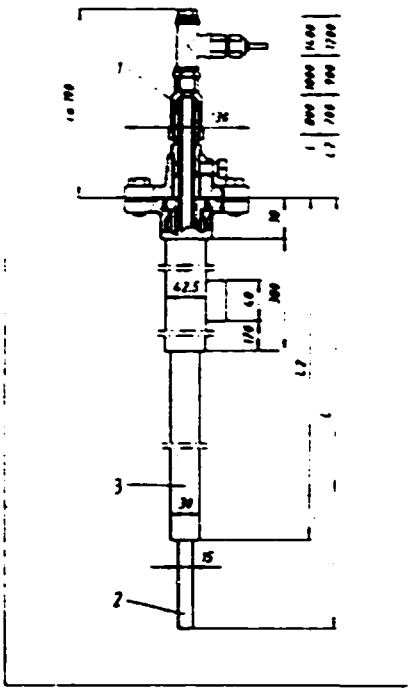
Spare parts

1: 014400 ceramic fibre cord
Ø 4 / 0.5 m

For L = 800 mm:
2: 015515 ceramic insert tube
Ga 30 900 mm
3: 015692 ceramic protection tube
Ker 13 700 mm

For L = 1000 mm:
2: 015516 ceramic insert tube
Ga 30 1100 mm
3: 015693 ceramic protection tube
Ker 13 900 mm

For L = 1400 mm:
2: 015517 015517 ceramic insert tube
Ga 30 1500 mm
3: 015694 ceramic protection tube
Ker 13 1200 mm



Specifications	Ga 53 + Ga 51	Ga 54 C	Ga 54 D	Ga 33
Max. gas temperature	770 K (500 °C)	1250 K (1000 °C)	470 K (200 °C)	1800 K (1500 °C)
Max. gas flow	300 l/h	300 l/h		200 l/h
Filter:				
material	silicon carbide	silicon carbide		–
mean pore diameter	approx. 100 µm	30 µm		–
filter surface (outside)	55 cm²	160 cm²		–
Installation depth (from flange to sampling probe)	210 ... 1000 mm	1000/2000 mm	1000 mm	800/1000/1400 mm
Sampling tube:				
outside dia.	17.5 mm	17.2 mm	20.5 mm	15 mm
inside dia.	12.5 mm	12.5 mm	9.5 mm	10 mm
material	stst 1.4571	stst 1.4762	PTFE (on steel 1.4571)	KER 610 (DIN 40685)
Other materials in contact with medium:				
installation tube	steel 1.0033	–		KER 530 + steel 1.0033
flange	cast iron 0.6022	stst 1.4301		cast iron 0.6022
gas lines, case etc.	–	stst 1.4301		steel 1.0711.07
Gas connection:	clamp ring screwing stst (1.4571 for tube of outside dia. 8 mm + reducer ring for tube with outside dia. 6 mm + nipple for hose of inside dia. 8 mm	clamp ring screwing of stst 1.4571 for tube of outside dia. 8 mm + support sleeve for PTFE tube 8 x 6 mm		same as Ga 53 + Ga 51
Weight (* shortest version)	1.3 kg (Ga 53) + 2.4 kg (Ga 51)	7.1 kg*	7.2 kg	4.4 kg*

UPK GmbH
D-6350 Bad Nauheim
Hauptstraße 95
Postfach 1223
Bundesrepublik Deutschland

Telefon (0 60 32) 3 19 71
Telex 4 15 535 upk d
Telegramme UMPRO

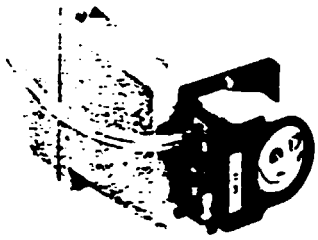
Vertreten durch:

Automatic Condensate Separator

for gas analyser systems

Fi 07 A/B
Gf 46 A

43.005 E/as



Fi 07 A/B

- transparent condensate collector
- stable construction
- corrosion-resistant materials
- Fi 07 A: 1 connections for condensate collection
- Fi 07 B: 2 connections for condensate separation from flowing sample gas

Description

Fi 07 is a condensate collector of a very robust construction: The removable collector is a beaker of 4 mm thick glass, fixed by a solid steel clamp and a large wing screw. Other components in contact with the gas are made of corrosion-resistant polypropylene. A suction hose in the vessel serves to connect a condensate pump.

2 versions are available:
– Fi 07 A having one hose nipple (in addition to the connection for the condensate pump) to allow the condensate to flow into the beaker; this nipple is sufficiently large. This model is used for sample gas coolers with separate condensate drain.

– Fi 07 B has two hose nipples to allow the sample gas to flow through the collector which takes up the condensate contained in the sample gas stream. This model is used for sample probes where condensate occurs and also following the pre-cooler Fi 83.

The collector vessel must be arranged on vertical mounting walls

Application

The measuring systems of gas analysers must remain free from condensate. Therefore, condensable portions of the sample gas have to be removed, usually by means of a sample gas cooler.

The resultant condensate must be removed from the sample gas system without opening the lines in order not to interrupt the measurements. This can be achieved by a peristaltic hose pump having a delivery system with a permanently gas-tight closure and consequently not allowing sample gas to pass (except perhaps with the delivered volume). The pump delivers the condensate to a central collection point or drain.

A collector vessel is installed upstream of the hose pump to serve as a safety vessel for taking up any temporary high volume of condensate. If installed in the sample gas stream, this vessel can separate gas and condensate. Also, the collector vessel serves as a buffer for temporarily switching off the hose pump (at intervals) in case of low volumes of condensate. A transparent collector vessel serves as inspection glass for a functional check of the measuring system.

Gf 46 A

- robust hose pump
- delivery rate 0.5 l/h
- delivery pressure 0.5 bar (= 5 m water column)
- plastic case
- new: fast closure for easy hose changing

Description

This hose pump features low speed (0.5 rpm), long life of the pump hoses and simple maintenance; it es specifically suitable for the requirements of gas analyser systems. Changing the pump hose, the only maintenance work, is a very quick operation owing to customized pump hoses which are simply placed into the removable hose bed after opening a fast closure. It is not necessary to switch off the pump drive for this exchange.

Depending on the operating conditions, the life of a pump hose in continuous operation is 4 to 8 weeks. For most applications the life can be extended considerably if the condensate yield is considerably less than the delivery rate of the pump, the pump can be operated at intervals by a timer. On-time and off-time depend on the condensate volumes. For example, if 5 minutes on /25 minutes off are sufficient, a maintenance interval of 6 months can be expected.

The pump can be mounted in any position; the upperpart of the case can be mounted in 4 different positions on the underpart.

Specifications

Fi 07 A/B

Function:	condensate collector
Capacity:	0.2 l
Materials of parts in contact with gas:	polypropylene, glass, viton B
Allowable gas temperature	max. 350 K (+ 80 °C)
Connection for condensate discharge:	screw nipple for hose / tube 6 x 4 mm
Fi 07 A: condensate connection	1 nipple for hose/tube 10 x 8 mm
Fi 07 B: gas connections	2 nipples for hose/tube 8 x 6 mm
Dimensions (hxbxd):	230 x 120 x 80
Weight:	1.0 kg

Gf 46 A

Function:	condensate delivery
Principle of function:	peristaltic hose pump
Hose material:	silicon
Delivery rate:	0.5 l/h
Delivery pressure	max. 50 kPa (0.5 bar)
Hose connections:	2 cylindrical nipples dia. 5 mm
Power supply:	220 V +/– 10 %, 50 ... 60 Hz 16 W
Electrical connection:	terminal screws through cable gland PG 13.5
Case:	polycarbonate
Protection (DIN 40050):	IP 44
Dimensions (hxbxc	105 x 125 x 185
Weight:	1.2 kg

Ordering codes

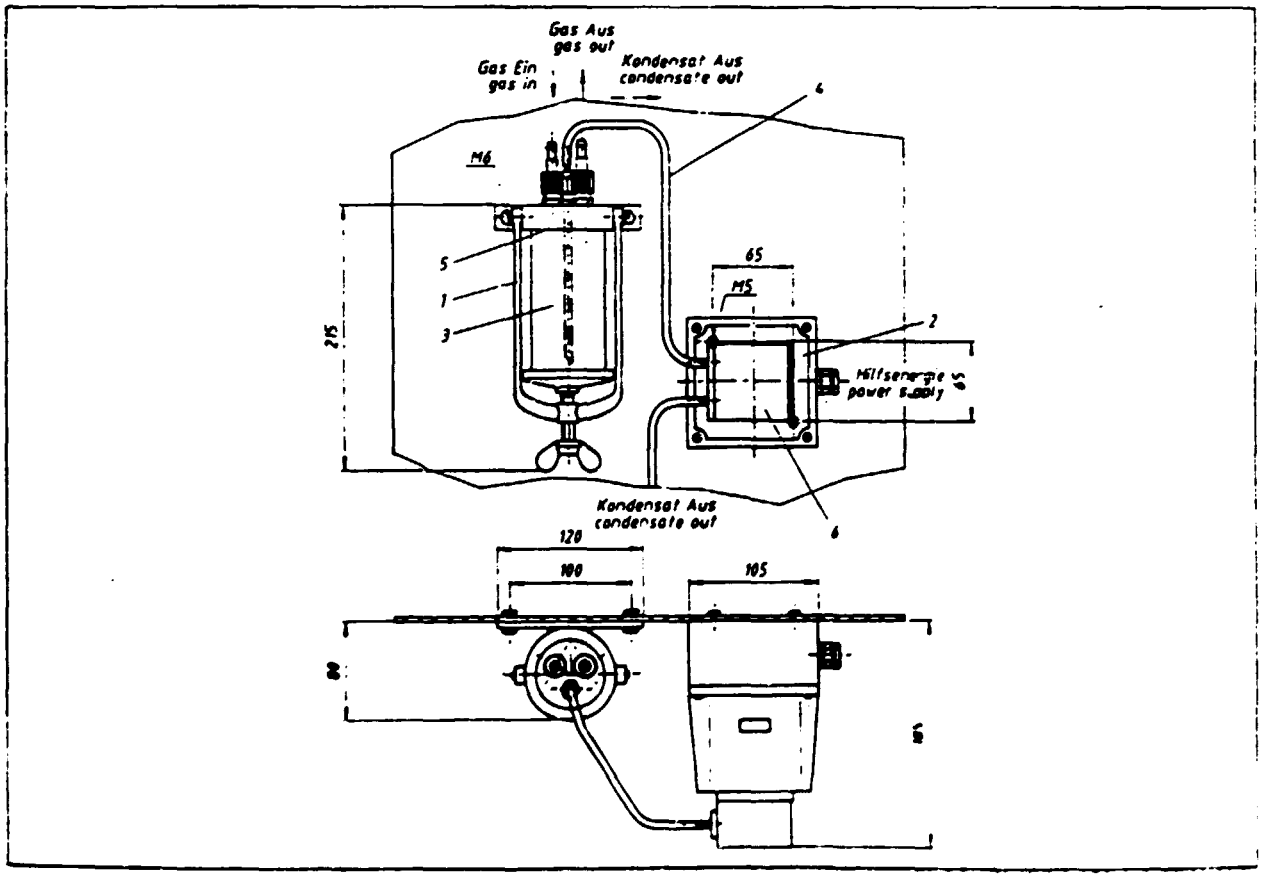
1:
- ☐ 305841 condensate collector Fi 07 A
- ☐ 305845 condensate collector Fi 07 B

2:
- ☐ 019643 hose pump Gf 46 A

Spare parts

3: 015572 glass beaker Glg 03
4: 015537 PVC hose Gil 25
5: 305842 sealing Gid 134
6: 019440 spare part set for Gf 46 A
(5 complete pump hoses
+ 1 hose bed)

Mounting example (with Fi 07 B)



UPK GmbH
D-6350 Bad Nauheim
Hauptstraße 95
Postfach 1223
Bundesrepublik Deutschland

Telefon (06032) 3 19 71
Telex 4 15 535 upk d
Telegramme UMPRO
C21

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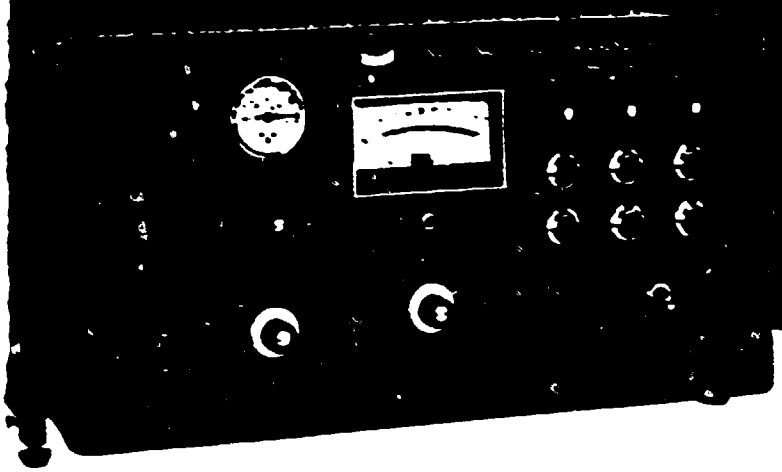


The Bendix $NO\ NO_2\ NO_x$ Analyzer

Analysis Method

The Model 8101-C utilizes the principle of photometric detection of the chemiluminescence resulting from the gas phase reaction of NO with ozone. The analyzer has a 23-second time cycle — 11.5 seconds in the NO mode and 11.5 seconds in the NO_x mode. In the NO mode, the sample passes directly to the detector cell where the reaction with ozone occurs. The resulting chemiluminescence is measured by a *thermoelectrically cooled photomultiplier tube*, and the value is stored in a memory circuit. In the NO_x mode, the sample passes through a *temperature controlled* converter which reduces NO_2 to NO. The total NO (converted NO_2 plus the NO in the original sample) now passes to the detector cell where the *reaction* with ozone occurs resulting in the chemiluminescence and photomultiplier tube output, and this value is also stored in a memory circuit. The value stored represents the concentration NO_x ($NO + NO_2$) in the sample. The stored value for NO will be subtracted from the stored NO_x value, and this value will represent the amount of NO_2. The NO_2 value will also be stored in a memory circuit. The analyzer provides automatic cycling through the NO and NO_x measurements with the output difference (NO_2) updated after each cycle.

Operation

The Model 8101-C Analyzer generates ozone for the gas phase reaction from an integral dry air supply protected by a particulate filter which enhances long term reliability of the integral air supply which operates from the analyzer sample pump.

The *sample flow rate is fixed* at approximately 200 cc per minute. This low sample flow rate reduces the need for large dilution air requirements during calibration.

The carbon converter used in the Bendix Model 8101-C Analyzer was selected for its reliable, high efficiency conversion at relatively *low operating temperature* and extremely low *conversion of ammonia to NO*. The use of this converter achieves measurements with almost no interference from ammonia.

The 23-second cycle time for NO and NO_x reduces the possibility of negative NO_2 output due to rapidly changing levels of concentrations at the sample intake such as those resulting from automotive traffic.

A carbon scrubber located in the analyzer exhaust removes high levels of ozone exhausting from the reaction chamber. *Analyzer flows are capillary controlled*, eliminating the need for time consuming precision measurements and adjustments during calibration.

Electronics

The electronics include high-reliability transistors and integrated circuits. All electronic components are mounted on plug-in circuit card assemblies enabling rapid repair in the field by simply interchanging cards.

The photomultiplier tube assembly is temperature controlled and has a self-contained high voltage power supply. *The photomultiplier tube is thermoelectrically cooled* to maintain a stable zero output, minimum "dark current," and is unaffected by temperature fluctuations.

The system has two proportional *solid state temperature controllers*: one controls the temperature of the catalytic converter block to 285°C, and the other controls the temperature of the reaction chamber block to 45°C.

Separate permanent memory type outputs are provided for each component. The front panel RECORDER output is selectable by the METER selector switch. Individual component outputs from memories are available at the rear panel terminal board.

Outstanding Features

- Thermoelectrically temperature controlled photomultiplier
- Temperature controlled reaction chamber
- Internal ozone generator with automatic shutoff in event of pump failure or loss of power
- Capillary controlled flow system
- Solid state modular electronics
- High vacuum pump not required for chemiluminescent reaction
- Internal NO_2 converter with solid state temperature control
- Single photomultiplier detector with single baseline output provides greater accuracy in NO_2 measurements

Model 8101-C Specifications NO/NO$_2$/NOX

Ranges:	0-0.2, 0.5, 1.0, 2.0 ppm full scale* Other ranges are available.
Lower Detectable Limit:	0.01 ppm (2 x standard deviation by definition)
Noise:	0.002 ppm at "0" 0.005 ppm at 80% of range (by standard deviation method)
Response Time:	
Lag Time:	0.5 Min.
Rise Time:	1.0 Min. 95% of full scale
Fall Time:	1.0 Min. 95% of full scale
Zero Drift:	±0.025 ppm in 24 hours
Span Drift:	±0.01 ppm in 24 hours at 20% of range ±0.02 ppm in 24 hours at 80% of range
Precision:	
— 20% of Upper Range Limit	0.005 ppm
— 80% of Upper Range Limit	0.01 ppm
Linearity:	±0.5% full scale
Interference Equivalent:	0.04 ppm
Operating Temperature Limits:	5°C to 40°C
Operating Temperature Fluctuation:	±5°C
Operational Period:	Seven or more days unattended
Outputs:	0 to 10 millivolts and 0 - 1 volt (other outputs optional)
Power Requirements:	105-125 volts, 50 or 60 Hz, @ 350 watts
Weight:	60 pounds (27.2 kg) approximately
Case Dimensions:	16½" (41.91 cm) wide x 8½" (21.59 cm) high x 17" (43.18 cm) deep

*To convert from ppm to $\mu g/M^3$ @ 25°C and 760 mm Hg multiply by 1880.

Ordering Data:

Contact Factory or the Local Representative shown below

Model	Voltage and Current	Part Number
Table Top Rack Mounted	115V — 60 Hz	5518950-1 -2
Table Top Rack Mounted	100V — 50 Hz	5518950-3 -4
Table Top Rack Mounted	220V — 50 Hz	5518950-5 -6

UPK GmbH
D-6350 Bad Nauheim
Hauptstraße 95
Postfach 1223
Bundesrepublik Deutschland

Telefon (0 60 32) 3 19 71
Telex 4 15 535 upk d
Telegramme UMPRO

Vertreten durch:

ıluting stack sampler for monitoring gaseous emissions with amıient air analyzers

UPK

As about half of all pollution originates from stationary sources some countries demand the continuous measurement of certain polluting compounds in stack gases as a legal obligation.

Continuous sample extraction offers many advantages over in-situ monitoring provided an appropriate interface for coupling analyzers to sources is available. Cascading several diluters reduces the ;oncentrations to the range of an .mbient air monitor and even permits olfactometry.

features

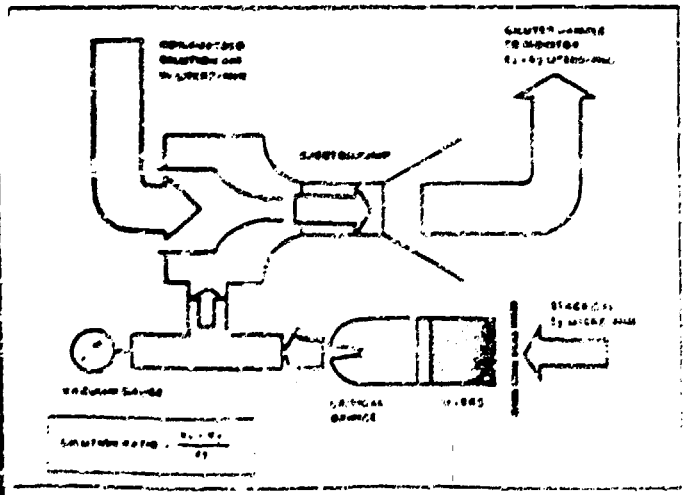
- the sample is diluted in the stack probe to a known adjustable proportion.
- quick dilution of the sample avoids reactions of the sample components.
- condensation in the unheated umbilical cord is avoided.
- ambient air monitors may be used for emission measurement.
- the system has no moving parts. The pump in the probe is of the ejector type.
- no additional heating is required.
- system is explosionproof as no electrical power is involved.
- small sample flow results in long expected utility of the coarse inlet filter, even at high levels of particulate matter in e.g. coal fired facilities.
- manual or optional automatic regenerating of coarse in-stack filter by back flushing.
- easy over-all dynamic calibration of sampling system including diluters.
- optional second diluter unit can be incorporated in the gas circuit so that even olfactometry is possible.

working principle

The stack gas is extracted continuously via a filter and a critical orifice by a newly developed small ejector pump (see fig. 1) which is mounted in the stack probe. The main air stream (pressurised air or nitrogen) with an adjustable flow of Q1 litres/min. creates a partial vacuum which is used to extract the sample via a critical orifice. The size of this critical orifice determines the sample flow at a value of Q2 litres/min.

The dilution ratio is $\frac{Q1 + Q2}{Q2}$

As flow Q1 may be set by the operator and the value of Q2 can be selected from a wide range of critical orifices, the dilution ratio can be set between 12:1 and 350:1.



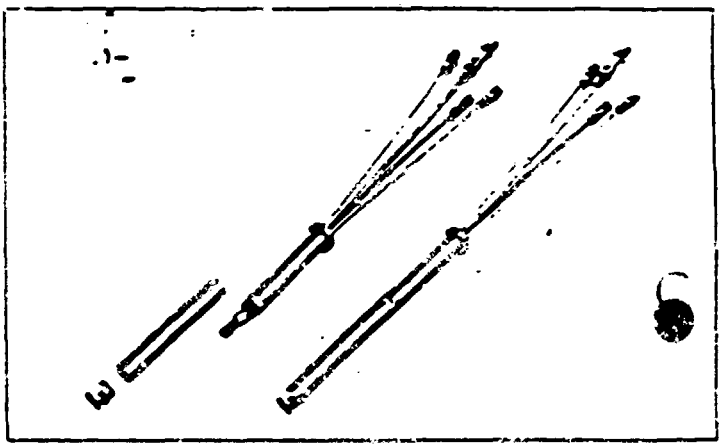
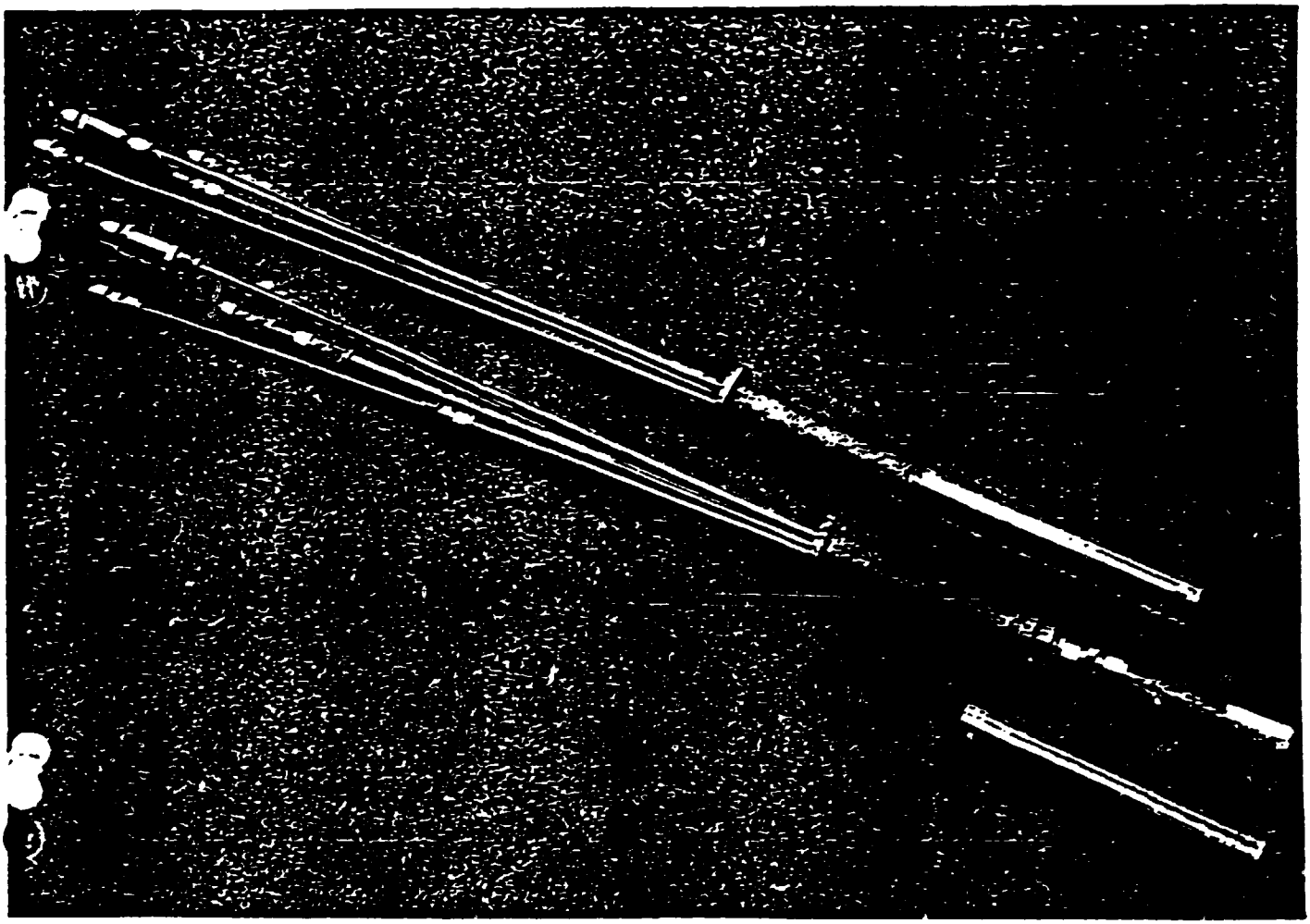


Fig. 2
Diluting stack probes 0797.302.
The left probe has been dismantled to show the critical orifice fine filter assembly.

stack probe

Figure 3 shows two cross sections of the probe. The outer mantle of the probe is made of inconel * a corrosion resistant nickle alloy, specially selected to withstand severe acid mist environment and high temperatures.
Between the ejector pump and this outer steel mantle a heat exchanger serves to pre-heat the dilution air before entering the pump so as to compensate for changes in dilution ratio at varying temperatures of the dilution air.
The second part of the probe consists of a corrosion resistant steel mantle which is screwed onto the ejector pump end.

model 797
diluting stack sampler



UPK GmbH
D-6350 Bad Nauheim
Hauptstraße 95
Postfach 1223
Bundesrepublik Deutschland

Telefon (0 60 32) 3 19 7*
Telex 4 15 535 upk d
Telegramme UMPRO

Vertreten durch:

Model 797
diluting stack sampler
technical specifications and ordering information

Model 17-0797.302 DILUTING STACK PROBE.
Special corrosion resistant nickle alloy tube.
Outer diameter 27 mm, total insertion length 310 mm.
Any blind standard flange can be adapted to fit the probe.
Max. allowable probe temperature: 400°C.
Exchangeable glass critical orifices (with fine filter) available for 6 sample flows (6 dilution ratio ranges).
The price for one orifice is included in the price of the probe.
The required orifice must be specified when ordering.
Critical orifices for sampling probe:

Nom. flow ml/min.	Dilution ratio min.	max.	glass orifice part no.
20	215:1	350:1	17-2126-064
50	95:1	150:1	17-2126.047
100	44:1	75:1	17-2126.044
150	32:1	50:1	17-2126.045
200	27:1	37:1	17-2126.046
250	20:1	30:1	17-2126.048
500	12:1	16:1	17-2126.049

Model 0797.430 MODULAR 19" MOUNT PANEL
with additional diluter. Max. dilution ratio 150:1 per diluter, adjustable by compressed air variation in combination with the selected critical orifice (see options 21 . . . 26, to be specified when ordering). The price for one critical orifice is included in the price of the additional diluter unit. More dilution steps in cascade are possible with the restriction that each step decreases the accuracy by 2%.
Accuracy per dilution step: 2%.
Panel height 222 mm (8¾" = 5 units). Compressed air requirements: 4 . . . 6 bar, consumption 3 . . . 8 l/min.
Critical orifices for additional diluter:

Nominal flow ml/min.	Dilution ratio min.	max.	Critical orifice part no.
20	215:1	350:1	17-2126.065
50	95:1	150:1	17-2126.050
100	44:1	75:1	17-2126.041
150	32:1	50:1	17-2126.042
200	27:1	37:1	17-82126.043
250	20:1	30:1	17-2126.051
500	12:1	16:1	17-2126.052

Four Function System reduces maintenance of both sampling system and analyzers

The 797 dry-air operated sample-conditioning probe performs all the necessary functions precisely to prepare the in-stack sample for transport and measurement. This sample is first filtered and metered to an exact volume by a critical orifice. The measured sample is diluted with the dry education air, reducing the relative humidity to a dew point below that of the ambient operating temperature. The In-Situ Conditioner is fabricated of Inconel 600 (Registered Trade Mark of The International Nickel Co., Inc.) for corrosion protection.

Sample transported without heat-traced lines

The metered, filtered, and diluted sample is transported under pressure through unheated sample lines to the selected analyzers for specific compound measurement. The diluted sample volume is approximately five liters or more – sufficient to meet the sample needs (simultaneously) for several analyzers, such as total sulfur, SO_2, NO, CO_2 and hydrocarbons. The umbilical cable connecting the sample unit to the analyzer contains four tubes ¼" OD. Two tubes are of Teflon (Registered Trade Mark of E.I. DuPont de Nemours & Co., Inc.) and two are of polyethylene. These tubes provide all the services for operation of the system. One tube brings dilution air to the probe and aspirates the samples through a filter and critical measuring orifice. A second tube returns the diluted sample to the analyzer. The third tube connects a tank of standard gas to the entrance of the probe for calibration as needed, and the fourth tube continuously monitors the vacuum of the aspirator.

Sample conditioner control unit automated

Operation of the Sample Conditioning Unit is by the use of compressed dry air. The necessary gauges, regulators, and switching sequences actuate each function automatically, allowing for control of dilution ratios and automatic standardization as required. Ranges up to 2,000 ppm (of the gas being measured) are normal with only the single critical orifice in the probe unit. Higher ranges are achieved with an additional dilution unit in series with the probe.

ENVICO ambient monitors in the system are designed specifically for low dew point air samples

Precision EPA Designated Envico Analyzers, especially designed to handle dilute air samples at atmospheric pressure on a continuous monitoring basis, complete the Envico Stack Gas Analyzer System. These analyzers have undergone extensive engineering, testing and field use for hundreds of instrument-operating-years to confirm the in-service data viability during gas analysis. Their reliability is further confirmed by field-performed Relative Accuracy Tests using EPA Method 6 in operating power plants.

UPK GmbH
D-6350 Bad Nauheim
Hauptstraße 95
Postfach 1223
Bundesrepublik Deutschland

Telefon (06032) 31971
Telex 415535 upk d
Telegramme UMPRO

Vertreten durch:

On the front end of this mantle a coarse filter is mounted.
Inside this part of the probe the critical orifice with a fine filter is mounted.
The critical orifice/fine filter part may be exchanged for other sample flows to obtain other dilution ratios (see ordering information). The CL/PA (Calibration Line/Purge Air) connection of the probe consists of a tube which ends in the front compartment (in which also the critical orifice is mounted) and which is used to supply the critical orifice inlet with calibration gas via the umbilical cord or to apply a purge air stream at a high flow rate to regenerate the coarse filter by back flushing.
The air stream blowing into the stack will remove particulate matter collected on the outside of the coarse filter.

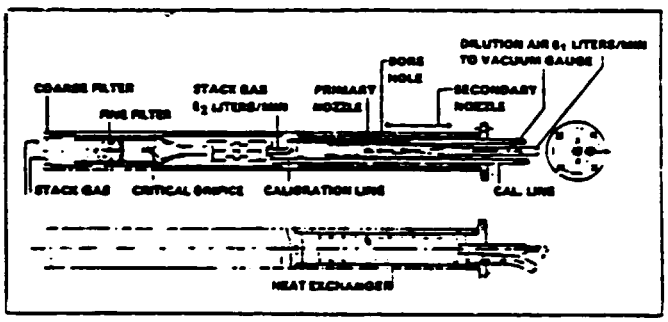
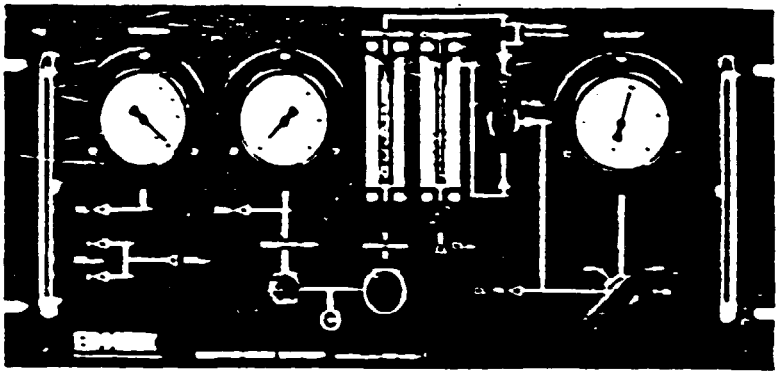


Fig. 3
2 cross sections of the stack probe.

umbilical cord

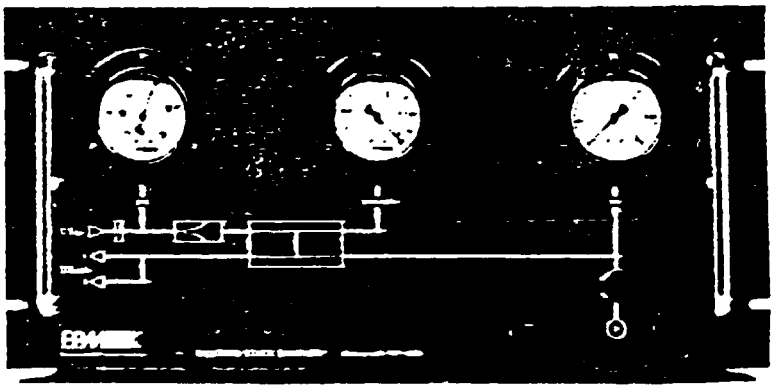
2 Teflon ⁴ ¼" O.D. lines for sample/ calibration gas transport and 2 propylene ¼" O.D. lines for pressurized air and vacuum gauge connection respectively in a plastic armoured cable form an integrated multiconductor assembly.

The cord is supplied in modular 5m, 10m and 20m lengths and permits operating distances up to 100m max. between the probe and the control unit. All interconnections are made with swagelok ⁴ couplings supplied with each cord.



control unit 17·0797.440

The modular 19" rack mount panel contains the diluting air reduction station with pressure gauge. The 'sample pressure' gauge monitors the pressure at the probe inlet whereas the 'vacuum' gauge indicates the partial vacuum in the ejector pump during operation.
All external connections are made with ¼" lines at the rear of the unit.
The flow circuit is indicated by white lines on the black enameled front.



diluter unit 17 0797.430

Modular 19" rack mount panel with additional diluter consisting of an ejector pump and a critical orifice. The maximum dilution ratio is 150:1 and is adjustable by varying the compressed air flow and by selecting a critical orifice out of the available range (see ordering information). Very high dilution ratios of more than 100.000:1 for e.g. odour measurement (olfactometry) may be achieved by cascading the diluter of the sampling probe and one or more units 0797.430. The accuracy is about 2% per diluting step

PURE AIR GENERATOR

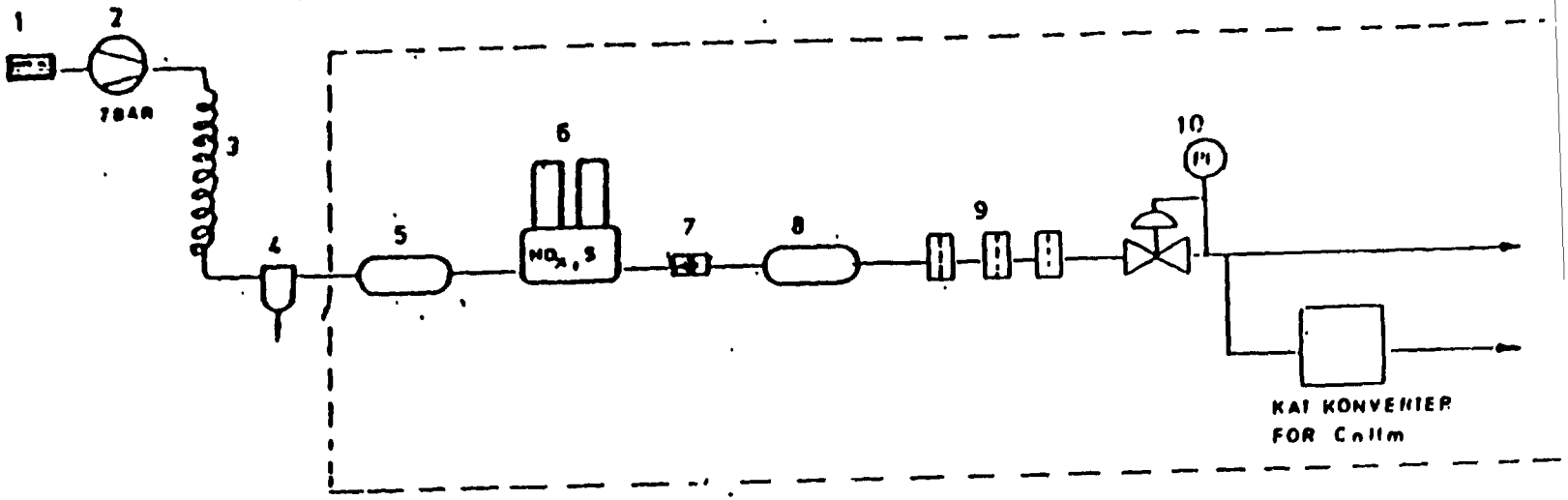
Max. gas flow:	16 l/min free of sulfur components, CO, O_3 and nitrogen oxide, 1 l/min free of hydrocarbons
Max. pressure:	5 - 6 bar
Power requirement:	220 V/50 Hz

The system consists of an oil free compressor with 80 l storage tank, a self regenerating drier, cartridges for oxidation NO to NO_2 and CO to CO_2 and adsorption of NO_2 and SO_2. In addition, a catalytic converter for destruction of hydrocarbons is contained.

The parts are mounted on a plate,
the compressor with 80 l storage tank separately.

Purity specification:

less than	0,2	ppb SO_2
	0,3	ppb NO_x
	1	ppb O_3
	100	ppb CO
	10	ppb Hydrocarbons

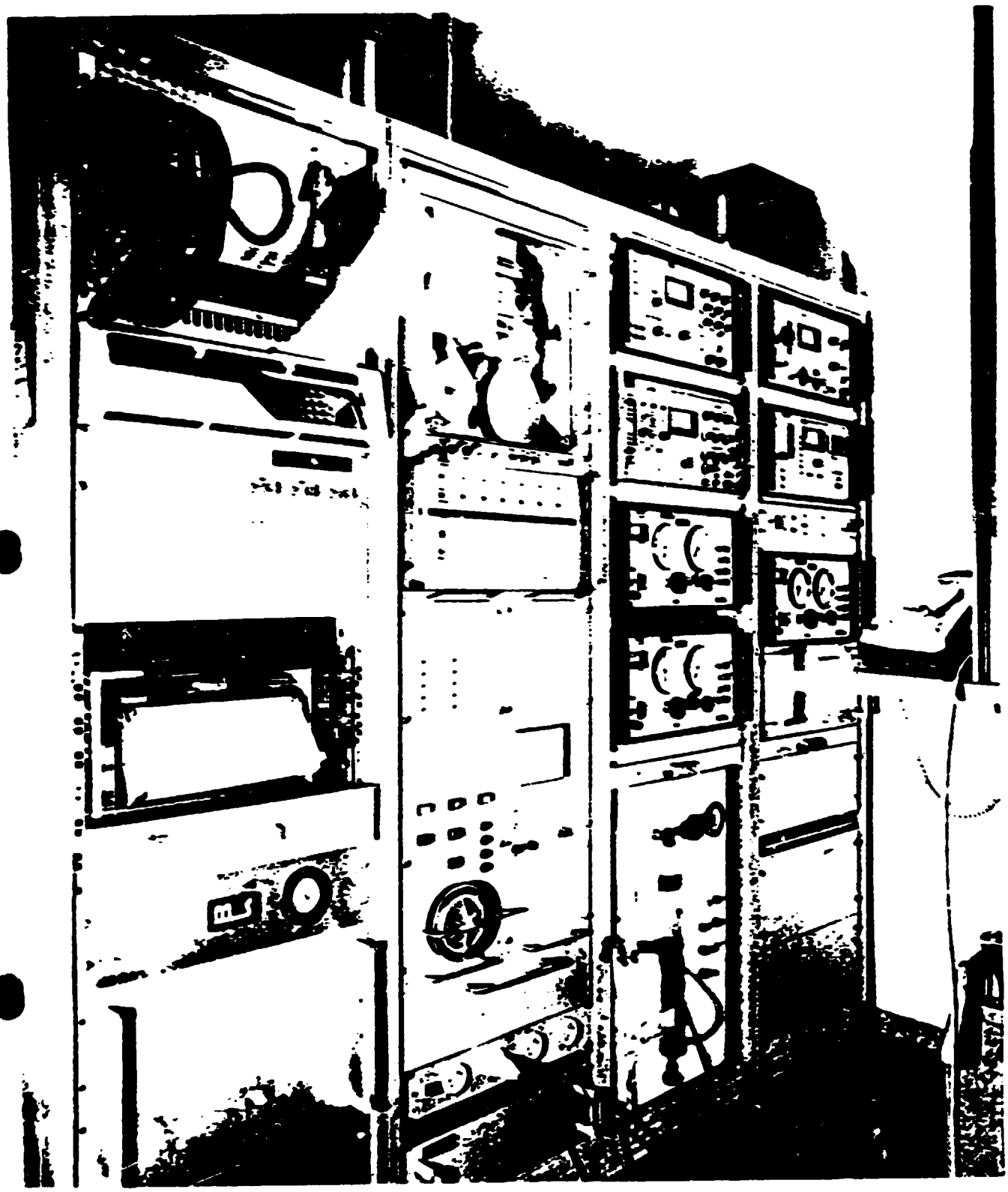


1. DUST FILTER
2. COMPRESSOR
3. COOLING COIL
4. AIR FILTER
5. SURGE TANK
6. DRIER
7. CHECK VALVE
8. AIR TANK
9. ADSORBER
10. PRESSURE REGULATOR WITH GAUGE

UPK Umwelt- und Prozeßkontroll GmbH
6350 Bad Nauheim

CENTRAL AIR SUPPLY UNIT MODEL NK 355

08 0355-4



HERSTELLER UPK UMWELT UND PROZESSKONTROLL GmbH, D-6350 BAD NAUHEIM, HAUPTSTR 95

LUFT-MESSSTATION MIT KALIBRIERSYSTEMEN UND DATENVERARBEITUNG

(GEMESSENE KOMPONENTEN SO_2, NO_x, NO, NO_2, O_3, CO, C_nH_m, CH_4, C_nH_m-CH, STAUB UND METEOROLOGIE)

(Ex)-version

The OXYGOR is available for the measurement of the O_2 content in hazardous areas, for the time being still under the type OXYGOR 2 in Ex-version for wall mounting. This instrument meets the requirements of VDE standards 0170/0171 for the classes (Ex)i, (Ex)e and (Ex)s G 3, and was tested by Berggewerkschaftliche Versuchsstrecke Dortmund-Derne (BVS-Certificate No. T 5382 of 8 September 1972).

The indicating current circuit of the instrument is intrinsically safe.

output signal: 0.1 . . . 1 mA
1 . . . 10 V into 10 kOhm

The following recorders may be used in accordance with the BVS Certificate for recording the measured values:

point recorder type NSK . . . (Ex)e
as per PTB No. III B/E-14652

point recorder type NSK . . . (Ex)i
as per PTB No. III B/E-162415

INSIST-recorder code No. 940433 . . . 1
as per PTB No. III B/E-14555

point recorder type ARUCOMP. / 4100 (Ex)
as per PTB No. III B/E-17442

point recorder type AR. . / . . .
as per PTB No. III B/E-14076

point recorder type AR. 144 . / . . .
as per PTB No. III B/E-15674

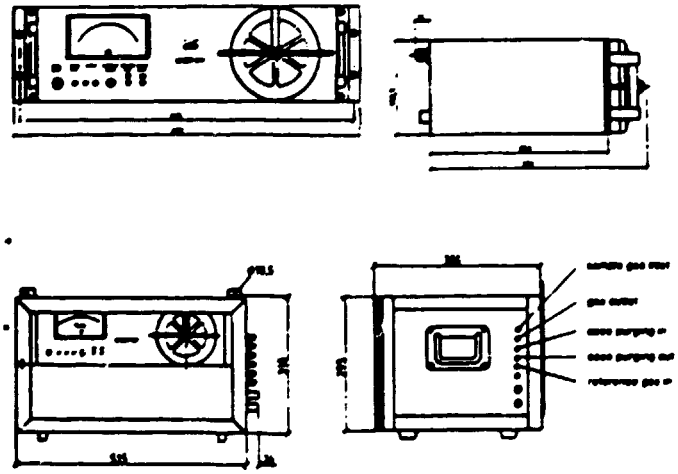


Fig. 2

Specifications OXYGOR 6 N

Standard measuring ranges:
from 0 . . . 2.0 % to 0 . . . 100 % O_2
also 18 . . . 21, 95 . . . 100 vol.% O_2

Special measuring ranges:
intermediate measuring ranges up to 100 vol.% upon enquiry
measuring span < 2 vol.% O_2,
such as 0 . . . 0.5 vol.%, 0 . . . 1 vol.% O_2
20 . . . 21 vol.% or 99 . . . 100 vol.% O_2
smallest measuring span 1000 ppm O_2
such as 21 % ± 500 ppm

Range switching:
electrical max. 1 : 5

Power supply: 110, 127, 220, 240 V ± 15 %
48 . . . 62 Hz
other voltages upon enquiry

Consumption: 40 (130) VA

Output signal: 0, 2, 4 . . . 20 mA, max. load 600 Ohm

Error limit: ≤ ± 2 % of measuring span

Temperature compensation wethin range:
273 K – 313 K ≙ 0 . . . 40° C

Sample gas flow:
20 – 120 l/h

Sample gas inlet pressure:
max. 1 bar
min. 0.2 bar

Reference gas:
depending on measuring range and service CO_2, N_2, O_2, compressed air from steel cylinder or atmospheric air through built-in diaphragm pump with pressure regulator

Reference gas flow:
0.6 l/h ± 5 %

Reference gas inlet pressure:
1 bar

90 % time: < 10 sec.

Warm-up time: about 1 h

Protection: OXYGOR 6 N: IP 53, on request IP 55

Dimensions: refer to outline drawing, fig. 2

Weight: about 12 kg for rack mounting
about 20 kg with wall-mounting case

Subject to technical modifications

UPK GmbH
D-6350 Bad Nauheim
Hauptstraße 95
Postfach 1223

Telefon (06032) 31971
Telex 415535 upk d
Telegramme UMPRO

Vertreten durch:

Technical design

The OXYGOR 6 N is arranged for panel mounting (19" rack or panel cut-out 131 x 447 mm, refer to dimensional drawing). The instrument can also be supplied in a case for wall mounting or as portable type (protection IP 53; on request IP 55).

The front plate of the OXYGOR 6 N is provided with an indicating meter, illuminated power button and, if these options are installed, switch for range changing, light-emitting diodes for threshold values and fault signal for sample gas failure. The front plate is furthermore equipped with a fine-dust inspection filter.

Power supply connection, signal outputs (20 mA / 600 Ohm load-independent current), sample and reference gas inlets and outlets are arranged at the rear side of the instrument.

The electronics and the analyser itself inside the OXYGOR 6 N are separated from each other. The front section of the instrument houses a large integrated printboard with the individual function modules, such as amplifier, range changing, threshold value, power supply section, and heater control. The analyser is thermally insulated and thermostat-controlled to 60° C, mounted on vibration-damping elements.

The instrument can be quipped with the following optionals:

Gas pumps

If the sample gas is not available with the necessary inlet pressure between 0.2 bar and 1 bar, a sample gas pump can be installed in the instrument.

If atmospheric air is used as reference gas, such as for measuring ranges 0–21 % O_2 or 10–21 % O_2, a second diaphragm gas pump can be installed in the instrument.

Fault monitor

This unit monitors the power supply and the sample gas flow to signal failure of the pump or blocking of the sample gas line. The threshold is set to 10 l/h, can however be adjusted to any value between 5 and 100 l/h as required. The contact is potential-free.

Range switching

The OXYGOR 6 N can be equipped with 2 measuring ranges, max. ratio 1 : 5. A potential-free contact is available.

Digital display

The OXYGOR 6 N can be equipped with a digital instrument in the place of the indicating meter.

Threshold switch

The instrument can be equipped with 2 threshold value contacts. These can be adjusted over the full measuring range. Rating 48 VA (max. 48 V, max. 2 A).

Remote transmission of measured values

Point recorders, self-balancing recorders, indicating instruments, or controllers can be connected to the signal output. Several indicating and recording units can be connected in series since the OXYGOR output signal is a load-independent current.

Installation

For installation purposes it is advisable to have the OXYGOR arranged on an assembly plate or in a 19" cabinet together with the accessories, such as flowmeter Str 04, steel cylinder with reference gas and change cock Us 01 for sample gas, test gas and zero gas.

The material for the gas sampling and conditioning system depends on the particular application. The measurement of O_2 in stack gas usually requires the following parts:

gas sampling sleeve Ga 51,
gas sampling tube with ceramic filter Ga 53.

Frequently it is necessary to use a gas cooler in order to avoid condensate inside the analyser. The electric sample gas cooler Fi 57 A with automatic condensate drain can be provided for this purpose.

Monoflex tubing Le 29 is used as sample gas line. This consists of an elastic, non-aging and acid-resistant plastic with dimensions 3.5 x 9 mm dia. This tubing should be run in a metal conduit for mechanical protection.

The correct performance of the measuring system depends decisively on appropriate gas sampling devices and filters for conditioning the sample gas in accordance with the particular requirements and operating conditions. If the operating conditions are specified, we shall be glad to submit appropriate proposals.

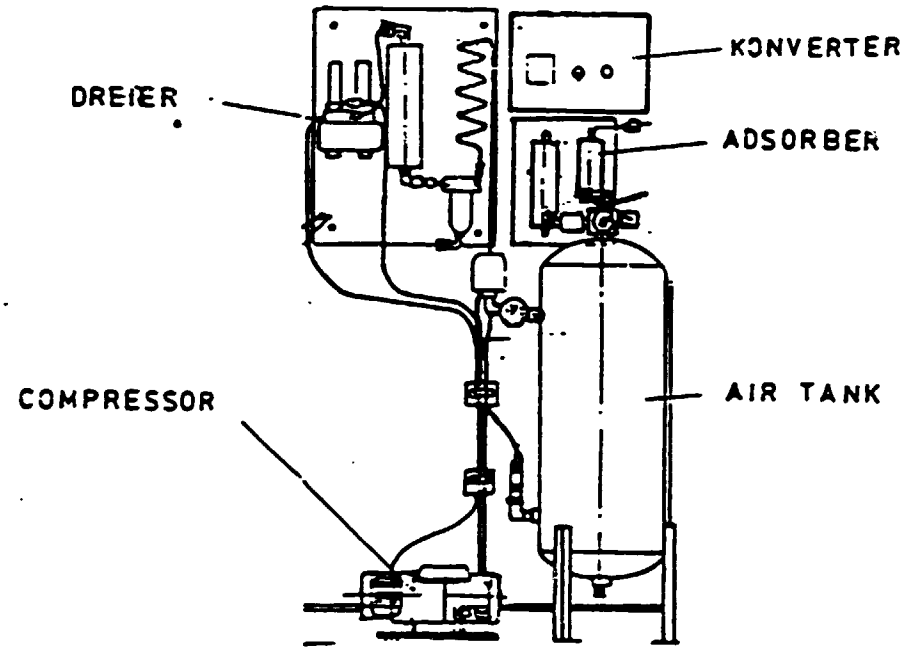
UPK Umwelt- und Prozeßkontrolle GmbH Postfach 1223 D-6350 Bad Nauheim

UPK

Seite

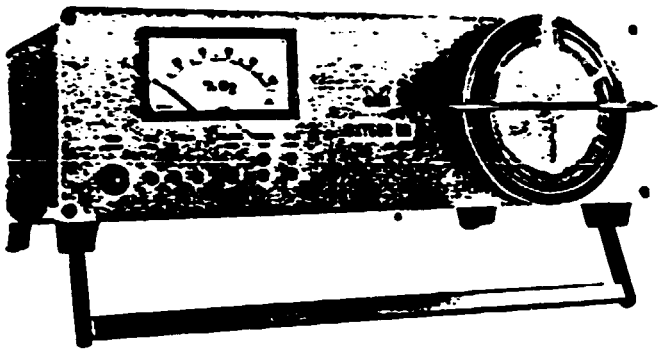
CENTRAL AIR SUPPLY UNIT

MODEL NK 355



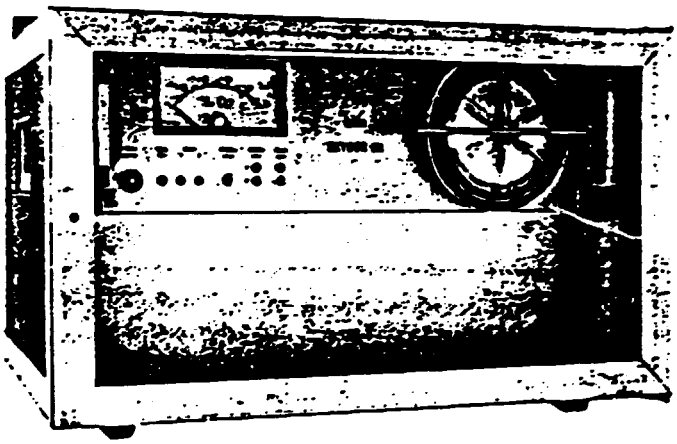
OXYGOR 6 N

Paramagnetic Oxygen Analyser

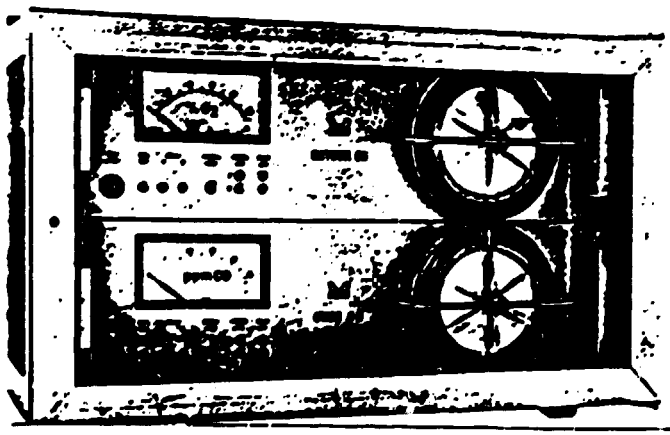


as laboratory unit
in a desk-top case

as plant control unit
in a wall-mounting case



as dual component unit
in a wall-mounting case



in 19" rack
for the measurement of

O_2 in gases and vapour
in the ppm and % range

UPK GmbH
D-6350 Bad Nauheim
Hauptstraße 95
Postfach 1223

Telefon (0 60 32) 3 19 71
Telex 4 15 535 upk d
Telegramme UMPRO

Vertreten durch:

The OXYGOR

is a gas analyser for the measurement of the oxygen content in air or other gases, suitable for many measuring problems, including the determination of the oxygen concentration in stack or exhaust gases of:

boiler firings
industrial furnaces
incinerator systems
internal combustion engines

and for the monitoring of:
protective gas
atmospheric air
fermentation processes
purity of oxygen
research work.

Measuring principle

The principle of measurement of the OXYGOR is based on the paramagnetic properties of the oxygen molecules, by which oxygen is distinguished from other common gases. O_2 molecules have a relatively strong permanent-magnetic moment. Therefore, in an inhomogeneous magnetic field, a force acts on the oxygen molecules in the direction of increasing field strengths. Since the magnetic field acts on each individual oxygen molecule, the force acting on the total gas increases with the volumetric concentration of oxygen. This force can be used for generating a selective effect of measurement.

Unlike the thermo-magnetic measuring instruments, the OXYGOR operates on the principle of the pure pressure effect between two gases of different magnetic susceptibility; consequently, the readings are substantially independent of the non-magnetic properties of the other sample gas components, such as thermal conductivity, thermal capacity, viscosity etc.

The measuring system, schematically shown in figure 1, consists of the two flow channels 1 and 2, each equipped with a thermo-sensor comprising a pair of measuring filaments 3–4 and 5–6 in a Wheatstone bridge. A constant voltage source is used as supply for the bridge circuit and heats the filaments to a certain temperature.

Reference gas, which may be CO_2, atmospheric air, N_2 or O_2, depending on the measuring application, is admitted at a constant rate and flows through the channels 1 and opposite ports into the measuring channel where it mixes with the sample gas, and leaves the measuring system. One of the two ports is arranged in the inhomogeneous field of a strong magnet.

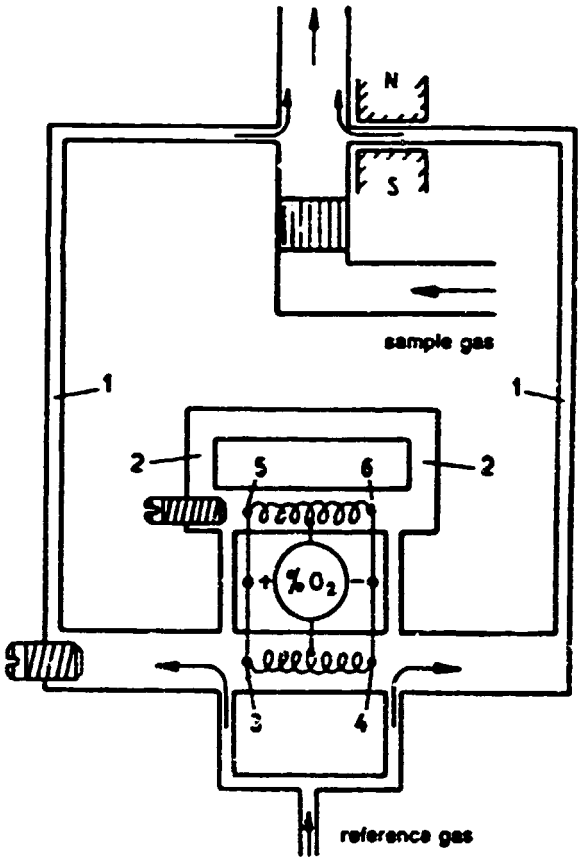


Fig. 1
functional diagram

The flow restrictions of the two channels 1 are balanced so that the gas flow in the measuring system is symmetrical if sample gas and reference gas have the same magnetic susceptibility.

The presence of oxygen in the sample gas causes a back-pressure at the outlet port of the reference gas in the magnetic field, since the oxygen tends to enter into the magnetic field due to its paramagnetic behaviour.

This results in a pressure difference between the two outlet ports and consequently a cross flow of the reference gas across the thermo-sensor 3–4, which causes different cooling of the two halves of the filament. The resultant change in resistance unbalances the bridge, producing a bridge signal which is proportional to the oxygen content of the sample gas.

The effect of any changes in the bridge resistance that may be caused by convection flow due to the position of the instrument is compensated by a filament 5–6 in the flow channel 2.

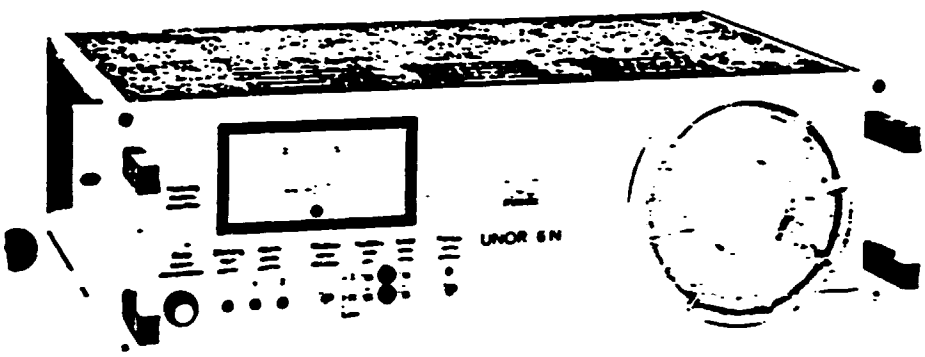
The instrument is highly independent of changes in viscosity, temperature, and density of the sample gas.

NDIR Gas Analyser

for CO, CO_2, SO_2, NO, CH_4, NH_3 and 60 other components

UNOR 6N

21.004 E/84 :2



UNOR 6N

- TÜV suitability-tested for SO_2, CO, NO/NO_2
- certified by German Department of the Interior in accordance with the Large Boiler Clean Air Regulations – 13. BImSchV
- tested for shock-proofness
- officially tested for use in shelters
- high measuring sensitivity
- measuring ranges from 20 ppm to 100 vol. %
- high selectivity – lowest cross response and interference gas influence
- excellent zero point stability
- high stability of sensitivity
- minimum of maintenance → high availability
- easy to operate
- low influence of ambient temperature
- 19"-3 PU slide-in chassis
- plug-in electronics printboard
- compact, fault-free CMOS electronics
- easy adaptation to other measuring ranges

Options

2 measuring ranges
external range switching
digital display
BCD-code data output
galvanically isolated analog output
linearisation
alarm limit value contacts
inbuilt sample gas pump
barometric pressure compensation of measured value
wall-mounting case IP 55
case protection (Ex)p
corrosion-resistant analyser version

Introduction

Automatic monitoring of gases in industry, measurement of stack gas concentration and particularly control of chemical processes can be achieved only by analysers which give the concentration of certain components with high accuracy continuously and rapidly.

Proven in operating practice are analysers for the photometrical determination of the integral radiation absorption at specific wavelength. These so-called non-dispersive infra-red absorption (NDIR) photometer are characterised by high measuring sensitivity and selectivity for detecting the concentration of one certain gas component.

Application

With its proven design principle, excellent measuring performance and continuous rapid indication, the UNOR 6N is a reliable measuring instrument for the determination of gas concentrations.

The UNOR 6N with its electric DC and voltage signal can be used as concentration indicator and also as control signal transmitter for the control of gas concentrations and mixtures.

Typical applications are:

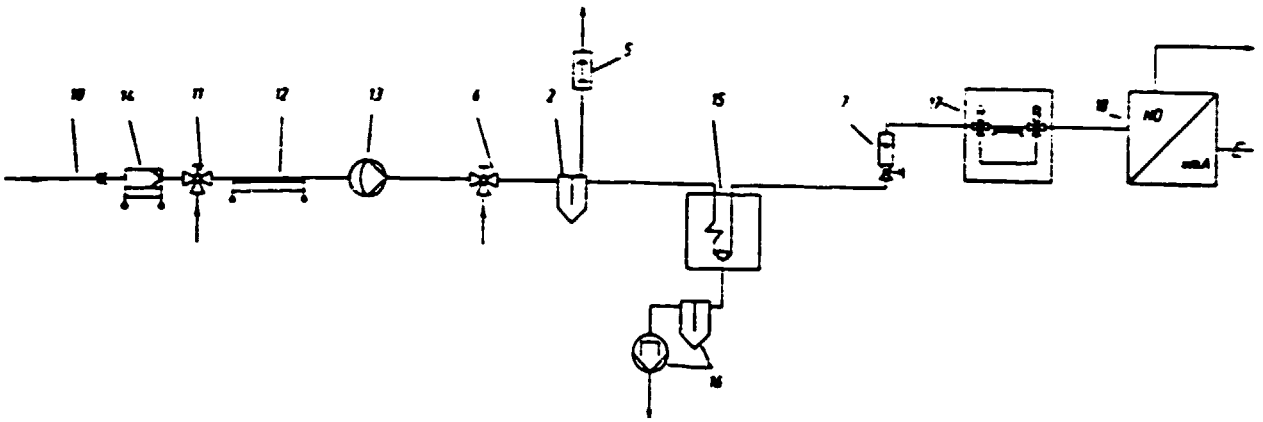
- process gas control in chemical plants.
- emission measurement on boiler stacks (Clean Air Regulations, 13. BImSchV): the instrument is TÜV-tested and officially approved
- air pollution measurement and clean air control,
- exhaust gas measurement on motor vehicles, engine and motor car test stands,
- monitoring of room atmosphere for tolerable limit values,
- measurement and control of blast furnace and converter gases,
- measurement and control of biological processes,
- monitoring of green house and fruit storage atmosphere,
- control of protective gas of kilns,
- measurement of natural gas, sewer gas, refuse pile gases and sewage treatment plants,
- monitoring of car parks, road tunnels and civil protection shelter; the instrument is shock-tested and officially aproved.

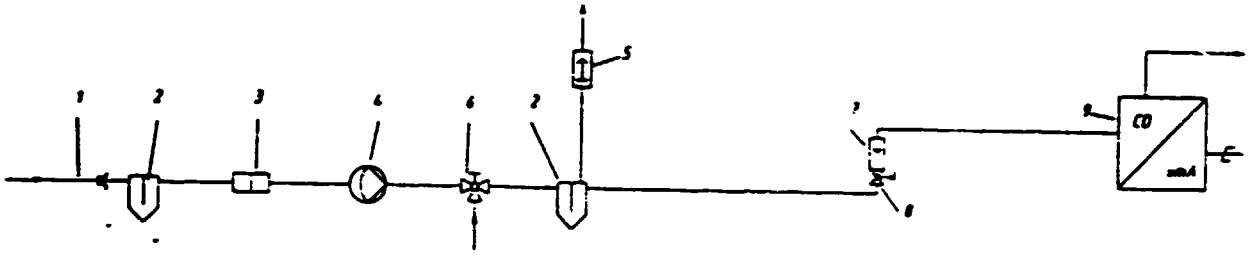
UPK GmbH
D-6350 Bad Nauheim
Hauptstraße 95
Postfach 1223
Bundesrepublik Deutschland

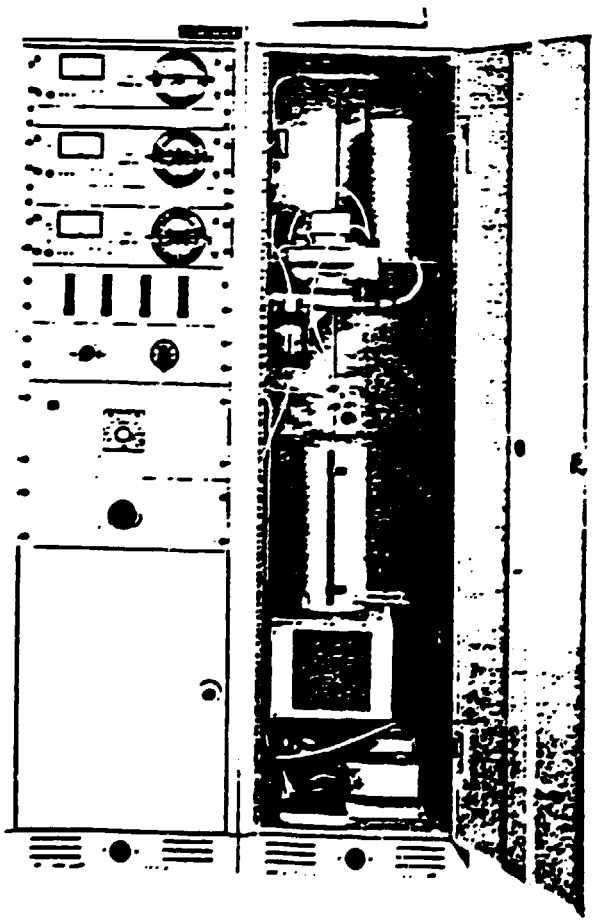
Telefon (06032) 31971
Telex 415535 upk d
Telegramme UMPRO

Vertreten durch:

Examples: gas sampling and conditioning







1 gas sampling probe
2 condensate separator
3 dust filter
4 sample gas pump
5 bypass overflow valve
6 switch cock for connecting test gas, manual or in connection with an automatic calibration unit
7 flow indicator
8 flow needle valve
9 CO-NDIR photometer UNOR 6N
10 gas sampling probe with protective tube
11 switch cock for connecting test gas (system calibration)
12 heated sample gas line
13 PTFE sample gas pump
14 heated coarse filter on probe
15 compressor-type sample gas cooler (PTFE gas lines)
16 condensate drain pump
17 $NO_2 \rightarrow NO$ converter
18 NO-NDIR photometer UNOR 6N

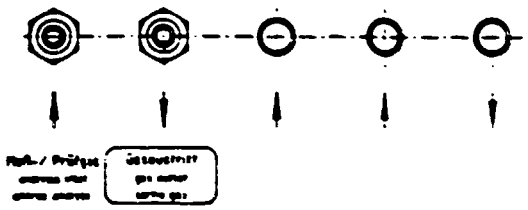
Measuring system for a refuse incinerator plant

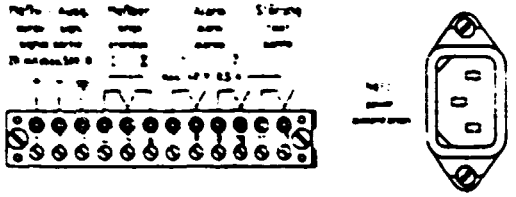
UPK GmbH
D-6350 Bad Nauheim
Hauptstraße 95
Postfach 1223
Bundesrepublik Deutschland

Telefon (06032) 31971
Telex 415335 upk d
Telegramme UMPRO

Vertreten durch:

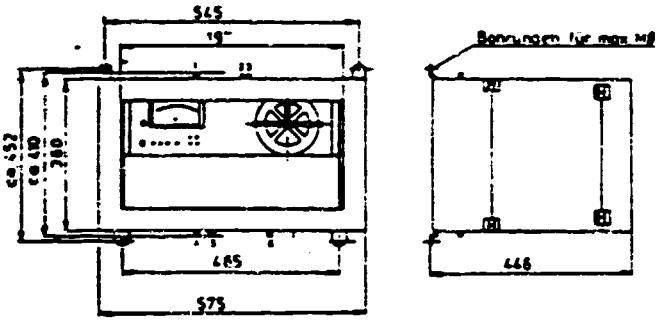
Connections





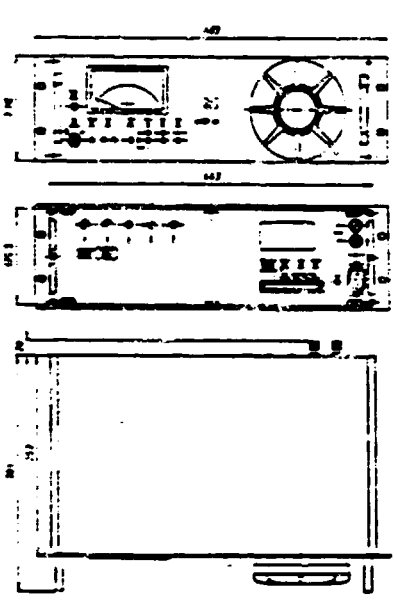
Dimensions wall-mounting case

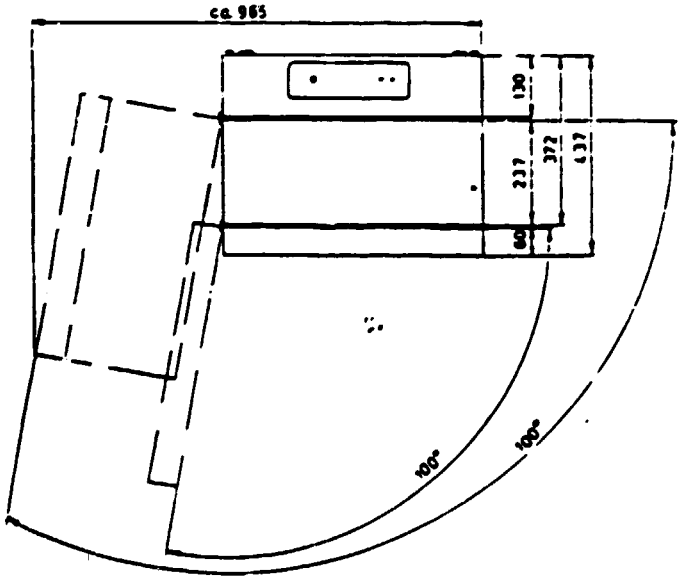
1. Austritt Spülgas, outlet purging gas, sortie gaz balayage (Ø15)
2. Gasaustritt, gas outlet, sortie gaz (Ø8)
3. Gaseintritt, gas inlet, entrée gaz (Ø8)



4. Netz 220V/50 Hz, power, alimentation (PG 13,5)
5. Meßwertausgang, output signal, signal sortie (PG 13,5)
6. Eintritt-Spülgas, inlet purging gas, entrée gaz balayage (Ø6)

Dimensions 19" chassis





UPK GmbH
D-6350 Bad Nauheim
Hauptstraße 95
Postfach 1223
Bundesrepublik Deutschland

Telefon (0 60 32) 3 19 71
Telex 4 15 535 upk d
Telegramme UMPRO

Vertreten durch:

Description

The UNOR 6N is arranged in a 19"-3 PU slide-in chassis for direct installation in 19" cabinets and racks. For wall mounting, this slide-in chassis is placed in an IP 55 case.

Electronic section and thermostat-controlled analyser are separated by a modular design. The analyser consisting of detector and HF-section, measuring cuvette and modulation unit, is mounted in the rear area connected by short hoses to the gas inlet and outlet connectors on the rear wall. An optional fault monitor checks the sample gas flow in the gas outlet and gives a fault state signal in case of flow below the set value.

The front part, behind the front plate, is provided with the large integrated plug-in electronics printboard with all the electronic components and controls. This space also houses the power mains transformer and any inbuilt sample gas pump.

Arranged on the front plate of the UNOR 6N are the measurement indication, either as analog meter or 3½ digit LED digital display,
the power switch,
the range switch,
the pump switch,
the LEDs for alarm 1, alarm 2, fault and the potentiometers for zero and sensitivity setting
for both measuring ranges.
A pilot lamp shows the correct function of the thermostat-control of the analyser.
A large-surface fine dust filter on the right side of the instrument front plate protects the analyser from sample gas dust.

In addition, two safety glass filters are installed in the inlet and outlet of the analyser cuvette.

The rear side of the instrument is provided with the gas connections, mains plug connector, power fuses, and terminal strip for electrical connections of measurement output, operating mode/measuring range, fault state signal/flow and power failure, limit value alarm contacts 1 and 2. Also external range switching control can be connected.

The UNOR 6N is built and tested in accordance with DIN 57411, part 1/VDE 0411, part 1 "Protective measures for electronic measuring instruments".

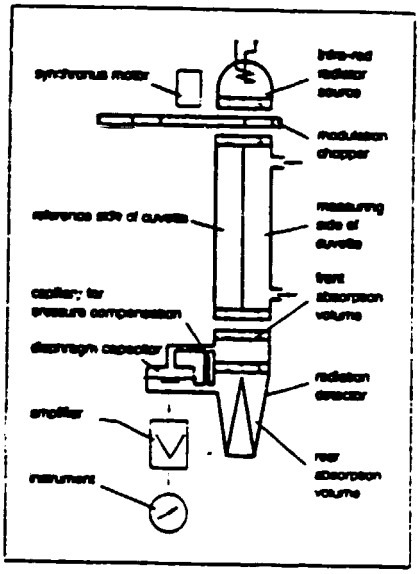
Principle of measurement

The UNOR gas analyser is an infra-red photometer operating on the single-beam principle with phase-opposed radiation modulation. This non-dispersive analysis method without spectral resolution uses the actual gas component to be measured for achieving selectivity.

The measuring component is therefore enclosed in the radiation detector which consists of two optical absorption layers in series, pneumatically separated by a window. The rear volume having a greater layer thickness, its wavelength-dependent absorption lines (fine structure of bands) have a larger half-value breadth than that of the front volume. Therefore the front volume mainly absorbs the energy of the centre of each absorption line, while the rear volume absorbs the remaining energy of the flancs.

The detector is dimensioned so that both portions of energy are equal, resulting in equal amplitude pressure pulses due to heating of the gas volumina.

Should the measuring side of the cuvette (having a length adapted to the measuring range) contain some of the component to be measured, infra-red radiation of the line centres is pre-absorbed so that



mainly the pressure pulses of the front volume are reduced. The pressure equilibrium is unbalanced and the resulting pressure pulses are applied through capillaries to a differential-type diaphragm-capacitor for being converted into variations of capacitance. Since a modulated radiation difference between line centre and flanks at the specific wavelength occurs only in the case of selective pre-absorption in the measuring side of the cuvette, the pressure pulse signal generated becomes the true measuring signal and the forming of the difference between high pressure pulses is avoided. This features ensures a high measuring accuracy and stable calibration curve.

The combination of optical and pneumatical signal compensation guarantees a very stable zero point, a high resolution and selectivity of the single-beam photometer.

Depending on the constellation of the single lines, interfering gas components with absorption bands overlapping with the bands of the measuring component would proportionately influence the absorption of the front and of the rear detector layer. The resulting cross-sensitivity values are positive and negative and, on the average largely compensated.

A high selectivity is obtained because non-selective attenuation of radiation by condensate films on the inside surface and windows of the cuvettes would not generate a measuring signal. This selectivity can be improved even further by the use of optical interference filters in the radiation path of the photometer to eliminate the influence of interference gases.

An electronic phase-controlled AC amplifier converts the changes in capacitance of the detector capacitor into a concentration-proportional DC signal which is indicated on the meter of the instrument and available as 20 mA output signal.

APPENDIX D

PROCEDURES USING HPLC FOR THE ANALYSIS OF TRACE ORGANICS IN ENVIRONMENTAL SAMPLES

D1. Analytical Procedure

The procedure for the determination of trace organic materials in environmental samples can be broadly split into three separate stages:

(i) Sample extraction/concentration.
(ii) Preliminary fractionation/clean up (if necessary).
(iii) Chromatographic separation/detection and quantification.

D1.1 Sample Extraction/Concentration

PAH's in gases are normally adsorbed on particulate material which is collected onto glass fibre filters or polyurethane foam. Regardless of the collection medium the extraction stage requires the continuous solvent washing afforded by soxhlet extraction - a standard reference method. The American Society for Testing and Materials (ASTM) recommends 5-6 hours Soxhlet extraction of air particulates with benzene. The US EPA manual for Environmental Assessment specifies a 24-hour soxhlet extraction using dichloromethane solvent for the determination of organics in solid and particulate process stream effluents.

PAH's are soluble in many solvents, the extraction efficiencies depend very much on the nature of the material being extracted. Benzene and cyclohexane are believed to be almost 100% efficient for Benzo(a)pyrene. However, since cyclohexane extracts fewer uncharacterised materials than benzene, and is itself less hazardous it has been endorsed by official bodies such as WHO[D1]. Thermal degradation of sample in the soxhlet is possible and solvents with lower boiling points such as dichloromethane have been suggested[D2].

A recommended method of extraction is a 24-hour soxhlet with dichloromethane in a fume cupboard with shielding to exclude UV light - UV possibly causes PAH degradation. It is suggested that a heavy inert gas such as argon be used to flush apparatus thus reducing the possibility of oxidation. Any materials likely to cause contamination should be prewashed with solvent e.g. filters, thimbles etc.

Concentration of the crude extract is necessary after soxhlet extraction. Two possible ways are:

(i) The use of a Kudurna Danish evaporator. The evaporator is a pear shaped piece of glassware open at both ends (with ground glass joints). One end is connected to a graduated test tube and the other to a Snyder fractionating column. The crude sample is immersed in a warm water bath, the solvent boils and evaporates slowly without the loss of volatile extracted components because of the Snyder column protection.

(ii) Rotary Evaporation. Care must be taken to ensure that temperatures are kept to a minimum when using rotary evaporation. The concentration stage results in a crude concentrate of 1-2 mls. It has been found that using a HPLC with a programmable fluorescence detector that there is not enough selectivity, therefore further clean up is required.

D1.2 Fractionation/Clean Up

The basic principle of most clean up techyniques is to use chromatographic principles to separate the components of a complex mixture and 'cut out' those of interest. A simple approach is to use a silica adsorption column or cartridge and elute the crude sample through it with a non polar mobile phase such as hexane. All low polarity components, including PAH's, are eluted and those components with a high polarity remain adsorbed in the silica. The hexane eluent is evaporated by 'nitrogen blow down' to obtain a clean concentrated extract of PAH's. This method has produced limited success.

A preferred method is to use a semi preparatory HPLC column to separate the crude extract and collect the fraction containing the PAH's of interest.

The column used for this has been successfully applied[D3,D4] to air particulate extracts prior to completion of the analysis by both HPLC and GC/MS.

D1.3 Analytical Separation and Measurement

Reversed phase HPLC using C-18 as octadecyl silane (ODS) bonded phases has been used for a number of years to separate PAH's for analytical measurement. In recent years specialist proprietary stationary phases and columns have been made available which separate all 16 PAH EPA priority pollutants with base line resolution on a single chromatographic run of less than 20 minutes. This is usually achieved by using a binary gradient solvent delivery with acetonitrile and water mixtures or alternatively with water and methanol mixes.

D2. REFERENCES

D1. Bartle, K.D. et al. Chem. Soc. Rev., 1981, 10-119.

D2. Bjoseth, A. Ed. Handbook of Polycyclic Aromatic Hydrocarbons. marcel Dekker Inc, New York, 1983, pp 100.

D3. Wise, S.A. et al. Anal. Chem., 1986, 56, 225-232.

D4. May, W.E. and Wise, S.A. Chem. Soc. Rev., 1981, 10, 119.