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to Test

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Corrosion
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PAGE 12
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SYSTEMS

FIELD

LAB

INSTRUMENTS

MACHINES

to Monitor

to Screen

to Study

to Perform

Corrosion Inhibitors
Scale Inhibitors
Biocides

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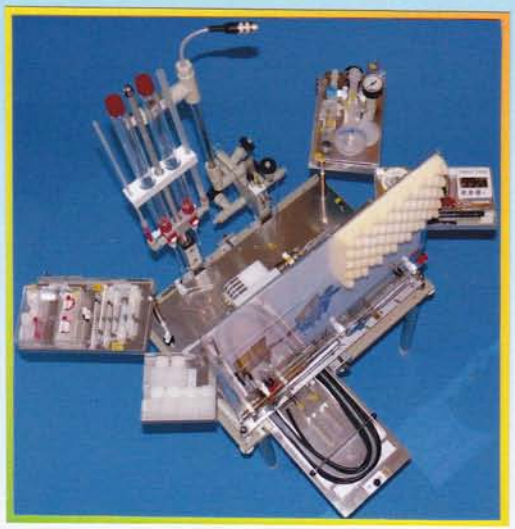
Microbial Surveys and On-Site Water Analyses

PAGE 4+7



to Select

Demulsifiers for Crude Oil Dehydration

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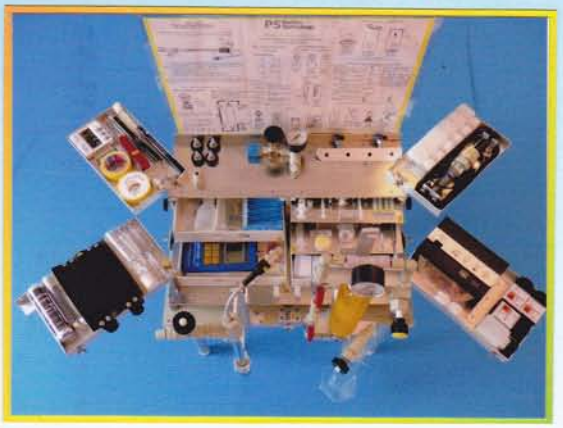

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PS Biofilm

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-ITEM#777 – PAGE 23 – MEMBRANE FILTRATION UNIT ADAPTED TO ITEMS#766+771+776+791 WITH ADDITIONAL FLOW METER + 2 ADDITIONAL CHEM. INJ. POINTS – IN AN ADDITIONAL CARRYING CASE
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-ITEM#706 – PAGE 18 – CONFECTIONED TYGON PUMP HOSES ID=0.51 MM TO INJECT CHEMICALS
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-ITEM#736 – PAGE 19+39 – SCALING TUBE SSA4-316Ti – L=32.5 CM/OD=8 MM/ID=6.49 MM
-ITEM#675 – PAGE 19+39 – HIGH PERFORMANCE HEATING ELEMENT – NiCrNi SENSOR in JACKET MIDDLE – 440 W – ¼"X4" – 110 or 220 V
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(to order arrays or probes, please consult pages 31+32+33)

SERIES 800 – Flow Loops – PAGE 24

-ITEM#803 – PAGE 24 – BYPASS BIOFILM+CORROSION+TREATMENT FLOWLOOP – PP/PTFE – 65°C/2.7 BAR (40 PSI) – 3 LITER – 9 L/MIN (3 M/S ≅ 10 ft/sec) – 5 FLOW UNITS WITHOUT ARRAYS OR PROBES – 110 or 220 V
-ITEM#804 – PAGE 24 – BYPASS BIOFILM+CORROSION+TREATMENT FLOWLOOP – PVDF/PFA – 90°C/3.4 BAR (50 PSI) – 3 LITER – 9 L/MIN (3 M/S ≅ 10 ft/sec) – 5 FLOW UNITS WITHOUT ARRAYS OR PROBES – 110 or 220 V
-ITEM#805 – PAGE 25+27 – COMBINATION BYPASS BIOFILM+CORROSION+TREATMENT FLOWLOOP WITH POROUS MEDIA ASSEMBLY-3 - PP/PTFE – 65°C/2.7 BAR (40 PSI) – 3 LITER – 9 L/MIN (3 M/S≅10 ft/sec) – 5 FLOW UNITS WITHOUT ARRAYS OR PROBES – 110 or 220 V
-ITEM#806 – PAGE 25+26+27 – COMBINATION BYPASS BIOFILM+CORROSION+TREATMENT FLOWLOOP WITH POROUS MEDIA ASSEMBLY-3 – PVDF/PFA – 90°C/3.4 BAR (50 PSI) – 3 LITER – 9 L/MIN (3 M/S≅10 ft/sec) – 5 FLOW UNITS WITHOUT ARRAYS OR PROBES – 110 or 220 V

(5-6 Liter capacity FlowLoops available upon request)

-ITEM#421.LP – PAGE 27+36 – LP POROUS MEDIA PACK EMPTY - PTFE JACKET+SCREENS 250+32 µM
-ITEM#551.LP – PAGE 27+32 – LP BIOFILM ARRAY 18 CS COUPONS 2 CM^2
-ITEM#552.LP – PAGE 27+32 – LP BIOFILM ARRAY 20 CS COUPONS 2 CM^2
-ITEM#866.LP – PAGE 27+31 – LP GRAVIMETRIC CORROSION ARRAY 6 CS COUPONS 8 CM^2 - SPACER 1.5 MM
-ITEM#867.LP – PAGE 27+31 – LP GRAVIMETRIC CORROSION ARRAY 5 CS COUPONS 8 CM^2 - SPACER 5 MM
-ITEM#131.LP – PAGE 27+33 - LP PENCELL LPR PROBE 3 CS ELEMENTS 8 CM^2
-ITEM#135.LP – PAGE 27+33 – LP PENCELL ER PROBE 2 CS ELEMENTS 12 CM^2 – E1:BLANK – E2:ECTFE COATED

SERIES 1000 – Demulsifier Testing Equipment – PAGE 28

-ITEM#1002 – PAGE 28 – DEMULSIFIER TESTING EQUIPMENT COMPLETE
-ITEM#1052 – PAGE 29 – SHAKING RACK WITH 6X CONICAL 100 ML DEMULSIFIER TUBES WITH CAP

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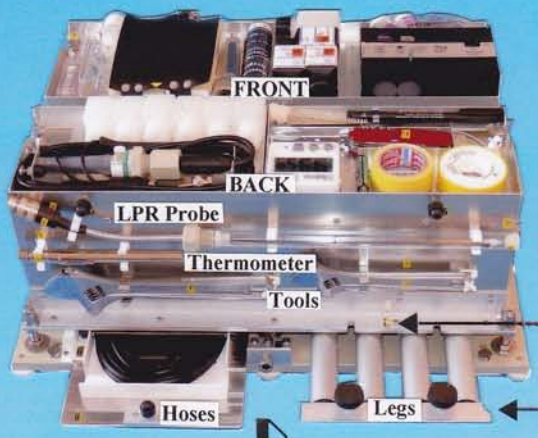
-ITEM#01 – PAGE 30 – FLOW UNIT STAND
-ITEM#10.LP – PAGE 30 – LP FLOW UNIT WITHOUT STAND, ARRAYS OR PROBES
-ITEM#10.HP – PAGE 31 – HP FLOW UNIT WITHOUT STAND, ARRAYS OR PROBES
-ITEM#20 – PAGE 34 – MEMBRANE FILTRATION UNIT WITH STAND – MATERIAL PP/GLASS
-ITEM#22 – PAGE 34 – MEMBRANE FILTRATION UNIT WITH STAND – MATERIAL PVDF/GLASS
-ITEM#30 – PAGE 35 – pH PRESSURE FLOW UNIT WITH PROBE AND STAND – 4 BAR/65°C
-ITEM#425 – PAGE 13+36 – HP POROUS MEDIA FLOW UNIT
-ITEM#435 – PAGE 13+35 – HP CAPILLARY FLOW UNIT
-ITEM#50.HP – PAGE 37 – HP HEAT EXCHANGE FOULING MODULE WITH STAND
-ITEM#50.LP – PAGE 38 – LP HEAT EXCHANGE FOULING MODULE WITH STAND
-ITEM#60 – PAGE 38 – HEATING ELEMENT DRIVE UNIT
-ITEM#70 – PAGE 19+39 – RESERVOIR AND METERING FACILITIES WITH STAND
-ITEM#73 – PAGE 19+20+39 – SCALING SCREENING MODULE WITH INJECTION MANIFOLD AND STAND
-ITEM#75 – PAGE 21+39 – CORROSION BIOFILM SCREENING MODULE AS EXCHANGE SINGLE UNIT
-ITEM#90 – PAGE 40 – VERTICAL RACK EMPTY FOR ARRAYS AND PROBES
-ITEM#91 – PAGE 40 – FLAT RACK EMPTY FOR ARRAYS AND PROBES

Portable Diagnosis Laboratory

A field laboratory mounted in a lid case equipped with conventional and reliable methods to measure on-line corrosion, water quality and to perform all on-site water analyses required to calculate scaling tendencies



'to take lid off'

LIFT

1 – Tablet to install lid with wheels on

A double numeration labelling shows how to pack and to display

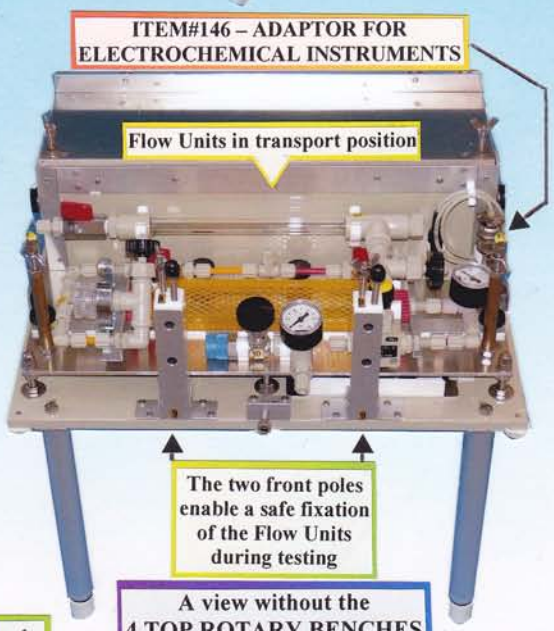
The 4 legs make a table out of it – They are adjustable to an uneven ground

See details LID CASE PAGE 42

After mounting wheels and lead

WHEEL BARROW CASE

,Lead and wheels are very seldom in use, to be able to take them off is an advantage'



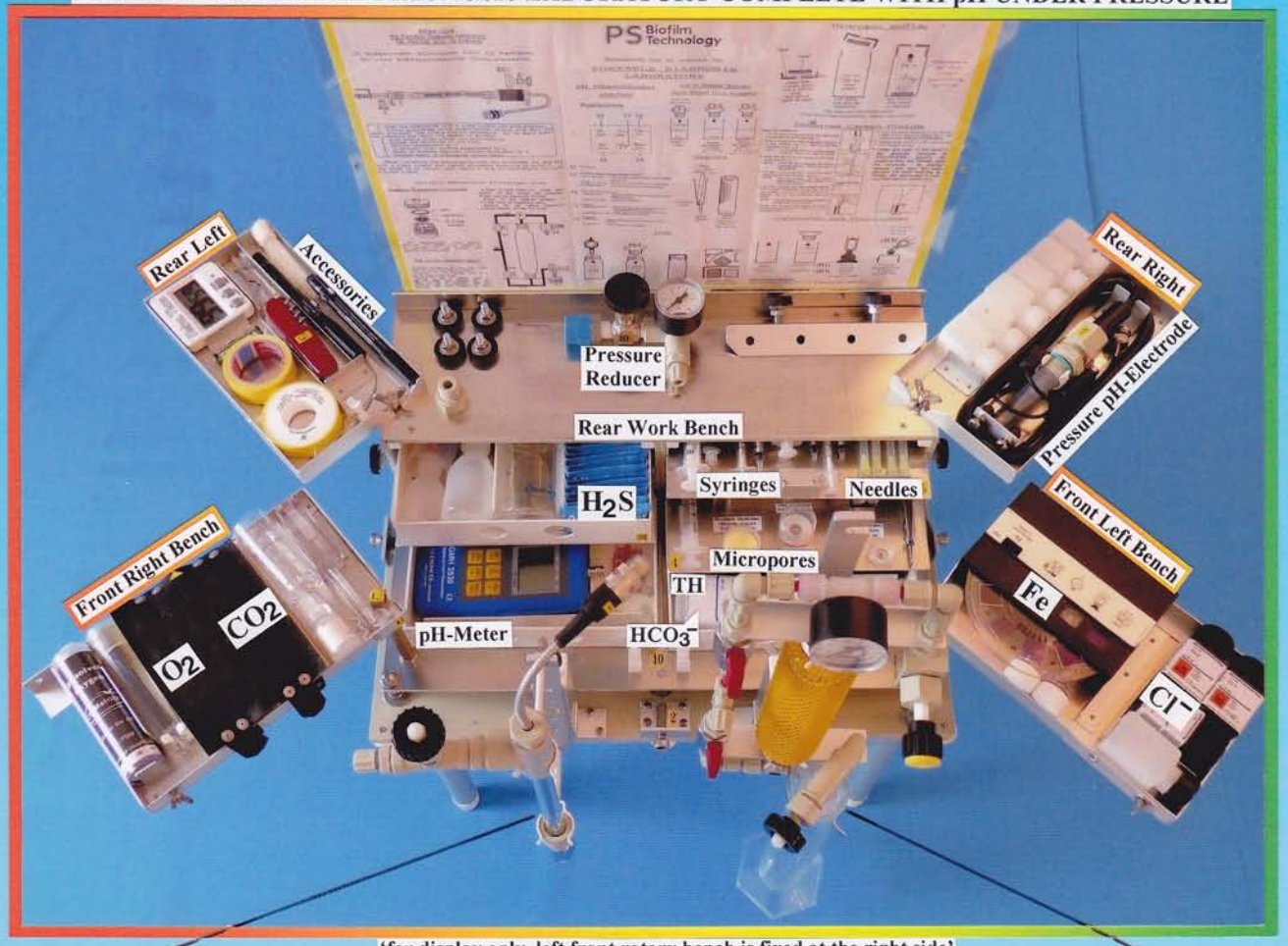
A view without the 4 TOP ROTARY BENCHES

When recommending a chemical treatment for water systems or performing field trials and general surveys, it is required to be able to make rapid diagnosis. In new systems, the operator has to predict and determine corrosiveness, water quality and scale tendencies. During regular operation, permanent information concerning such detrimental phenomena is required. Those measurements have to be performed on-line and on-site in the most remote locations, outdoors and often in a very short period of time.

The Portable Diagnosis Laboratory is presented in a lid case which weighs 18 Kg, its dimensions are 52X38X23 cm, thus it can be taken into an aircraft cabin. The miniaturized instrumentation performs:

-Electrochemical corrosion measurements with an on-line Corrosion Flow Unit.
-Water quality by measuring suspended solids and filtration rates with an on-line micropore Membrane Filtration Unit with reservoir.
-On-site water analyses.

ITEM#103 – PORTABLE DIAGNOSIS LABORATORY COMPLETE WITH pH UNDER PRESSURE



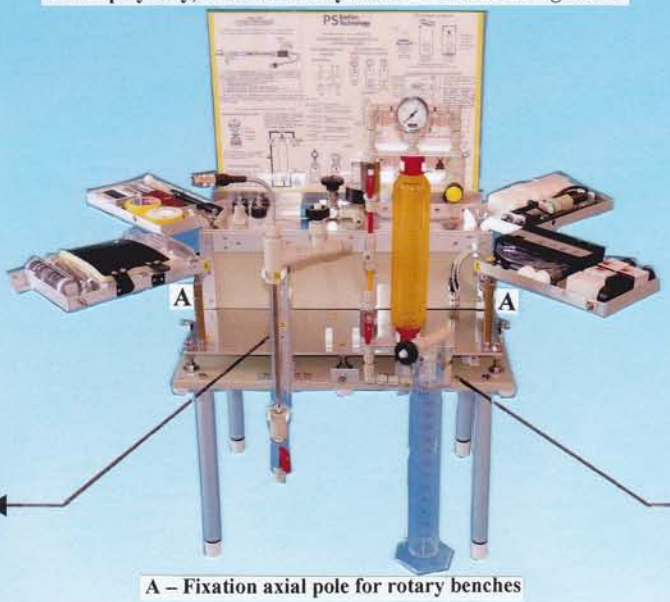
'for display only, left front rotary bench is fixed at the right side'

LP CORROSION FLOW UNIT WITH LPR PROBE

'Depending upon application this unit is delivered as LP or HP version'

ITEM#111.LP

SEE DETAILS PAGE 30



A – Fixation axial pole for rotary benches

MICROPORE MEMBRANE FILTRATION UNIT

PAGE 34

ITEM#152

STANDARD TEST CAPACITY OF THE PORTABLE DIAGNOSIS LABORATORY

-pH and temperature: No limitation
-Chlorides: 50 tests
-Alkalinity: 200 tests
-Carbonates: 50 tests
-Dissolved or total iron: 500 tests
-Hydrogen sulfide: 100 tests
-Oxygen: 30 tests
-Dissolved carbon dioxide: 30 tests
-Corrosion measurements: No limitation
-Micropore filtration: 100 tests

BACK-UP CASE

In both versions ITEM#102 and #103, the Portable Diagnosis Laboratory is delivered with a Back-up Case containing all extra reagents, spares and accessories.

pH PRESSURE FLOW UNIT

In the version ITEM#103, The pH Pressure Flow Unit is packed in the back-up case. Basically, it consists of a PP block with pressure gauge on which the pH probe fits in the top as indicated herewith. The outlet is equipped with a flow adjusting valve. The pressure is regulated with the pressure reducer.

pH PRESSURE FLOW UNIT 4 BAR 65°C

SEE DETAILS PAGE 35

ITEM #171

PRESSURE pH PROBE WITH FITTING 4 BAR, 65°C

Set-up for pH measurement under pressure

ITEM#170

General Selection Considerations of an On-Site Water Analyses Package

PS Biofilm does not aim to develop new analytical methods. The goal of the Portable Diagnosis Laboratory is to offer an ergonomic instrumentation mounted in an aircraft board case.

The major considerations when selecting the analytical techniques and equipment have been miniaturization, simplicity and relevance to field conditions. Thus the instrumentation has to be small, light and easy to operate. Accuracy, reproducibility and reliability are crucial. It is not easy to find a single producer that meets all those requirements. Therefore, the Portable Diagnosis Laboratory is equipped with methods produced by several companies with large experience. Their products can be easily purchased almost allover. Should reagents and parts be locally available, please ask the supplier of your choice.

Certain water properties change very quickly after sampling. Those variations are mainly due to temperature changes, release of gases, e.g. hydrogen sulfide, carbon dioxide or oxygen intrusion, as well as redox reactions. Few characteristics may begin to change immidiately. Therefore, a series of analyses must be conducted in the field, the most relevant are: Temperature, pH, iron, hydrogen sulfide, oxygen, carbon dioxide, hardness and alkalinity.

The rest of values required to calculate the scaling tendencies may be carried out from water samples in the laboratory; i.e. sodium, calcium, magnesium, sulfates and chlorides.

Microbial Survey Instruments

A carrying lid-case incubator containing all equipment to perform microbiological surveys and rapid diagnosis of microbial problems in fluids and pipe walls

Microbial problems in water systems are very complex. The bacterial population is very dependent of the system conditions. Thus, the investigations have to be conducted on-site and under aseptic conditions. Nowadays, it is widely accepted that the assessment of the sessile bacterial population is crucial. Moreover, even under almost anaerobic conditions, besides sulfate-reducing bacteria, also general heterotrophic bacteria, iron-oxydizing bacteria, sulphur-oxydizing bacteria and others types, or consortia of all of them grow in biofilms.

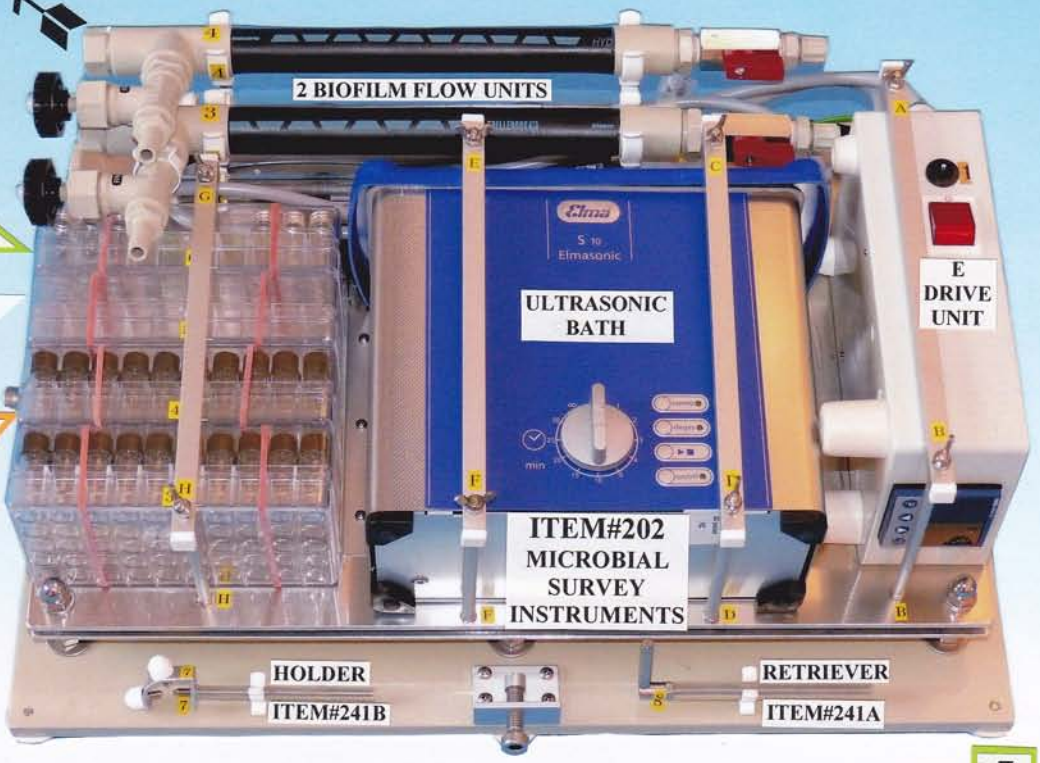
The above mentioned facts complicate microbiological surveys. One of the major problems of the field engineer in charge of the investigations is to collect all parts and instruments in a small and light carrying case that can be used as an incubator and houses all instrumention during transport. The content is presented below:

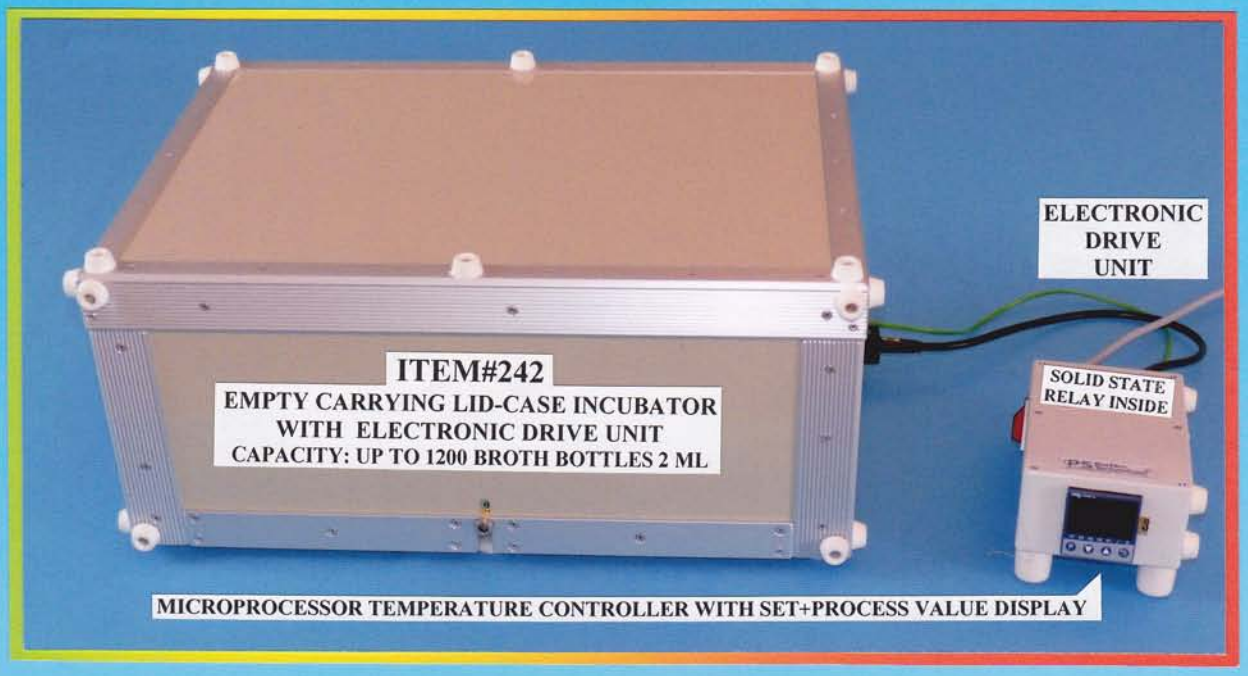
ITEM#211+221
LOW PRESSURE (LP) OR HIGH PRESSURE (HP)

24 EMPTY 2 ML BROTH BOTTLES WIDE NECK FOR COUPON TRANSFER

EXTRA TRANSPARENT BOX-RACK

100 EMPTY 2 ML BROTH BOTTLES NARROW NECK FOR SERIAL DILUTIONS





ITEM#242
EMPTY CARRYING LID-CASE INCUBATOR WITH ELECTRONIC DRIVE UNIT
CAPACITY: UP TO 1200 BROTH BOTTLES 2 ML

ITEM#251
ULTRASONIC BATH

The dispersion effect is caused by vacuum bubbles within the fluid, they behave as particles which collide and strike surfaces with high frequency.
A large number of tests have shown that the intensity of the sonicator provided does not damage bacteria.

ITEM#261
TRANSPARENT BOX-RACK CONTAINING 50 EMPTY 2 ML BROTH BOTTLES, WIDE NECK, FOR BIOFILM COUPON TRANSFER
(ALUMINIUM CAP AND BUTYL RUBBER SEAL)

ITEM#266
TRANSPARENT BOX-RACK CONTAINING 50 EMPTY 2 ML BROTH BOTTLES – PHENOL RESIN CAP (150°C) – NARROW NECK – FOR STANDARD SERIAL DILUTIONS
(OXYGEN TIGHT BUTYL RUBBER SEAL)

1 ML GRADUATED SYRINGES + NEEDLES FOR SERIAL DILUTIONS
(25 UNITS PER PACK)

Microbial Transfer Case

A light and miniaturized body-case containing all equipment required to make serial dilutions, transfer biofilm coupons and quantify bacterial byproducts right on-spot

ITEM#231
MICROBIAL TRANSFER CASE

To conduct serial dilutions and to perform regular transfers, a limited amount of instruments and items are required on-site.

The Microbial Transfer Case with a weight of 3 Kg and and very small dimensions is ideal to be carried in a field aircraft cabin. Moreover, during testing it can be adjusted and carried in the body allowing walking and free hands for testing.

Hydrogen sulfide increase at the end of the system is related to sulfate-reducing bacteria growth. The kit available enables quantification on-site and in the most remote locations.

The iron test kit permits measurement on-spot as well as quantification of the iron compounds precipited on the surfaces.

Small membrane filtration holders (D: 13 mm) enable measurement of total solids accumulated on the surfaces or enrichment of planktonic populations.

The disadvange of the serial dilutions with conventional 10 ml bottles is the considerable weight – With the introduction of the 2 ml bottles and the incubator case, weight and space are no longer a problem. Moreover, the use of cultural methods permits specific detection of any bacterial type.

The serial dilution determines the bacterial number by extinction. The results can be given in units/ml, whereby each unit or single particle may originate from a clump containing several single microorganisms. Duplication or triplication increases the relevance of the results. In addition, different types of serial dilutions may be applied:

-10 FOLD: 5, 50,500, 5000 … UNITS/ML
0.2 ml are inoculated to 1.8 ml medium.
-4 FOLD: 8, 32, 128, 512 … UNITS/ML
0.5 ml are inoculated to 1.5 ml medium.
-2 FOLD: 2, 4, 8, 16, 32 … UNITS/ML
1.0 ml is inoculated to 1 ml medium.

Culture Media Preparation Equipment

A fully equipped lid carrying case to produce culture media and to prepare broth bottles in a field laboratory

To be selfsupplier of culture media boosts flexibity, independency and capacity. It opens the door to complete microbiological studies:

- Culture media for any specific type of bacteria can be produced right on-site.
- Permits the use of original field water.
- There is no need to carry liquid broth.
- Fresh medium can be used, no storage required, no leftovers. Specially for large surveys or screening tests, it is difficult to forsee the number required.
- It is possible to undertake metabolic studies and medium optimization by changing nutrients and ingredients.
- If the Microbial Survey Instruments is used, the advantage of the 2 ml bottles and the incubator make the operation totally selfsufficient.

Experience shows that it is very difficult to produce a universal medium on which all SRB strains develop.

Often, the best approach is to use the existing knowledge, that is, if a medium has shown rapid gowth (2-3 days on the first dilution bottle when population of 1000 units/ml is present); then, it is the one to be used.

PS Biofilm does not market culture media in fluid or dry form. For the customers of this equipment however, standard recipies for sulfate-reducing bacteria, general heterotrophic bacteria, iron-oxydizing bacteria and sulphur-oxydizing bacteria are presented in the users guide. In addition, ingredients to produce 1000-2 ml SRB bottles and 1000-2 ml GHB bottles are supplied with this equipment.

ITEM#303

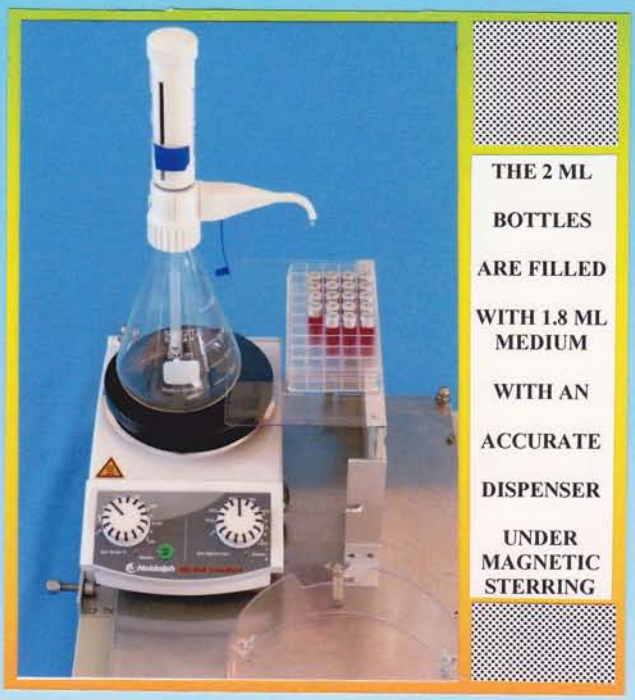
CULTURE MEDIA PREPARATION EQUIPMENT

PRINCIPLE OF OXYGEN-FREE FILLING

One of the major changes introduced during filling of broth bottles is the absence of nitrogen blanketing and sparging. Anaerobic conditions are achieved by sterilization of the bottles with cap loose. After sterilization, the bottles are tighten with the gloves supplied while they are still hot. The vacuum resulting during cooling provides perfect anaerobic conditions. Such a change makes the procedure much easier, indeed, it is difficult to find nitrogen bottles in remote laboratory locations. The threaded cap of the 2 ml bottles makes such a procedure possible.

DRY SINGLE INGREDIENTS TO PRODUCE 1000-2 ML SRB 1000-2 ML GHB BROTH BOTTLES

REAR DRAWER MODULE FRONT VIEW



THE 2 ML BOTTLES ARE FILLED WITH 1.8 ML MEDIUM WITH AN ACCURATE DISPENSER UNDER MAGNETIC STERRING

REAR DRAWER MODULE BACK VIEW

The hot plate is mounted in the base of the lid case, it can be used without necessity of taking it out.
The bottles are evently distributed in a polycarbonate platform that fits into the pressure cooker. After sterilization the platform is taken out and caps are tighten with gloves while they are still hot. The vacuum generated makes it air free.

DETAILED PROCEDURE IN THE USERS GUIDE

General instructions.
- How to prepare SRB culture medium.
- Production of broth bottles for SRB.
- Production of broth Bottles for GHB.

HP On-Line Diagnosis System

An on-line testing instrumentation to back-up diagnosis, to select the most suitable side-flow monitoring devices, to control field trial performances in water systems and to simulate reservoir souring

1 – ITEM#421 – EMPTY SAND PACK WITH PTFE INTERNAL JACKET + SCREENS
2 – TRANSFER ROD
3 – HOLDER TO FIX IN A VICE
PRINCIPLE, PROCEDURE, DIFFERENTIATION PARAMETER SEE PAGE 36

Whenever a very high amount of information is required in a short period of time, the On-Line Diagnosis System is the right instrumentation, it is characterized by a small testing capacity, but it has a variety of sensoring elements.

One of the purposes of this testing equipment is to check the sensitiveness to changes of a series of on-line devices, this allows selection of the optimum monitoring units. Its exposure during the commissioning of water systems yields to a full diagnosis of corrosion, scale and bacterial growth on surfaces and porous media. When performing field trials with chemicals, the exposure of this instrumentation during the testing period of each product enables to get valuable data of each type of treatment.

The equipment is presented in a lid cabinet for field installation. The four face lid can be lifted off allowing access to all parts mounted in the two face base. The cabinet can be installed at any location of the system where water can be disposed or recycled into lower pressure locations of the system.

The system consists of three functional assemblies connected in series and in parallel:

-Flow Unit Assembly-2 in series to assess sessile bacteria, solids accumulation and gravimetric or electrochemical corrosion.

-Porous Media Assembly-2 in parallel to simulate microbial induced reservoir souring, to measure microbial accumulation in porous media and flow rates through it.

-Capillary assembly-2 in parallel to determine flow reduction and plugging through capillaries due to mineral scale.

The porous media and capillary assemblies are mounted in parallel in an internal bypass manifold.
The standard HP On-Line Diagnosis System is made of connections of 1.4404 (316L, S31603) and tubing of 1.4571 (316Ti, S31635). It withstands pressures up to 200 Bar. If arrays of PEEK (Page 43) are available, it can be used at temperatures up to 150°C.

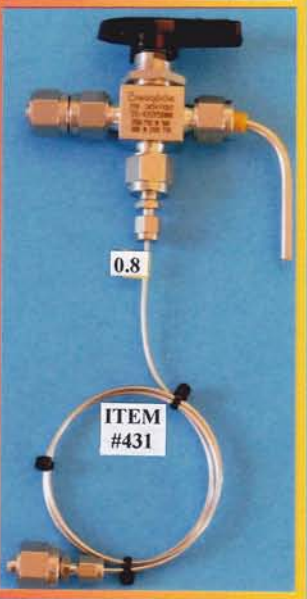
SEE DETAILS PAGES 31+32+33

ITEM#416.HP – GRAV. CORR. COUPON ARRAY-3
ITEM#221.HP – BIOFILM COUPON ARRAY-12
In between it is always possible
to measure corrosion electrochemically
ITEM#131.HP – LPR PROBE 3 CS ELEMENTS

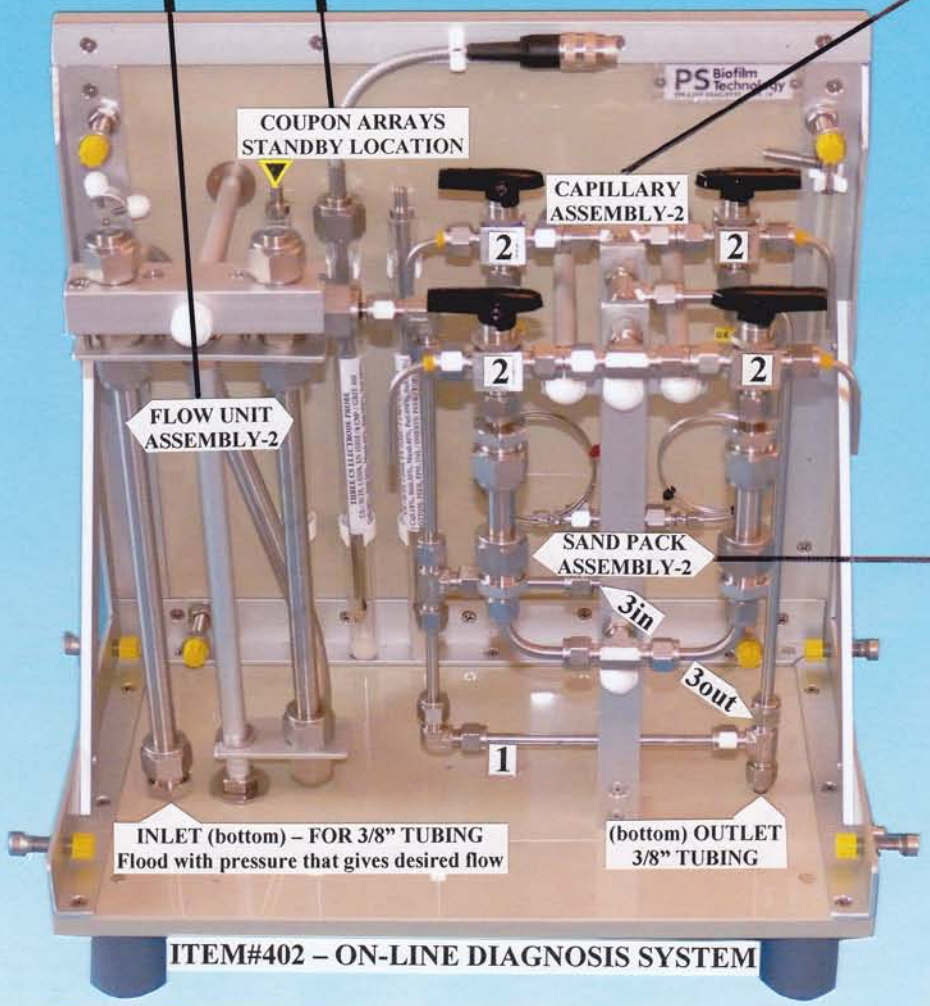
TOTAL FLEXIBILITY by use of SENSORS or FLOW UNITS

JUST BY PULLING OUT OR SLIDING IN
In the top of the two flow units a variety of arrays can be used

ITEM#435
CAPILLARY FLOW UNIT



Depending upon the specific problem 4 capillary units, 4 sand pack units or combinations of them can be used



ITEM#402 – ON-LINE DIAGNOSIS SYSTEM

POROUS MEDIA UNIT
ITEM#425

1 – FLOW CONTROLLING SECTION: This tube with an ID of 2 mm acts as a valve generating the back pressure required to squeeze the fluid through the capillary and sand pack assemblies. A tube restricts the flow by pressure drop and not punctually as a valve, thus plugging is unlikely to occur.

2 – FOUR 3-WAY VALVES installed at the outlet of the capillaries and sand packs enable to individually flood each pack or capillary, to stop flow or measure the flow rates with a volume cylinder and a stop watch.

3 - 3in and 3out are the inlet and outlet of the INTERNAL BYPASS on which the two assemblies are mounted in parallel. At location 3in the INTERNAL BYPASS MANIFOLD distributes the fluid to the four units mounted in parallel. At location 3out the fluid coming out from the assemblies is reinjected at the lower pressure point downstream of the FLOW CONTROLLING SECTION (1).

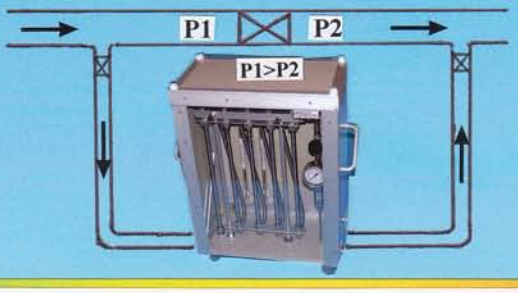
LP (Low Pressure) Flow Unit Assemblies

HP (High Pressure) Flow Unit Assemblies

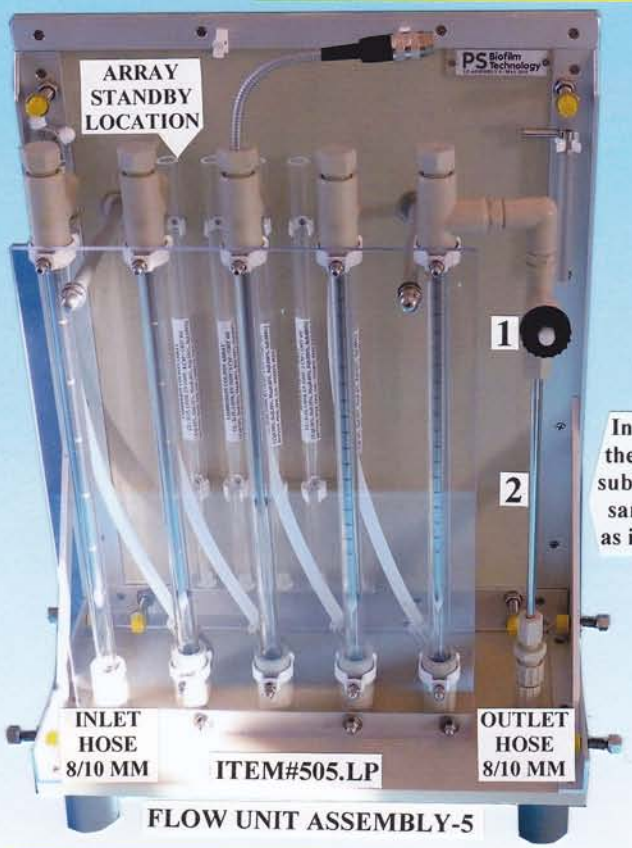
On-line biofilm generators for field installation to select biocides on biofouled surfaces, to adjust treatment parameters and to perform continuous monitoring of biofouling and corrosion

INSTALLATION

- AS SIDESTREAM RECYCLING WATER AT LOWER SYSTEM PRESSURES
- AS BYPASS WITH REINJECTION UPSTREAM PUMPS
- AS BYPASS WITH REINJECTION DOWNSTREAM VALVES

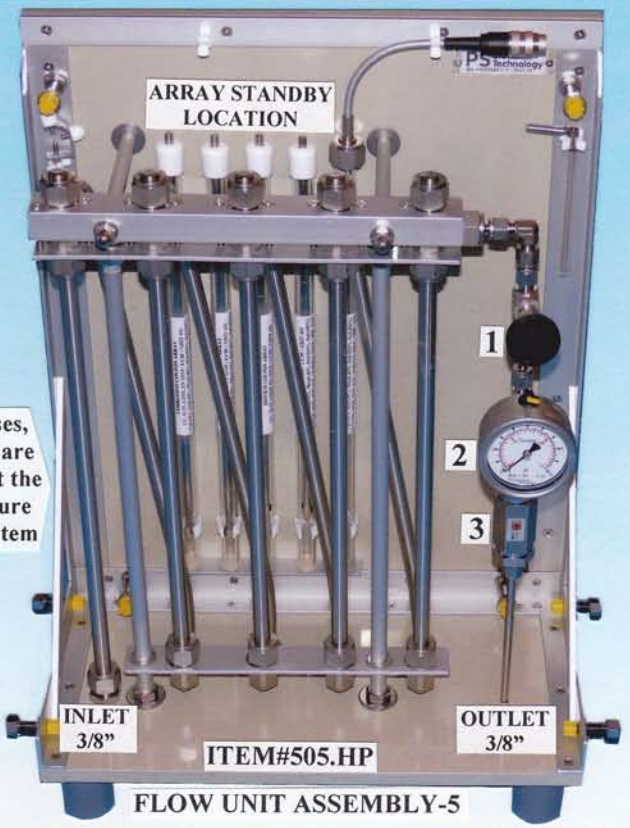


PRESSURE GLASS ⟵ TUBING ⟶ SSA4 – 1.4571 (316 Ti, S31635)
PP or PVDF ⟵ CONNECTIONS ⟶ SSA4 – 1.4404 (316 L, S31603)
10 BAR – 20°C / 4 BAR – 70°C ⟵ MAX. SYSTEM PRESSURE ⟶ 200 BAR



FLOW UNIT ASSEMBLY-5

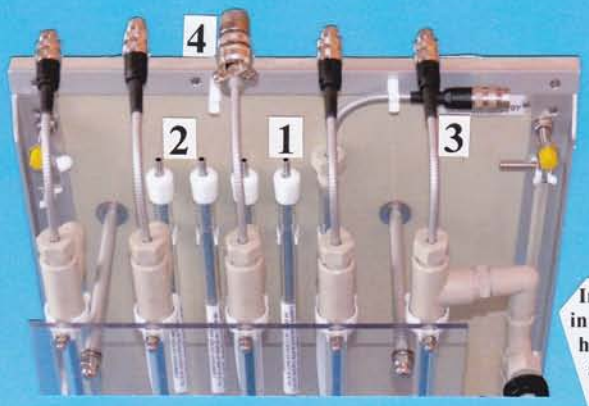
In both cases, the sensors are submitted at the same pressure as in the system



FLOW UNIT ASSEMBLY-5

Flow can be adjusted with VALVE-1 – If it is left fully open, the flow is controlled by TUBE SECTION-2 with an ID of 2 mm, it restricts the flow by pressure drop, thus plugging is unlikely to occur.

FLOW CONTROLLER-3 maintains constant flow within pressures up to 10 Bar. With HP VALVE-1, it is intended to reduce pressure down to the 10 Bar range – The pressure applied to the FLOW CONTROLLER-3 is measured by MANOMETER-2



In the 5 flow units in series a variety of high port capacity arrays or probes can be installed

1 – ITEM#551.LP – BIOFILM ARRAY 18 CS COUPONS 2 CM² - ITEM#551.HP – 1
1 – ITEM#552.LP – BIOFILM ARRAY 20 CS COUPONS 2 CM² - ITEM#552.HP – 1
2 – ITEM#555.LP – GRAVIMETRIC CORROSION ARRAY 5 CS COUPONS 8 CM² - ITEM#555.HP – 2
3 – ITEM#131.LP – LPR PENCELL PROBE 3 CS ELEMENTS 8 CM² - ITEM#131.HP – 3
4 – ITEM#135.LP – ER PENCELL PROBE 2 CS ELEMENTS 12 CM² - REF. ECTFE COATED – ITEM#135.HP
(SEE DETAILS PAGES 31+32+33)

All Dynamic Biocide Selection

The final selection of biocides effective on biofilms has to be conducted on surfaces exposed to the system. For such purposes, a very high number of metal specimens are required. The direct installation of coupons in-the-line with retractable holders is too complicated and costly and does not have enough capacity.

The high port capacity of a Flow Unit Assembly-5 enables to overcome such problems. The assembly is used as biofilm generator, it is exposed to the system for a given time until a biofilm with a high bacterial number develops. The usual duration of the colonization period is 10 to 30 days. The screening tests which can be performed are:

-Dynamic time-kill test on biofouled surfaces.
-Simulation of a periodic slug treatment.
-Simulation of continuous injection.

Further information in:
Microbial Survey Instruments (Page 7+8+9)
Chemical Treatment Simulation Machines (Page 22)

Treatment Parameters Optimization

In order to adjust the Concentration of the slug, the Flow Unit Assembly-5 is installed at the beginning of the field trial. Before and after injection of the slug, coupons are transferred to broth bottles and bacterial populations assessed.

The optimization of the Contact Time can be determined by periodical transfer of specimens during treatment.

The Frequency can be adjusted by periodical transfers of coupons to broth bottles between slugs.

ITEM#515.LP
FLOW UNIT ASSEMBLY-2

Monitoring Transfer Programmes

According to the type of instruments, coupon arrays or probes, different long term monitoring programmes can be applied. Particular adjustments should be done to the type of plant and testing schedule.

Gravimetric corrosion specimens can be transferred monthly. The user guide shows how to determine total solids accumulated, scaling rates and weight loss corrosion.

LPR corrosion rates can be measured at the same flow units where gravimetric corrosion arrays are installed. During measurement with the LPR PenCell probes, the corrosion or biofilm arrays are kept in the standby tubes filled with field water.

With periodic transfer of biofilm coupons, the biofouling kinetics can be determined. The high port capacity enables to make duplicates or triplicates. Transfers can be scheduled periodically between or before and after chemical treatments.

ITEM#515.HP
FLOW UNIT ASSEMBY-2

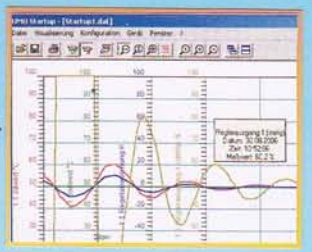
Multiple Monitoring Systems

Heat exchange fouling monitors with multifunctional flow units

Wherever heat exchange problems take place, it is very likely that they are due to biofouling, scale or corrosion. Such detrimental phenomena are closely intercorrelated and decrease heat transfer efficiency.

Multiple Monitoring Systems consist of several flow units mounted in series (1)+(2)+(3) – The last one, (4) is the heat exchange fouling module on which the water flows in the annulus between glass tube and heat exchange fouling tube. A high performance heating element driven by a control unit provides adjustable heat flux up to 176 kW/m². The process value shown in the temperature controller is the Tw, that is, the temperature between heat source and heat exchange surface. Just by increasing set value correspondingly, heating takes place continuously. The temperature controller hysteresis is programmed in such a way that if flow stops no overheating can take place. The basic differentiation parameter is the increase of Tw, which under constant flow conditions, is proportional to the heat transfer deterioration. Moreover, the heat exchange tube can be weighed before and after exposure.

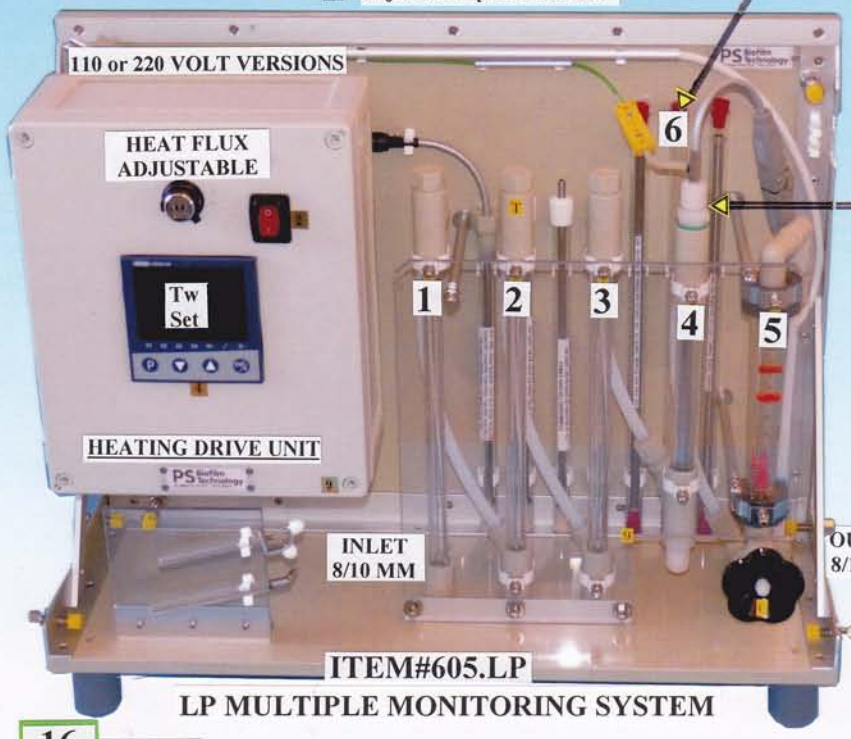
The temperature controller is equipped with an interface and a converter USB/TTL – A windows software consists of a multichannel recording facility with graphic presentation and storage facilities

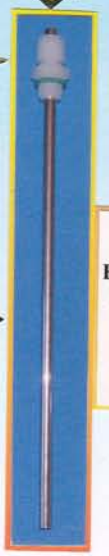


The HEAT FLUX is adjustable up to 176 kW/m²

SEE ADDITIONAL INFORMATION AT PAGES 37+38

NiCrNi SENSOR IN CONTACT WITH JACKET IN THE MIDDLE



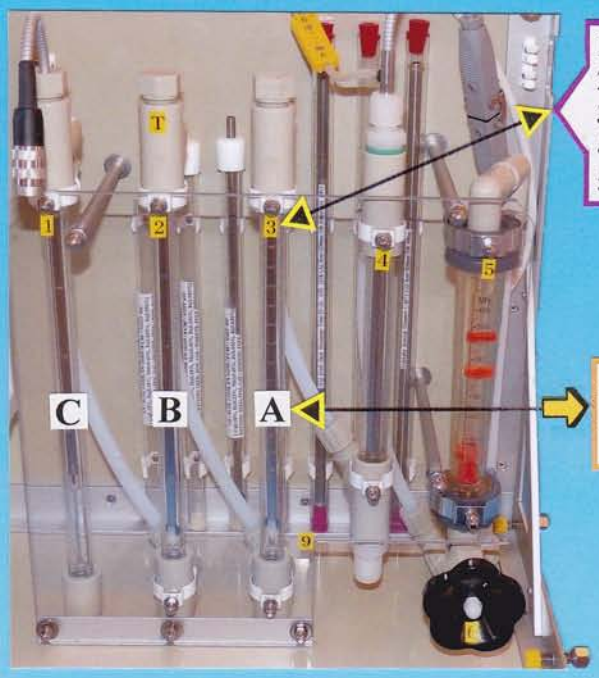


Heating element fits perfectly in the middle of the tube. Surface under heat exchange: 25 cm²

ITEM#685 HEAT EXCHANGE FOULING TUBES available in CS or SS

ITEM#605.LP

LP MULTIPLE MONITORING SYSTEM



1 – ELECTROCHEMICAL CORROSION FLOW UNIT
2 – GRAVIMETRIC CORROSION FLOW UNIT
3 – BIOFILM FLOW UNIT
4 – HEAT EXCHANGE FOULING MODULE
5 – FLOW CONTROL (ADJUSTMENT + MEASUREMENT)

SENSORS FOR MULTIPLE MONITORING SYSTEMS

A – ITEM#640 – LP or HP BIOFILM ARRAY 14 CS COUPONS 2 CM²
B – ITEM#645 – LP or HP GRAV. CORR. ARRAY 4 CS COUPONS 8 CM²
C – ITEM#131 – LP or HP LPR PENCELL PROBE 3 CS ELEMENTS 8 CM²
(See details in Pages 31+32+33)

HP MULTIPLE MONITORING SYSTEM

A complex combination of high pressure heat exchange fouling, biofilm, internal corrosion monitoring with heated capillaries and sand pack assemblies

1 – HEATING DRIVE UNIT
2 – TEMPERATURE CONTROLLER FOR HEAT EXCHANGE ELEMENT
3 – TEMPERATURE CONTROLLER FOR CAPILLARY BOX
4 – POTI TO ADJUST HEAT FLUX
5 – CHEMICAL INJECTION POINT
6 – CORROSION FLOW UNIT
7 – BIOFILM FLOW UNIT
8 – HP HEAT EXCHANGE MODULE
9 – SAND PACK ASSEMBLY-2
10 – CAPILLARY ASSEMBLY-2
11 – HEATED BOX FOR CAPILLARIES
12 – FLOW CONTROLLING SECTION

ITEM#660.HP
HP MULTIPLE MONITORING SYSTEM

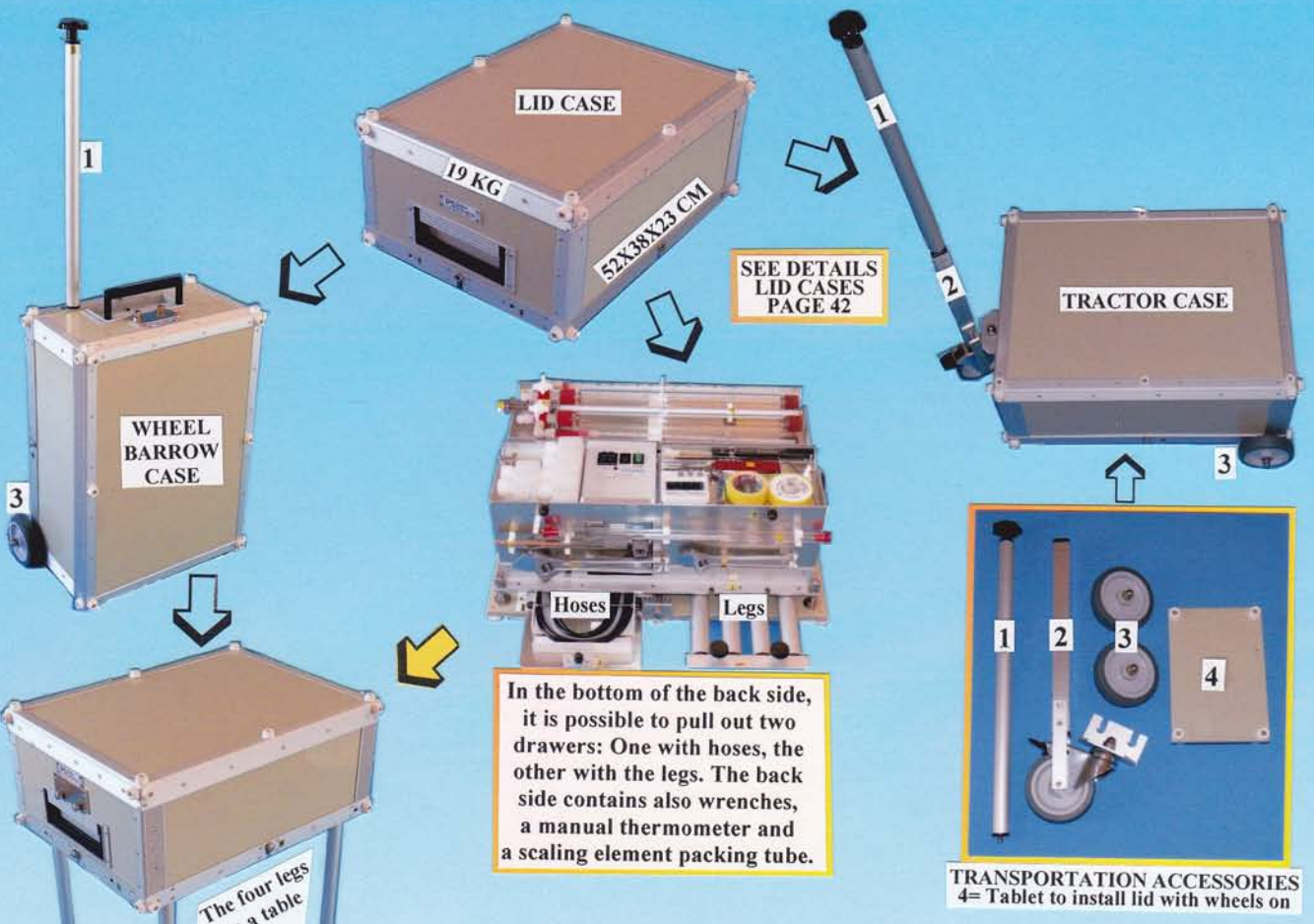
Field research instrumentation to determine the most appropriate flow units to monitor the system – To control the efficiency of chemicals during field trials.
To screen water treating chemicals:
- Corrosion inhibitors
- Scale inhibitors
- Biocides

in most close field conditions.

ITEM#630.LP
LP SINGLE HEAT EXCHANGE FOULING MONITOR
Consist only of an electrically driven (1) heat exchange module (2), flow adjustment (3) and flow meter (4)

Chemical Treatment Simulation Machines

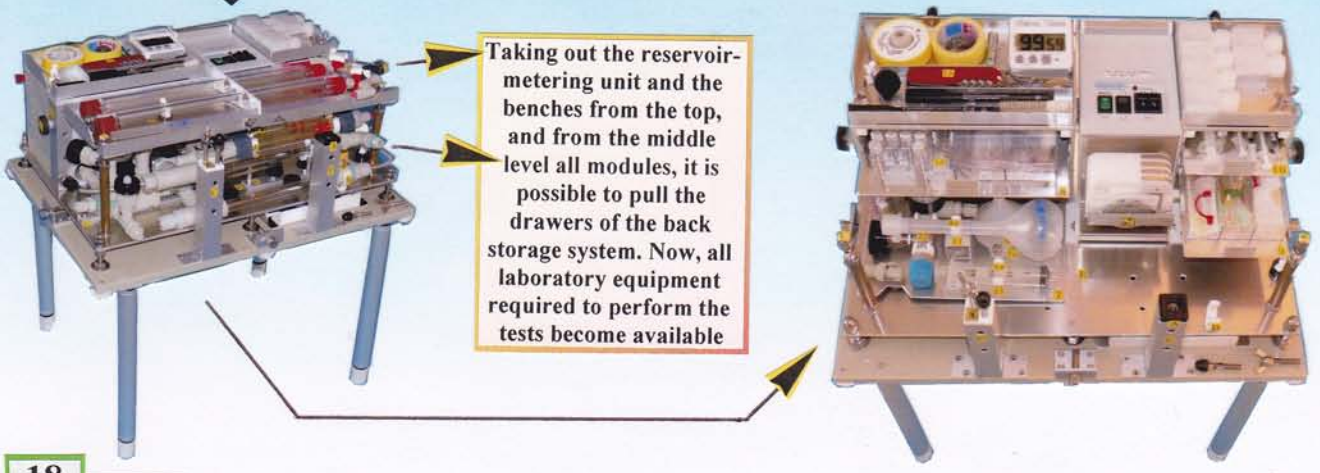
Portable field or laboratory instrumentation to select under flow and on-line CORROSION INHIBITORS, SCALE INHIBITORS and BIOCIDES



In the bottom of the back side, it is possible to pull out two drawers: One with hoses, the other with the legs. The back side contains also wrenches, a manual thermometer and a scaling element packing tube.

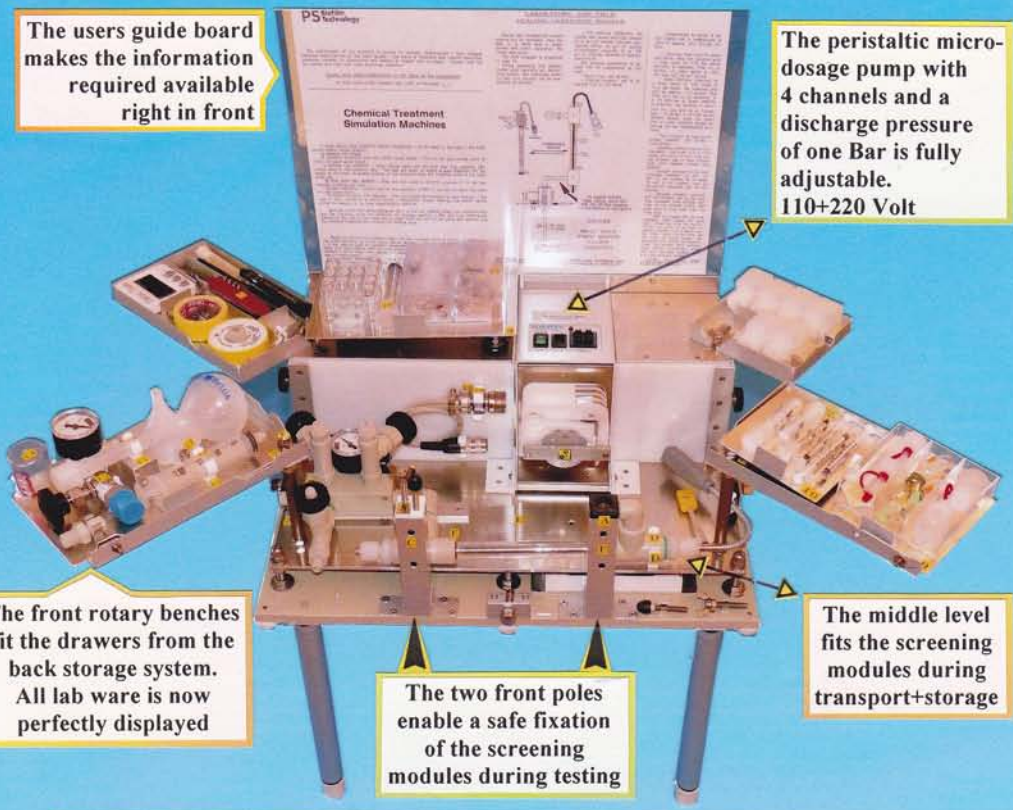
TRANSPORTATION ACCESSORIES
4= Tablet to install lid with wheels on

In spite of its complexity, the instrumentation is small, light, easy to operate, ideal to be used in the most remote locations



Taking out the reservoir-metering unit and the benches from the top, and from the middle level all modules, it is possible to pull the drawers of the back storage system. Now, all laboratory equipment required to perform the tests become available

The users guide board makes the information required available right in front



The peristaltic micro-dosage pump with 4 channels and a discharge pressure of one Bar is fully adjustable. 110+220 Volt

RESERVOIR AND METERING FACILITIES

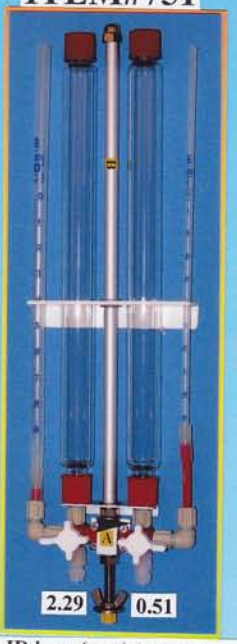
The glass cylinder at the right side is to store chemicals, the one at the left side is to store scaling or corrosive solutions – Both are connected to measuring pipettes through a 3 way valve, thus injection rate control with stop watch is possible.

The front rotary benches fit the drawers from the back storage system. All lab ware is now perfectly displayed

The two front poles enable a safe fixation of the screening modules during testing

The middle level fits the screening modules during transport+storage

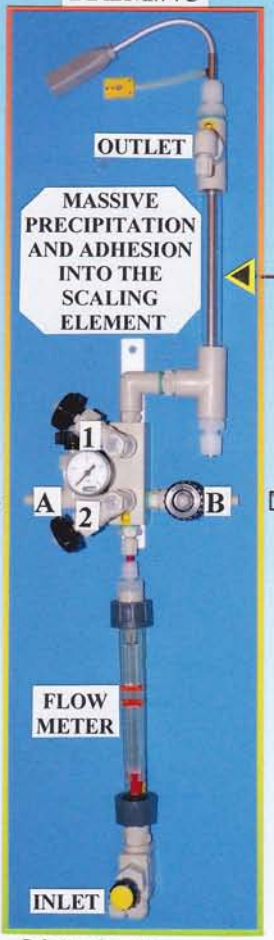
ITEM#751



ID hose (mm) to pump through luer-lock connection

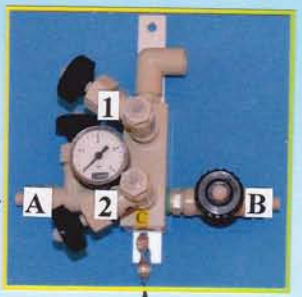
SCALE INHIBITOR SCREENING

PAGE 39
ITEM#73



Inlet main water source: Tap water or field water

The scaling solution flows through the annulus between glass tube and scaling element
SCALING CHAMBER



Static mixer inside

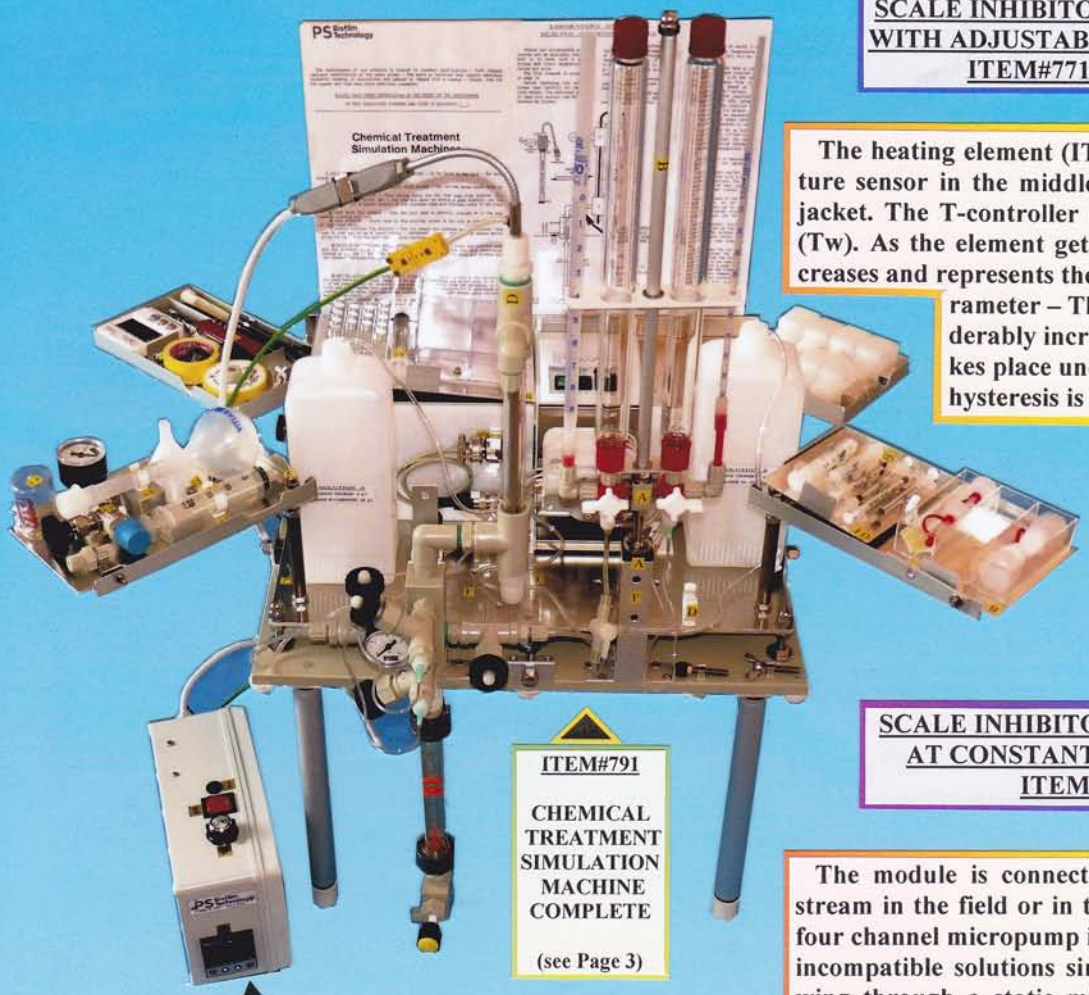
INJECTION POINT MANIFOLD

The two incompatible solutions are injected into point A and B. Chemicals can be injected into point 1 and 2 directly into the stream with an internally built-in capillary tube.

SCALE INHIBITOR SCREENING WITH ADJUSTABLE HEAT FLUX ITEM#771 and 791

The heating element (ITEM#675) has a temperature sensor in the middle and in contact with the jacket. The T-controller displays its process value (Tw). As the element gets scaled, such a value increases and represents the basic differentiation parameter – The set value is then considerably increased so that heating takes place under continuous basis. The hysteresis is programmed so that no overheating can take place.

It is then possible to log, assess and study the kinetics of scale adherence.



ITEM#791

CHEMICAL TREATMENT SIMULATION MACHINE COMPLETE

(see Page 3)

HEATING DRIVE UNIT

SCALE INHIBITOR SCREENING AT CONSTANT HEAT FLUX ITEM#766

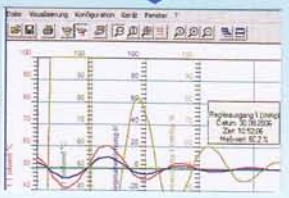
The module is connected to any type of water stream in the field or in the laboratory – With the four channel micropump it is possible to inject two incompatible solutions simultaneously – After flowing through a static mixer, the scaling solution drops pressure, precipitates in the scaling chamber and adheres into the 25 cm² surface of the scaling tube which is heated from inside with a 350 W heating element. The result is a massive scale adhesion within the first 15 minutes of exposure.

Such a phenomenon can be observed visually through the glass tube of the scaling chamber – In the other two injection points, two chemicals, scale inhibitors or combinations can be injected at once.

HEAT FLUX ADJUST 176 kW/m²

2 – To interface
3 – To main
4 – To thermocouple
5 – To heating element

The temperature controller (1) displays simultaneously the Tw and set value and is delivered with an interface + USB/TTL converter. A windows software consists of a multi-channel recording facility with graphical presentation and storage facilities.



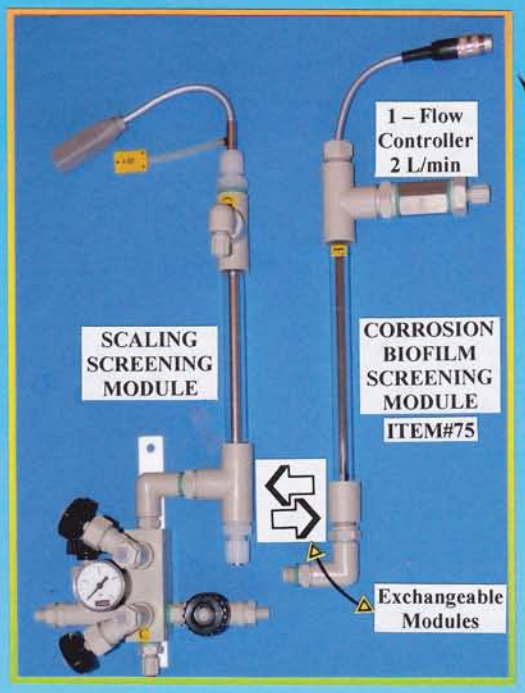
BASIC DIFFERENTIATION PARAMETER

The scaling element (tube) is weighed before and after exposure. The weight difference represents the SCALE ADHESION under DYNAMIC CONDITIONS – It can be expressed in mg/cm².hour – The comparison of the scaling rate with and without scale inhibitor will determine the % of SCALE ADHERENCE INHIBITION under flow conditions.

30 minutes exposure is the ideal duration of one test – In one day it is possible to screen 5 or 6 scale inhibitors.

ITEM#736
SCALING ELEMENTS

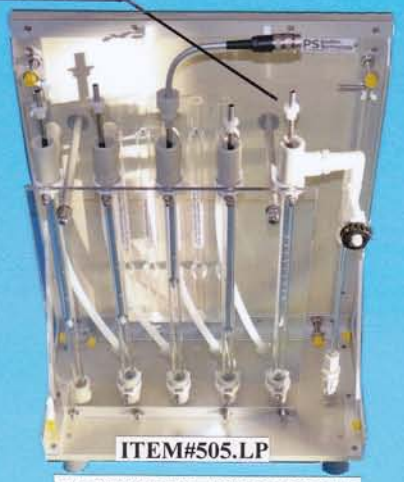
ITEM#775 – BACK-UP CASE CONTAINING THE HEATING DRIVE UNIT + BOTTLES TO STORE SCALE SOLUTIONS AND 5X ITEM#736 – 110 or 220 V



To screen biocides, mature biofilms developed in a Flow Unit Assembly are treated in the Biofilm Screening Module.

Corrosion Probes can be exchanged by biofilm arrays

ITEM#221.LP BIOFILM ARRAY-12



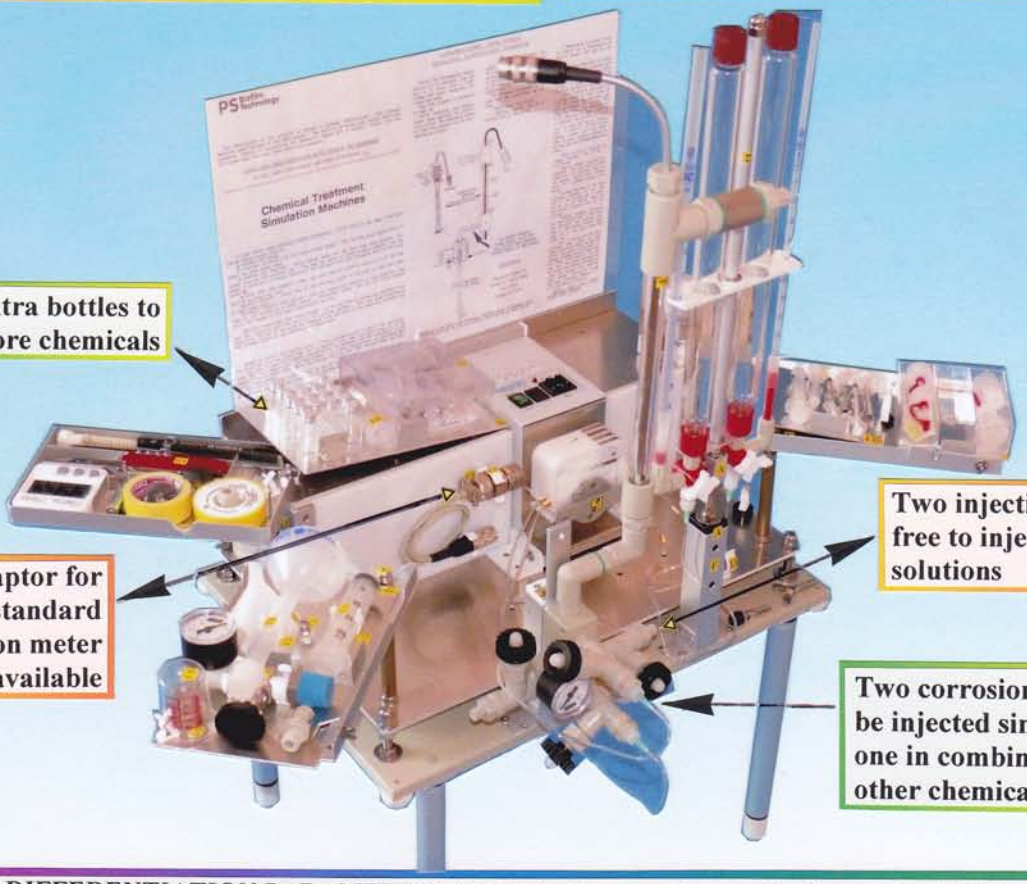
ITEM#505.LP

FLOW UNIT ASSEMBLY-5 (SEE PAGE 14)

CORROSION INHIBITOR SCREENING

The pressure is regulated by the pressure reducer (see two pages before) – A pressure of one Bar is sufficient to maintain the gases dissolved. The flow controller device (1) maintains the flow constant – Usually the tests are conducted with a flow of 2 L/min – Flow controllers for other flow rates are available upon request.

The retrievable bayonet probes can be used for any type of electrochemical technique. However, the easiest method to perform rapid screening is to use Linear Polarization Resistance (LPR) techniques. In systems containing carbon dioxide and even with hydrogen sulfide but no oxygen, the corrosion rate of freshly exposed surfaces becomes stable usually within the first ten minutes of exposure.



BASIC DIFFERENTIATION PARAMETER: After injecting small amounts of corrosion inhibitor, 2 to 10 ppm, it is possible to observe a sharp decrease of corrosion rate within the next 15 minutes. That represents, indeed, the basic differentation parameter. Using such a technique, it is possible to screen up to two products per hour.

BIOCIDE SCREENING PROCEDURES

DYNAMIC TIME-KILL TEST ON BIOFOULED SURFACES

After the colonization period in a Flow Unit Assembly (see page before), the mature biofilm arrays are transferred into the Biofilm Screening Module, where a slug of biocide at a given concentration is applied. During treatment, coupons are transferred each 5 or 10 minutes into broth bottles for the specific type of bacteria to test or to aseptic bottles containing field water and after sonication a serial dilution is made according the procedures mentioned in the Microbial Transfer Case. Using such a procedure 5 to 6 biocides can be screened in one day.

BASIC DIFFERENTIATION PARAMETER

The products to select are the ones exhibiting total kill within the shortest contact time and the ones that show the greatest reduction of the bacterial population. The test gives also an idea of the optimum contact time for a given constant concentration.

SIMULATION OF PERIODIC SLUG TREATMENT

Provided that the assembly can be left on stream for a long period of time, a periodic slug treatment program can be planned. If the product is already selected, each unit can be treated with a different program, that is varying concentration, duration and frequency of the slug. Such test enables optimization of the treatment parameters. If three Flow Unit Assemblies are available, then it is possible to vary a single parameter in each assembly, that allows independent optimization of each treatment parameter. Such tests can also be conducted on aged surfaces, thus kill and regrowth studies can be undertaken.

SIMULATION OF CONTINUOUS INJECTION AND MULTIPLE TREATMENT PARAMETERS

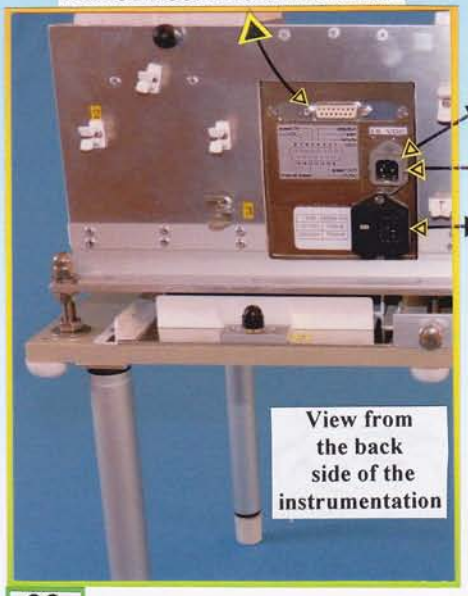
Those investigations are performed injecting continuously small amounts of corrosion inhibitors or biofilm preventives. The continuous treatment can be compared with slug treatment and against combinations of both types.

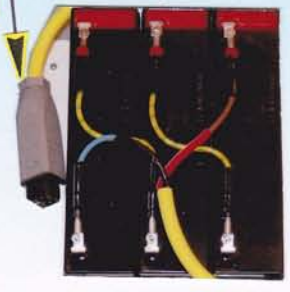
Accumulator Recharge Facilities

DC Power Supply

The scaling tests require AC 110 or 220 V current. Corrosion inhibitor and biocide tests can be performed with a DC 18 V. They are obtained by serial connection of 3 accumulators: 6 V, 2.8 Ah

1 – Accumulator recharge set-up





The accumulators are recharged all three together in parallel – It takes approx. 2 hours

COMPATIBILITY SIMULATION STUDIES

Chemical compatibility is a very broad notion. In principle, two or more chemicals are called compatible when they do not exhibit any kind of negative influence on their effectiveness when applied together. A second type of compatibility problems takes place when the injection of a chemical produces solids, thus deteriorating the water quality.

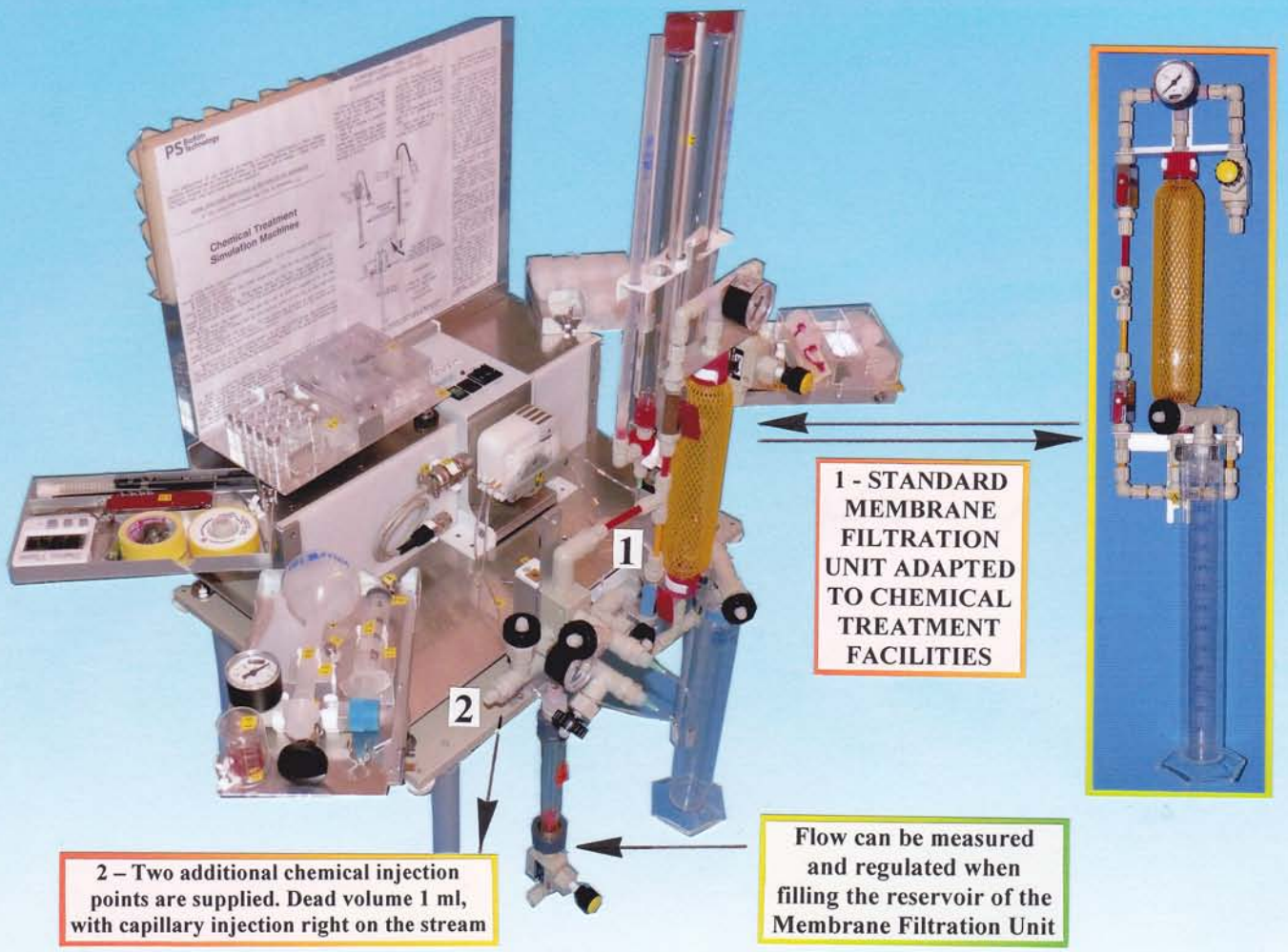
Multiple compatibility studies: The two additional injection points enable to perform scale inhibitor screening injecting one additional chemical or test the effectiveness of corrosion inhibitors and biocides injecting simultaneously 3 additional chemicals. The compatibility study programmes are multiple and should be adjusted to each particular situation.

WATER QUALITY COMPATIBILITY

It is studied with the Membrane Filtration Unit supplied. Such tests can be performed with simultaneous injection of up to four chemicals.

The procedure is easy, during the filling of the reservoir of the Membrane Filtration Unit, the flow is maintained constant with the valve of the pressure reducer and the one at the inlet of the flow meter. Once the flow is determined, the injection rate is adjusted accordingly.

It is then just the matter of running filtration rates and suspended solids with the Membrane Filtration Unit and comparing the results with blank tests without chemical injection.



ITEM#777

MEMBRANE FILTRATION UNIT ADAPTED TO ITEMS#776, 971, 776 or 991 WITH ADDITIONAL FLOW METER + 2 ADDITIONAL INJECTION POINTS – DELIVERED IN AN ADDITIONAL CARRYING CASE

FlowLoops

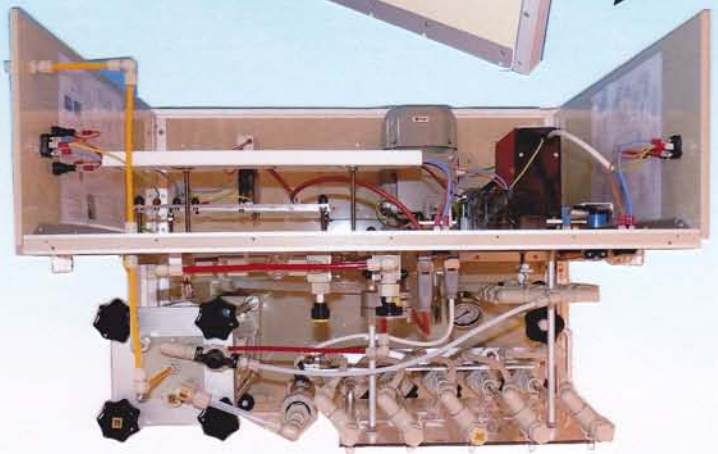
A bypass flow unit system with reservoir to simulate biofouling and corrosion in the laboratory, to select materials, corrosion inhibitors and biocides, equipped with built-in temperature, flow and blanketing control facilities

BENCH TOP CABINET
84X58X72 CM – 60 KG

LID OFF
⇓
'everything ready to hand'

The front lid with 3 handles (1) can be easily taken off just by lifting – The front window (2) is delivered with an extra opaque plate of PP that can be easily changed by a transparent one of PC – To avoid the influence of light, biofouling should be simulated in the dark – For corrosion it is not relevant.

T-HOUSING



Such a so-called T-Housing (inverted T base), enables separation of the electrical and hydraulic circuits – The back houses the electricity: Pump motor, frequency inverter, T-controller - Flow and temperature e-circuits are totally separated. Each one has its own main circuit with independent plug.

The front side of the instrumentation houses the hydraulic circuits and the controls.

The facility is connected to the gas outlet at the top of the reservoir, opening Valve-2 (V2), it is possible to conduct normal gas sparging. By closing Valve-2 and opening Valve-1 (V1) just very slightly, the system can be pressurized, the gas bubble counter (B) enables constant pressure regulation using a minimum amount of gas. The safety valve (P) opens at 2.7 Bar (≅40 PSI), thus there is no danger of overpressure.

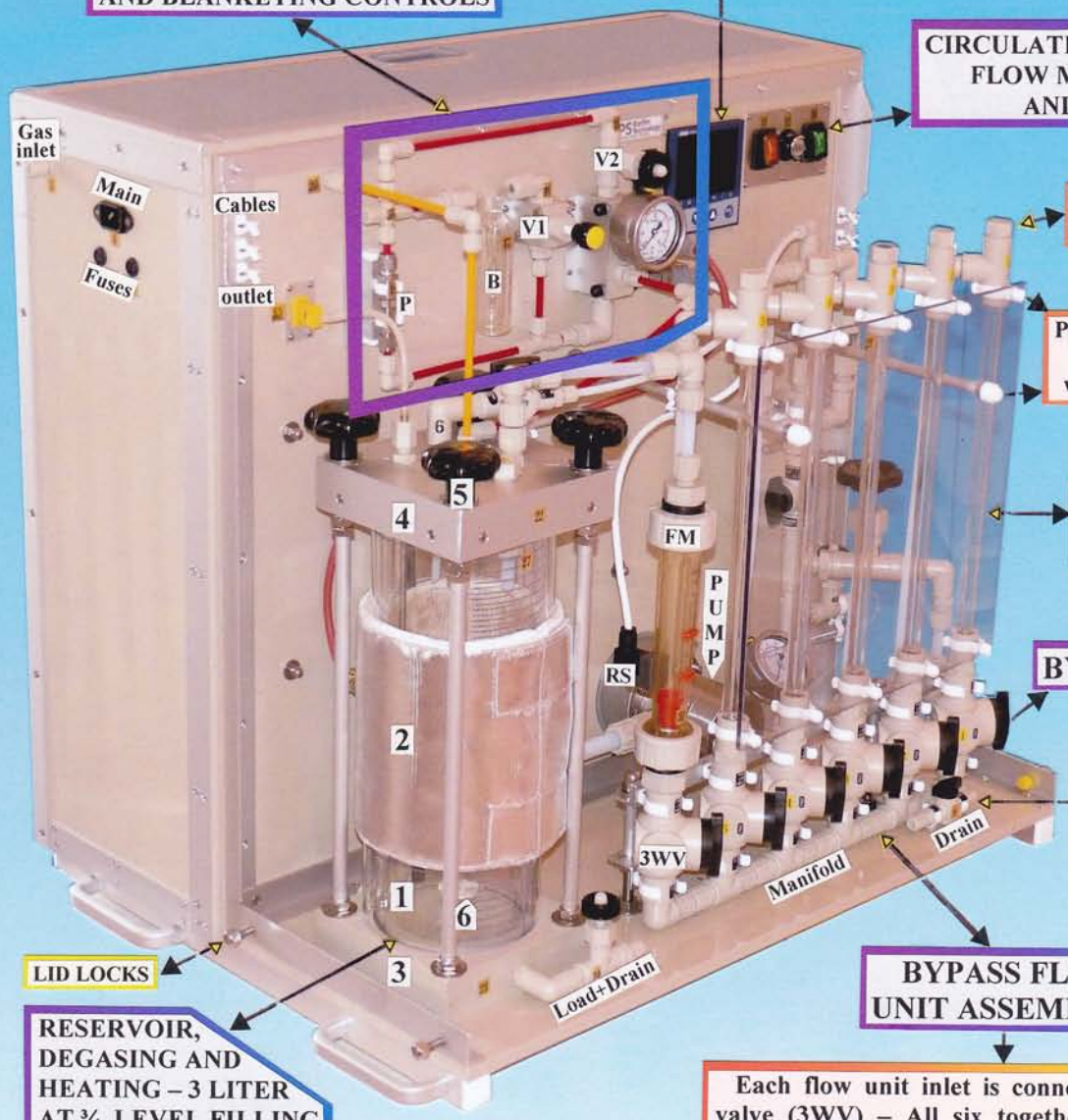
TEMPERATURE CONTROLLER WITH PROCESS AND SET VALUE DISPLAY

The continuous duty magnetically driven pump, throughput 9 L/min, enables a flow velocity at the coupon of 3 m/s ≅ 10 ft/sec – The electrical motor is driven by a frequency inverter, thus the flow velocity is perfectly and fully adjustable – The flow meter (FM), 10 L/min, with magnetic swimmer is equipped with a reed switch (RS) that stops the pump automatically, thus avoiding dry run.

GAS SPARGING AND BLANKETING CONTROLS

TEMPERATURE CONTROL

CIRCULATION – PROPULSION FLOW MEASUREMENT AND CONTROL



TOP-T – ARRAY OR PROBE FITTING

PC GLASS PROTECTION 'very easy to take off with hand-tighten screws'

FLOW UNIT ASSEMBLY-5

BYPASS FACILITY

‚a quick and total drain is possible with the two drain valves'

LID LOCKS

RESERVOIR, DEGASING AND HEATING – 3 LITER AT ¾ LEVEL FILLING

Consists basically of a protected pressure glass cylinder (1) with extra thick walls, externally heated by a jacket (2) – The cylinder sits in a conical bottom block (3) of PP or PVDF – The top is closed by a block structure (4) with all corresponding connections – The two blocks seal the glass cylinder with special FPM o-rings – The pressure to seal is exercised by four tighting knobs (5) – A fritted glass candle mounted in the top block enables gas sparging (6) – The thermocouple is located at the first 1/4 level of the cylinder.

BYPASS FLOW UNIT ASSEMBLY-5

Each flow unit inlet is connected to a three way valve (3WV) – All six together are linked to the manifold – This results in following functions:

FLOW UNIT ISOLATION FUNCTION: Each unit can be individually isolated with the flow loop under pressure and running – It is posible to transfer coupons or change probes while the other units are running normally.

FLUID EXCHANGE FUNCTION: The drain valves at the bottom of the reservoir and the one in the manifold make an easy and quick drain possible – Such a function enables to use the instrumentation as biofilm generator and treatment loop at once.

Such a flowLoop can be used for a variety of applications:

BIOFILM GENERATION

The large port capacity is ideal to generate biofilm. Up to 100 biofilm coupons can be exposed to the fouling medium.

MATERIAL TESTING: Among the large variety of steels, alloys, coatings and plastics, to know which type is more resistant to biofilm development is of interest to pipe producers and designers of water systems.

The selection principle is easy, if five material types have to be tested each array is made out of a different material. A periodic transfer program with complete microbial assesssment and solids accumulation measurements will determine which material is best under strictly similar conditions.

BIOFILM TREATMENT

In the early days to treat the biofilm in the same generator loop seemed to be out of question – An additional treatment loop was recommended. The new ones equipped with:

-BYPASS FACILITY
-FLUID EXCHANGE FUNCTION
-FLOW UNIT ISOLATION FUNCTION

make possible to perform all tests in the same loop.

DYNAMIC TIME-KILL TEST ON BIOFOULED SURFACES: After development of a mature biofilm in the generation loop, the procedure is as follows:

- Isolation of all flow units.
- Total drain (10 min).
- Loading with treated fluid with biocide (10 min).
- Gas sparging under flow (5 min).
- Start treating flow unit-1 while the rest of the units remain isolated.

Now it is just the matter to run a conventional time-kill test. That is, periodic transfers of biofilm coupons, followed by assessment of the sessile bacterial population and solids accumulation if required.

After having treated flow unit-1, start previous procedure with flow unit-2 with biocide-2 . Repeat same procedure for the rest of units with the other biocides to select.

The best product is the one that reduces the bacterial population to a minimum within the shortest exposure time.

ITEM#805

COMBINATION FLOWLOOP

BYPASS BIOFILM, CORROSION AND TREATMENT LOOP WITH SAND PACK ASSEMBLY-3, PP/PTFE, 65°C, 2.7 BAR (≦40 PSI), 3 LITER, 9 L/MIN (3 M/S ≅ 10 FT/SEC), 5 FLOW UNITS, WITHOUT SENSORS, 110 or 220 V

SIMULATION OF A PERIODIC SLUG TREATMENT PROGRAM: Each unit is treated similarly as above described. After treatment, the array is left in the standby packing tube with sparged medium – Then, they are cultured all together again to start regrowth – It is a kill-regrowth study – Continuous injection can also be simulated with treated growth medium.

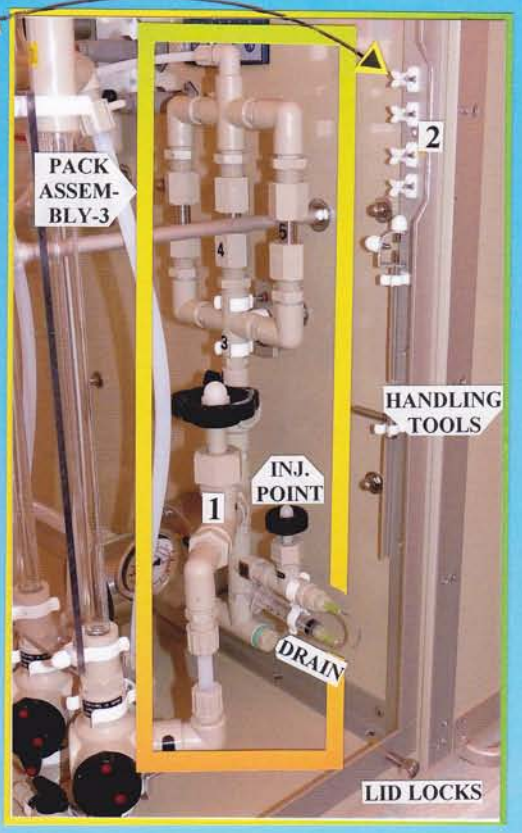
CORROSION MEASUREMENTS

By changing the biofilm arrays by gravimetric corrosion arrays and electrochemical probes, the loop converts itself in a corrosion resistant water circulation system to test materials and corrosion inhibitors with gravimetric and several electrochemical techniques simultaneously. The most relevant characteristics to be mentioned are:

- Perfectly adjustable flow velocity up to 10 ft/sec.
- Controllable gas sparging and blanketing up to 50 PSI.
- Adjustable temperature up to 90°C with PVDF/PFA loops.
- The five flow units make possible to use simultaneously gravimetry, linear polarization, potentiodynamics, AC impedance and electrical resistance, thus serious research programmes can be undertaken.
- Film persistence can be measured at the same loop.
- A layer of oil can be added to the corrosive medium, thus the positive or negative influence to corrosion inhibitor effectivenes can be studied.
- The combination of glass, PVDF, PFA and fluor rubber sealing elements make the instrumentation very resistant to highly corrosive environments.

ELECTROCHEMICAL CABLES WAY OUT CLAMP – 2

MICROBIAL GROWTH IN POROUS MEDIA



The combination FlowLoop presented herewith enables simulation of microbial growth in porous media – The Sand Pack Assembly-3 is bypassed in the main stream – Valve-1 (1) generates a back pressure that squeezes the fluid through the assembly-3, reinjecting the fluid to the reservoir top – The sand pack bypass can be fully isolated by inlet and outled valves – Each run enables to gather the results of a blank or one product by triple measurement.

The assessment of the microbial population in a porous media pack as well as the significance of results is described in Page 36.

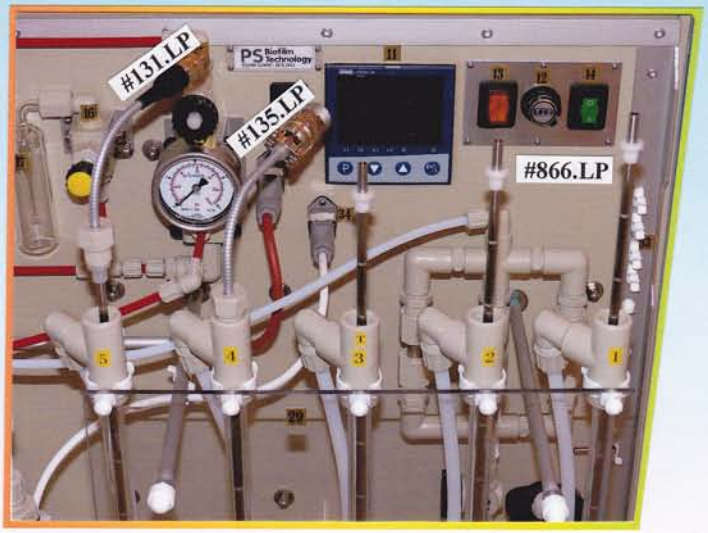
The assembly is ideal to select products to prevent wellbore plugging due to microbial growth. The products or treatment selected will be the one which decreases the bacterial population to a minimum.

INJECTION POINT: Aseptic inoculation of cultures or chemical injection – Dead volume 1 ml – With luer-lock connection and capillary injection in the middle of the stream.

INDEX CODE: Each part is labeled with a number - In the users guide all comments and instructions are related to the numeration code.

ARRAYS AND PROBES FOR FLOWLOOPS

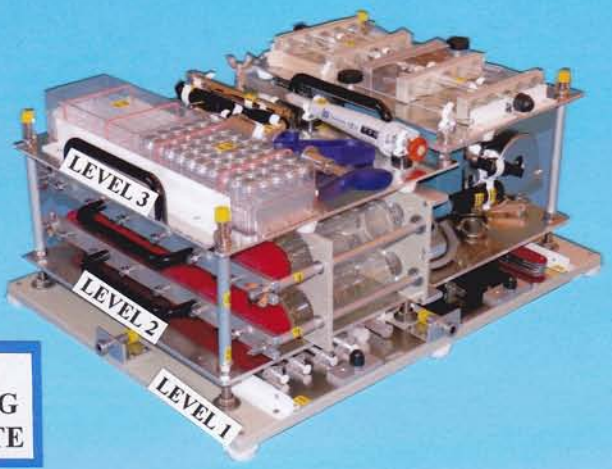
ITEM#551.LP – BIOFILM ARRAY 18 CS COUPONS 2 CM²
ITEM#552.LP – BIOFILM ARRAY 20 CS COUPONS 2 CM²
ITEM#866.LP – GRAVIMETRIC CORROSION ARRAY 6 CS COUPONS 8 CM² - SPACER 1.5 CM
ITEM#867.LP – GRAV. CORR. ARRAY 5 CS COUPONS 8 CM² - SPACER 5 MM
ITEM#131.LP – LPR PENCELL PROBE 3 CS ELEMENTS 8 CM²
ITEM#135.LP – ER PENCELL PROBE 2 CS EL. 12 CM² - REF. ECTFE COATED
(see details in Pages 31+32+33)



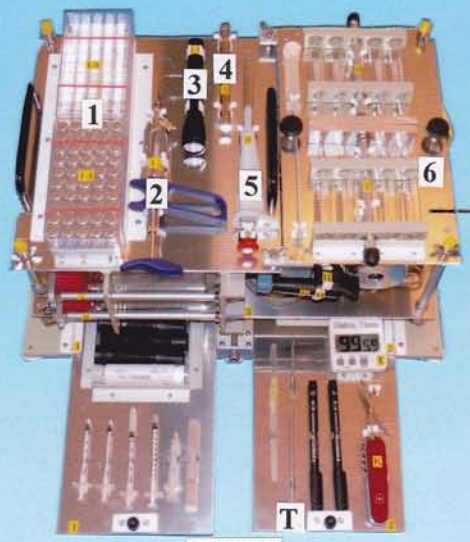
ITEM# 551.LP | ITEM# 866.LP | ITEM# 131.LP | ITEM# 135.LP

Demulsifier Testing Equipment

A lid carrying case containing all equipment to select emulsion breakers for crude oil dehydration



ITEM#1002
DEMULSIFIER TESTING EQUIPMENT COMPLETE



LEVEL 1

Packing and unpacking is very easy, most of the parts are skid mounted and held by fixation clamps – The numeration labelling at the top of each part, accessory or instrument corresponds to the same number where it does belong for packing. It is just the matter of matching numbers. Thus everything finds its right place very easy.

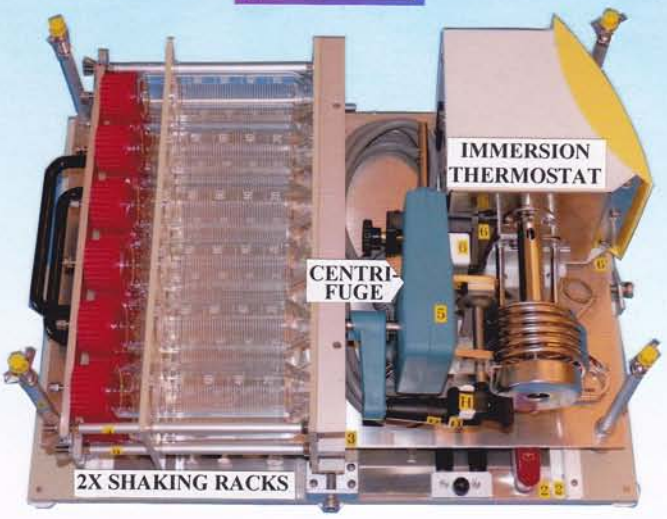
LEVEL 3 contains one box with 50 empty 2 ml bottles (1) with FPM seal and wide neck cap for demulsifier samples. An additional empty box rack is available – A pipetting syringe (2) to sample top oils – A flash light (3) to observe the interface – A manual thermometer (4) – A microsyringe (5) 1-10 µl that enables accurate demulsifier dosification undiluted directly into the emulsion – The tray at the right side (6) houses two racks, each with 4 API centrifuge tubes to determine basic sediments and water from the top oils.

LEVEL 1

Consist of two drawers that can be totally taken out just by pulling – The small parts and accessories find its place here:

The left drawer contains a set of syringes of different volumes to prepare new blends or make dilutions + The hull sleeves to centrifuge the API finger tubes – The drawer at the right side contains the yellow cloth bands to label, the markers and the scissors of the Swiss knife to cut labels to the right size + The chronometer and the tubes to take top oil samples are also available here (T).

LEVEL 2



WATER BATH

The lid of the carrying case is lined with an aluminium jacked of 2 mm thickness, thus perfectly water tight. As shown besides it is used as water bath with a capacity for 4 racks (24 tubes) – An immersion thermostat with microprocessor temperature controller and circulation facility maintains constant temperature at all locations of the bath.

NEW SHAKING RACK – 0.5 KG

A new construction has allowed to drastically decrease weight of the empty rack (now only 0.5 Kg) – Together with the 6 tubes it weighs 1.2 Kg – The base has been reinforced with 2 aluminium bars – No bending possible now – The 6, 100 ml conical graduated tubes are equipped with a screw cap and made of special thick glass walls – If a shaking machine is available, the racks can be assembled together.

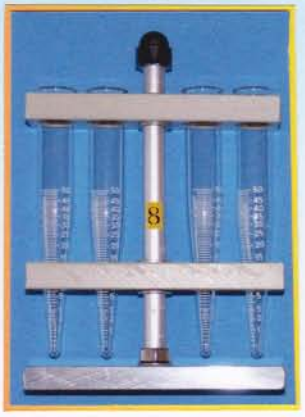
SHAKING RACK WITH 6, 100 ML DEMULSIFIER TUBES

The top bar can be totally taken off. Each tube can be individually fixed with an adjusting screw. No vibration when shaking or during transport.

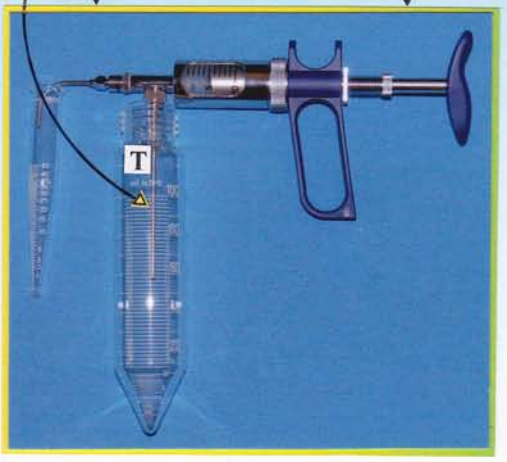
TOP OIL GRINDING

After finishing water separation, the top oil quality can be determined with API tubes and by grinding with a small hand centrifuge. It can be operated with a minimum force, no electricity required, extremely robust and totally maintenance free.

Rack with 4 API finger tubes. The rack provides best protection for such fragile glass ware.



Top oils are taken precisely at the same level with an automatic pipetting syringe. (T) – Two tubes with different length are available – Samples can be taken at two levels.



Flow Units

LP LOW PRESSURE

Surveys and Investigations

The LP Flow Units are made of glass and PP or PVDF connections. They withstand a pressure of 10 Bar by 20°C and 4 Bar by 70°C. As the flow is regulated downstream, exposure to conditions beyond above values should not be considered.

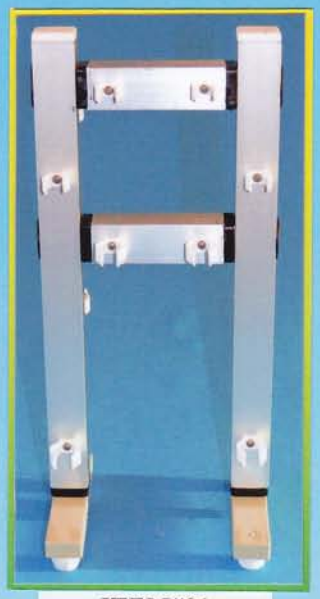
HIGH PRESSURE **HP**

Field Monitoring

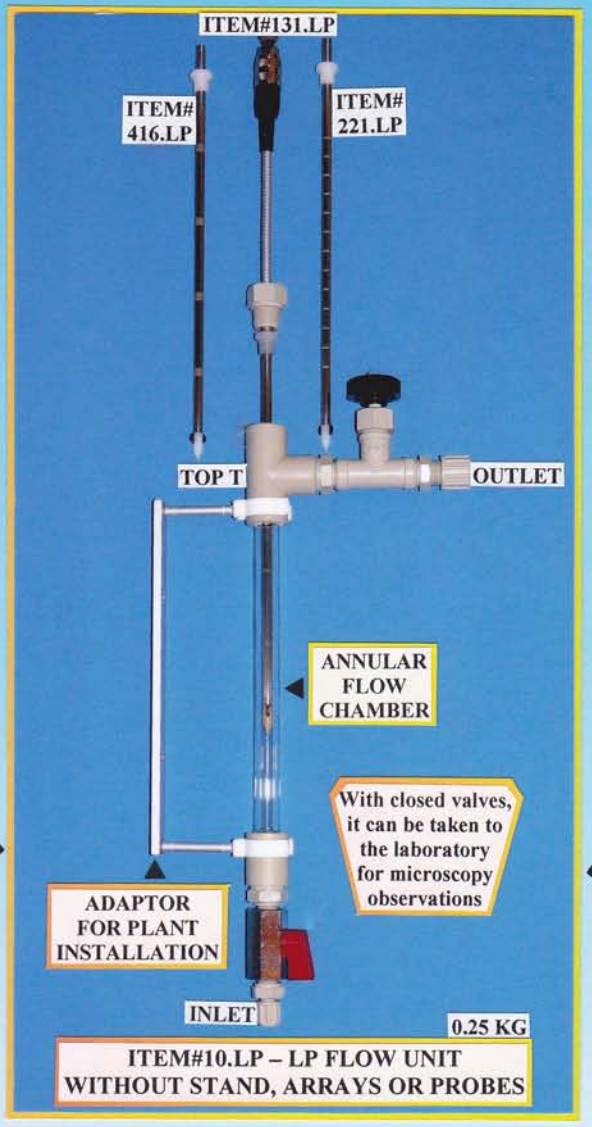
The HP Flow Units are made of SS-316 Ti tubing and SS-316 L connections and withstand pressures of 200 Bar. As such units are designed to be exposed permanently for monitoring, to avoid the danger of plugging, they are delivered without valves.

SEE INSTALLATION DETAILS AT PAGE 14

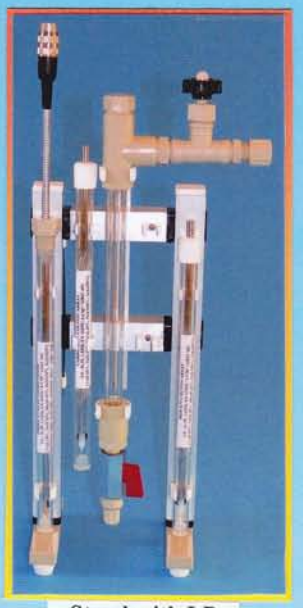
LP FLOW UNIT



ITEM#01
FLOW UNIT STAND



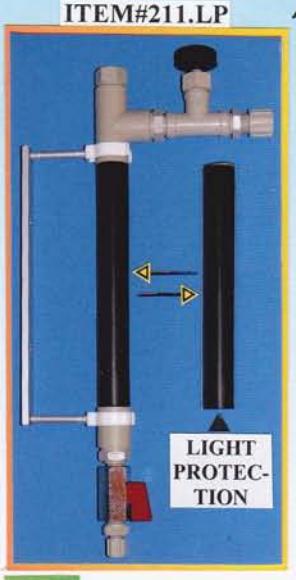
ITEM#10.LP – LP FLOW UNIT
WITHOUT STAND, ARRAYS OR PROBES



Stand with LP Flow Unit, arrays and probes

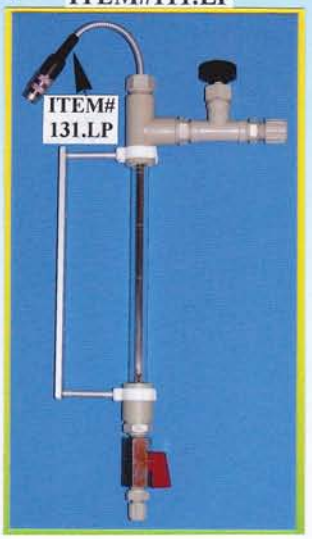
LP BIOFILM FLOW UNIT WITH ARRAY-12 (ITEM#221.LP)

ITEM#211.LP



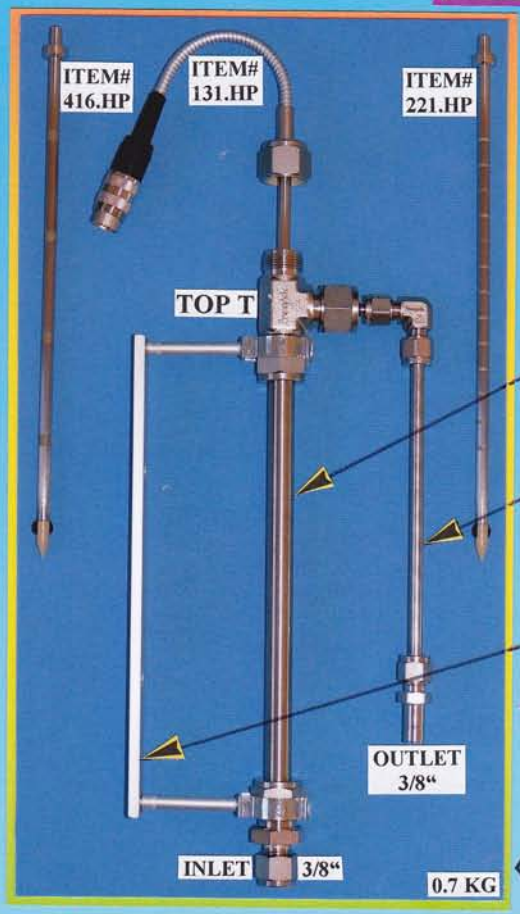
LP CORROSION FLOW UNIT WITH LPR PROBE

ITEM#111.LP



The LP Flow Unit consists basically of a pressure glass tube (15 Bar), connected to an inlet valve and a T-Top fitting on which coupon arrays or corrosion probes can be slid in. The water flows then in the annulus between glass tube and probe. The fluid magnifies the surface of the probe, thus it is possible to better observe visually the fouling process. The outlet valve permits to adjust the flow up to 6 L/min. Such a throughput generates a flow velocity of 2.26 m/s (≈7.4 ft/sec) at the coupon surface.

HP FLOW UNIT



Annular flow devices to measure gravimetric and electrochemical corrosion, to assess the microbial population in biofilms and solids accumulated on surfaces

Stand with HP Flow Unit, probes and arrays

ANNULAR FLOW CHAMBER:
A SS-316 Ti tube on which through the TOP T, biofilm, corrosion arrays or probes can be slid in.

FLOW CONTROLLING SECTION:
A tube with an ID of 2 mm that reduces flow by pressure drop and not punctually as valves do, thus plugging is very unlikely to occur.

ADAPTOR FOR PLANT INSTALLATION:
Facilitates vertical mounting at any location of the system.

The annular flow reproduces very closely the hydrodynamics of a tube and enables high linear velocity for a relative low flow.

ITEM#10.HP – HP FLOW UNIT WITHOUT STAND, ARRAYS OR PROBES

GRAVIMETRIC CORROSION COUPON ARRAYS

GRAVIMETRIC CORROSION ARRAYS:
ITEM#416.LP or HP – 3 CS COUPONS 8 CM²
ITEM#645.LP or HP – 4 CS COUPONS 8 CM²
ITEM#555.LP or HP – 5 CS COUPONS 8 CM²
ITEM#866.LP or HP – 6 CS COUPONS 8 CM²

HP COUPON ARRAYS

THE COUPONS ARRAY enables exposure of several specimens under identical conditions. The periodic retrieval allows to study the corrosion kinetics. With the simultaneous retrieval of several coupons it is possible to apply statistics. The coupons are most adequate to determine total solids accumulated on surfaces.

1.5 mm ← INSERT SPACING → 5 mm

INSERT SPACING: Depending upon the specific application 1.5 mm or 5 mm insert spaces are delivered. Such space between the coupons isolates one from each other. Usually, for long time exposure and high pressure the 5 mm spacers are favoured.

THE SINGLE GRAVIMETRIC CORROSION COUPON consists of a specimen of same or similar metallurgy as the system. The ends are internally threaded. A PEEK double nipple, also so-called INSERT, holds the coupon array together and enables single transfer (see next page).

EXPOSED SURFACE OF EACH SPECIMEN: 8 CM²

FLOW STABILIZATION SECTION: SS-316 L section with a length of 20 annular diameters to stabilize the flow and enable constant flow regime in all coupons.

CENTERING FPM BRAKE: Fits highly precisely into the tube and acts as a brake producing a friction, so that the array does not abruptly drops and centers the array just in the middle allowing a perfect annular flow.

BIOFILM COUPON ARRAYS

BIOFILM ARRAYS:
ITEM#221.LP or HP – 12 CS COUPONS 2 CM²
ITEM#640.LP or HP – 14 CS COUPONS 2 CM²
ITEM#551.LP or HP – 18 CS COUPONS 2 CM²
ITEM#552.LP or HP – 20 CS COUPONS 2 CM²

ITEM# 221.LP

ITEM# 221.HP

It is elementary to simulate biofouling in a similar material as the system and under flow regime. It is a necessity to be able to study the kinetics and not to rely upon single measurements. The biofilm arrays fulfil literally those requirements.

The annular flow pattern enables the use of a RETRIEVABLE and TRANSFERRABLE coupon array in which a multitude of cylindrical specimens are exposed under identical flow pattern – 'It is a retractable pipe inside a pipe'- It allows miniaturization and flexibility – The exposure of such a high number of specimens multiplies the testing, monitoring and screening capacity.

The arrays are polished manually in longitudinal motion with gradual grit grades up to 400 grit. It results into a perfectly flush mounted exposure. They are delivered with internal and external threads aseptic.

The arrays are delivered in an acrylglass (PMMA) tube. In case that the flow units require cleaning, the exposed arrays can be kept in the packing tube, filled with field water, while cleaning – No considerable changes will occur for such a short exposure in an aerobic media.

Specimens Transfer Procedure

'The T-TOP of the LP flow unit has an FPM o-ring with triangular sealing space'

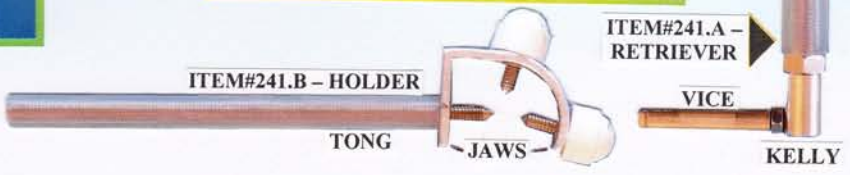
IRON SULFIDE DEPOSITS QUANTIFICATION

BACTERIAL ENUMERATION BY ANY METHOD or TOTAL SOLIDS ACCUMULATED INTO SURFACES MEASUREMENT by Micropre filtration and total dissolved iron determination

REVERSION OF SESSILE INTO PLANKTONIC POPULATION BY SONICATION

PAGE 43
PEEK INSERT

ITEM#241 – COUPON HANDLING TOOLS



ELECTROCHEMICAL PenCell PROBES

Annular space probes to measure corrosion electrochemically

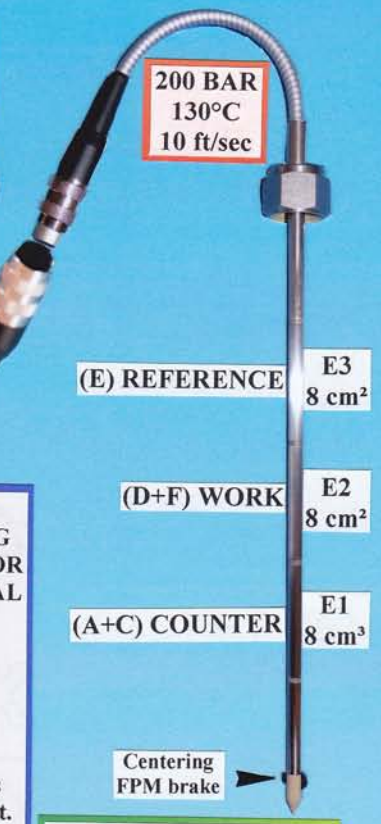
ITEM#131.LP
PENCELL
LPR PROBE
3 CS ELEMENTS
8 CM²

Pencell, bayonet, stick or slide probes. The designation is not relevant. The fact is that the cylindrical elements are held together with PEEK inserts of a spacing of 1.5 or 5 mm depending upon the application. The internal wires are connected to the elements by soldering and threaded inserts to achieve a safe and permanent contact. The internal spaces are filled with epoxy resin. Thus, perfectly tight but not dismountable. Instead just by sliding in or pulling out, the probe is extremely easily retrievable and transferable, thus very flexible and easy to use.
A surface finishing up to 400 grit enables a perfect flush mounted annular space, thus reproducing very closely the hydrodynamics of a tube wall. The design is ideal to reach high linear velocities with a relative low flow.

COUPLER PLUG
+ SOCKET FITTING
CONFIGURATED FOR
ELECTROCHEMICAL
INSTRUMENTS

Above pin code
is just given as
an example

Other configurations available upon request. The probes can be used as two or three electrode systems



ITEM#131.HP
PENCELL LPR PROBE
3 CS ELEMENTS 8 CM²

The probes are most adequate to perform linear polarization resistance (LPR), potentiodynamic or AC impedance measurements.
The probe elements are available in different metallurgies. The standard versions are made with 1.5 mm spacing PEEK inserts. 5 mm spacing inserts available upon request.

The socket connector of all PenCell probes is held by a flexible microphone cable. Therefore, the connection can be done from all directions and stays rigid. Moreover, the flexible tube acts as a shield.

ER PenCell PROBES

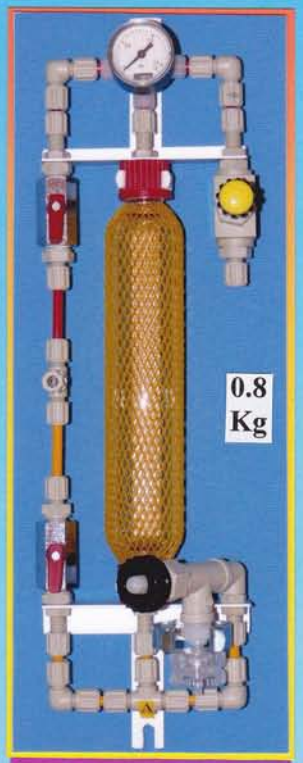
Annular space probes to measure corrosion through electrical resistance

Basically, the electrical resistance of metal specimens increases when they get corroded or decreases its original weight. Such a principle can be used to measure metal loss.
As electrical resistance increases with the temperature, it is elementary to expose the reference element under same conditions as the measure element. Therefore, the reference element is coated with ECTFE (copolymer of ethylene+monochlorinetrifluorethylene), resistant up to 150°C and to most of chemicals – Separate electrical current and voltage monitoring wires are used.
It is clear that if extremely thin elements are used, the response will be faster, the probe however will not last long. Therefore, the wall thickness has been left normal and the surface exposed increased to 12 cm².

ITEM#135.LP or HP – ER PENCELL PROBE 2 CS ELEMENTS
E1: BLANK – E2: ECTFE COATED

MEMBRANE FILTRATION UNIT

An on-line micropore membrane unit with reservoir, to measure filtration rates and suspended solids

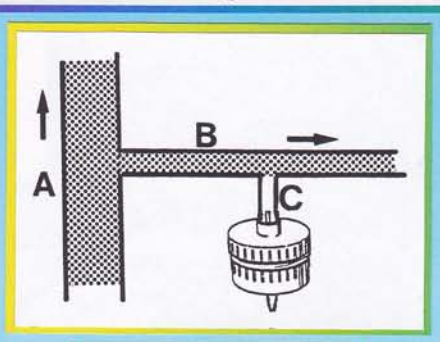


ITEM#152
MEMBRANE
FILTRATION
UNIT – PP/GLASS

ITEM#153
MEMBRANE
FILTRATION
UNIT – PVDF/GLASS

The Membrane Filtration Unit has been designed to fit in the Portable Diagnosis Laboratory, it has small dimensions and weighs 0.8 Kg. However, that is not the major innovation. Indeed, it samples and collects water under one bar and then uses the system pressure through a regulating sidestream to maintain constant pressure, thus avoiding the inconvinience of instruments without reservoir. That is, only the water that has been sampled in the reservoir, without aeration, passes through the membrane.

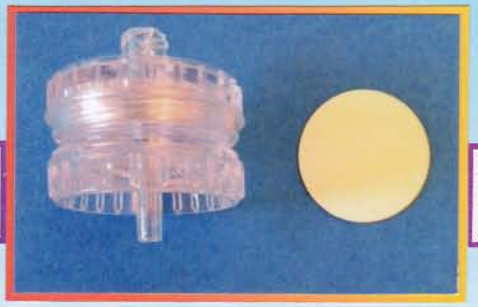
Sidestream micropore devices without reservoir require a regulating stream B to maintain constant pressure, as the membrane gets plugged, the stream C becomes negligible compared to stream B, thus all big particles avoid stream C and are carried through B.



Further information about application in PAGES 5+23

ITEM#20 - MEMBRANE
FILTRATION UNIT
WITH STAND
PP/GLASS

ITEM#22 – MEMBRANE
FILTRATION UNIT
WITH STAND
PVDF/GLASS



ITEM#157 – POLYCARBONATE HOLDERS – D=25 MM -12 UNITS

ITEM#162 – MICROPORE MEMBRANES – 0.45 µM – 25 MM – CELLULOSE ACETATE – 100 UNITS

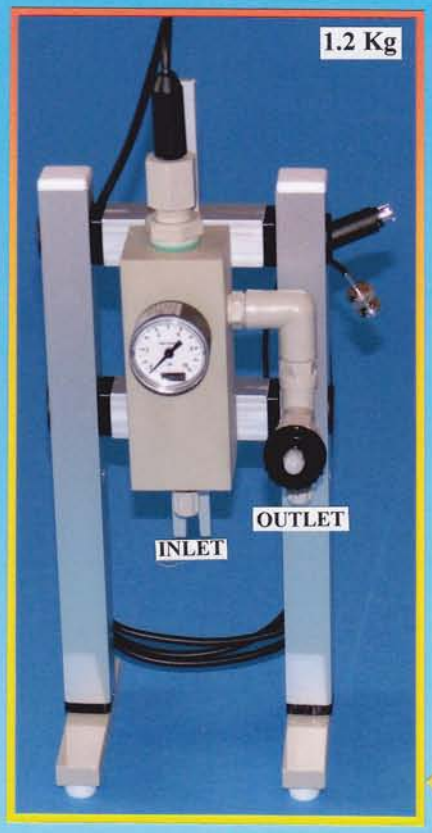
The 25 mm size holders are used for filtration with the Micropore Filtration Unit

ITEM#158 – POLYCARBONATE HOLDERS – D=13 MM -12 UNITS

ITEM#163 – MICROPORE MEMBRANES – 0.45 µM – 13 MM – CELLULOSE ACETATE – 100 UNITS

The 13 mm size holders are used to determine suspended solids in highly dirty waters or to measure total solids accumulated on surfaces after sonication. In such case, volumes of 2 to 10 ml are sufficient and filtration can be done with a normal syringe.

pH PRESSURE FLOW UNIT



Sidestream flow unit to measure pH under pressure

ITEM#171 PRESSURE pH PROBE WITH FITTING – 4 BAR/65°C

See Page 6 – The chemistry of the water changes immidiately after sampling. Temperature, release of hydrogen sulfide and carbon dioxide as well as oxygen intrusion and redox reactions take place. A water sample in the laboratory is not representative. pH measurement on-line is crucial.

The pH Pressure Flow Unit consist of a PP block fitting a pH probe. The water flows through the annular space with pressure gauge. Flow and pressure are regulated by the outlet valve.

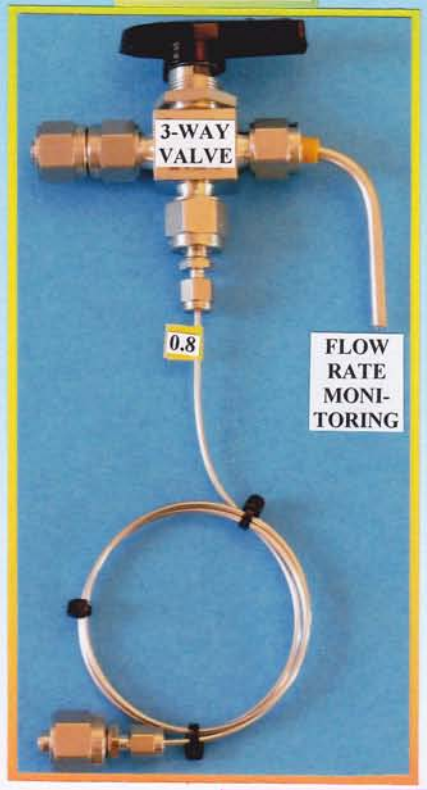
The maximum pressure by 65°C is 4 Bar, sufficient to maintain the usual amounts of carbon dioxide and other gases perfectly dissolved. The chemistry of the water does not change in the flow unit.

In case that the Portable Diagnosis Laboratory is not available, the stand enables a confortable use of the flow unit at any location of the system.

ITEM#30 – pH PRESSURE FLOW UNIT WITH PROBE AND STAND – 4 BAR/65°C

HP CAPILLARY FLOW UNIT

ITEM#435.HP HP CAPILLARY FLOW UNIT



Determination of tube plugging by mineral scale deposits with capillaries

The unit consists of one capillary of a length of 50 cm and ID's of 0.3 or 0.8 mm. The connection at the capillary inlet houses a double lattice-screen, one with a mesh of 250 µm to support a fine screen of 32 µm mesh, thus if the capillary gets plugged will be due to scale formation and not to suspended solids.

The outlet of the capillary is connected to a 3-way valve which enables measurement of the flow rate with a volume cylinder and a stop watch. The periodical collection of such data permits to assess the plugging kinetics.

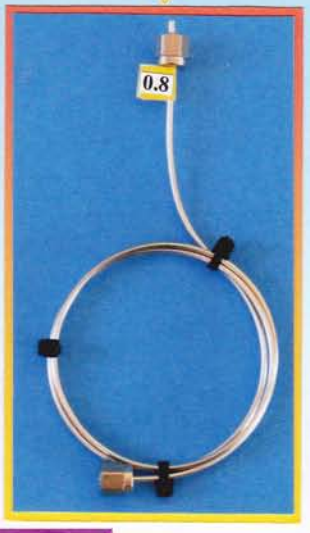
Plugging will occur according to Poiseulles's low which states that the volume passing through a tube reduces exponentially as its internal diameter reduces. Capillaries are most likely to get plugged at the end where the maximum pressure drop takes place.

Cutting a small piece of capillary from the end, it is possible to observe it by scanning electron microscopy and determine its nature by X-ray microanalysis or X-ray diffraction.

Plugged capillaries by scale can be reused by injection of an acidic solution with a syringe or a peristaltic pump.

ITEM#431 – SINGLE SPARE CAPILLARY WITH CONNECTIONS ID=0.8 MM – L=50 CM

ITEM#432 – SINGLE SPARE CAPILLARY WITH CONNECTIONS ID=0.3 MM – L=50 CM



See Pages 12+13, capillary units are only available for installation in the HP On-Line Diagnosis System or with HP Multiple Monitoring Systems (Page 17)

HP POROUS MEDIA FLOW UNIT

The HP Porous Media Flow Unit consists of a SS-316 Ti column with a PTFE internal jacket longitudinally sectioned that houses the porous media allowing a filling volume of 3.5 cm^3. The grain is trapped in the column by a double inlet and outlet lattice-screen, one with a mesh of 250 µm to support a fine screen of 32 µm mesh.

The sand packs are delivered without porous media to enable filling with ground cores or local standard quartz sand. Mixtures of sand and other components present in the formation are very much recommended.

The average particle diameter to use is between 40 and 150 µm.

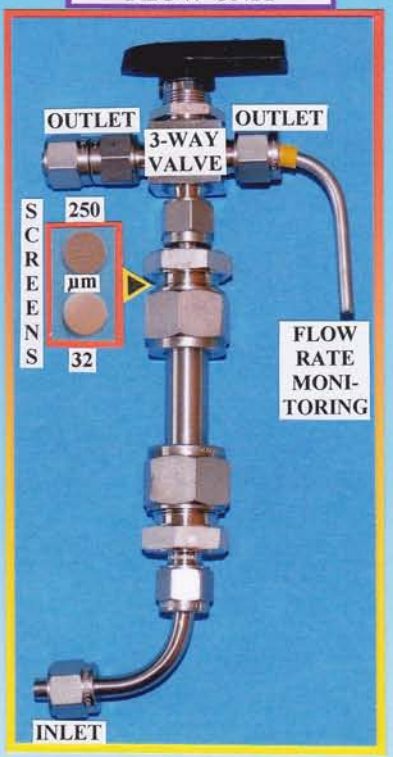
The 3-way valve installed at the outlet of the pack permits to measure periodically the flow rates with a graduated cylinder and a stop watch.

A very easy porous media transfer procedure makes the enumeration of the bacterial population possible.

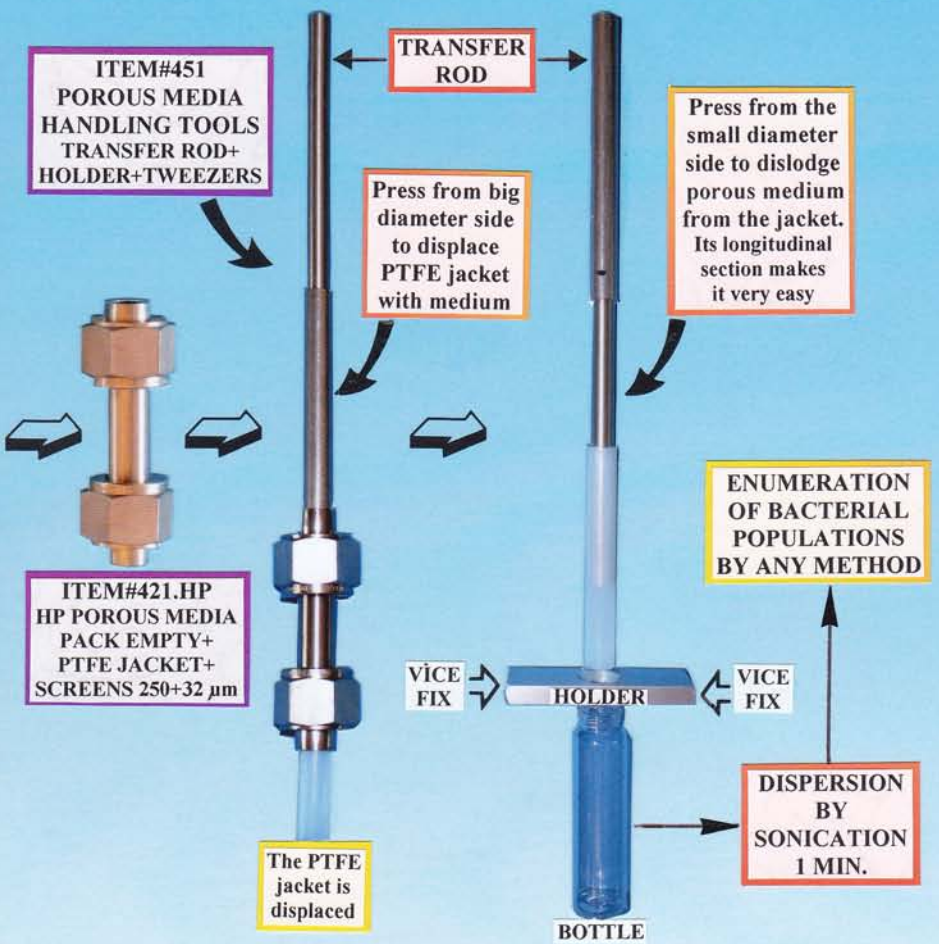
See Pages 12+13, HP porous media flow units are only available for installation in HP On-Line Diagnosis System or with HP Multiple Monitoring Systems (Page 17).

Porous Media Transfer Procedure

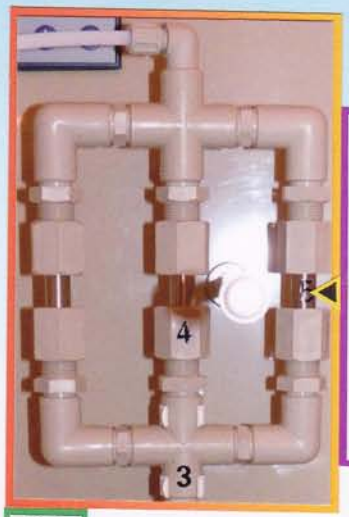
ITEM#425.HP
HP POROUS MEDIA FLOW UNIT



ITEM#451
POROUS MEDIA HANDLING TOOLS
TRANSFER ROD+ HOLDER+TWEEZERS



ITEM#421.HP
HP POROUS MEDIA PACK EMPTY+ PTFE JACKET+ SCREENS 250+32 µm



ITEM#421.LP
LP POROUS MEDIA PACK EMPTY+PTFE JACKET+ SCREENS 250+32 µm
–
LP Sand pack Assembly-3 is used in FlowLoops
SEE PAGE 27

SIGNIFICANCE AND DISCUSSION OF RESULTS: It is very difficult to simulate bacterial growth in the formation, the best approach is to work with cores, however that is always related to a complicated technology. The small size of the porous pack unit as well as the possibility to install them in parallel enables simulation of microbial growth in porous media.

The plugging of a porous media pack reproduces in certain extent the wellbore plugging phenomenon, usually it tends to get plugged with iron sulphide, slime and microbes.

If with a particular treatment, the microbial counts in the porous pack decrease and its flow rate remanins constant, undoubtedly, such a treatment should be favoured.

HP HEAT EXCHANGE FOULING MODULE

According to RP-189-89 Nace Standard the relation between heat flux and differential temperature can be expressed as follows:

$$U = (q/A)/(Tw-Tb)$$

The values for this particular application are as follows:

-The heat input (q) is adjustable up to 440 W.

-The surface (A) exposed to heat exchange is 25 cm².

-The heat flux (q/A) will be therefore:

176 kW/m² or 55 837 BTU/(h)(ft²)

-The bulk water temperature (Tb) can be measured anytime.

-(Tw) or temperature of wall between heat source and heat exchange surface is the process value figuring in the display of the temperature controller.

Thus, the overall heat transfer coefficient (U) can be calculated anytime and expressed in (W/m²/°C).

ITEM#50.HP
HEAT EXCHANGE FOULING MODULE WITH STAND

The heating cartridge fits highly precisely into the heat exchange tube allowing a heat exchange surface of 25 cm²

Gravimetric Controls as Additional Differentiation Parameters

As the efficiency of the heat exchanger depends upon the total amount of deposits accumulated to the heat exchange surface, an additional differentiation parameter is the weight increase. Such a parameter can only be measured because the tubes are easy to change and to store without skimming in the acrylglass tube supplied. It is also possible to measure corrosion gravimetrically.

Basic Construction Features

ANNULAR FLOW HEAT EXCHANGE CHAMBER

The module consists basically of an annular flow heat exchange chamber on which the heat exchange tube is perfectly centered in the middle by the bottom and top T's. Special FPM o-rings make the chamber tight and allow to take the heat exchange tube on and off, and to weigh it before and after exposure.

FLOW CONTROL SECTION
(see next page)

ADAPTOR FOR PLANT INSTALLATION

Facilitates vertical fixation at any location of the system and acts as a distance holder enabling free 'hand handling' by tube installation.

to avoid skimming of deposits

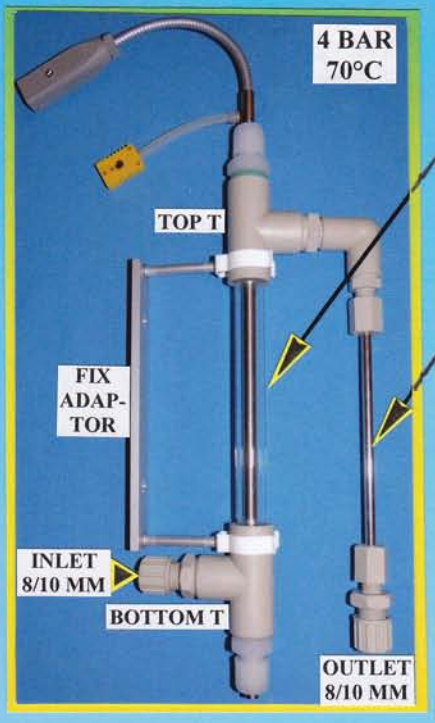
SPACING RING

Delivered in an acrylglass tube

ITEM#685 HEAT EXCHANGE FOULING TUBES

SS or CS

LP HEAT EXCHANGE FOULING MODULE



In this version the glass tube of the Annular Flow Heat Exchange Chamber enables to observe visually as the heat exchange tube gets fouled. The rest of the parts are made of PP or PVDF.

FLOW CONTROLLING SECTION

A tube with an ID of 2 mm that reduces flow by pressure drop and not punctually as valves do, thus plugging is very unlikely to occur.

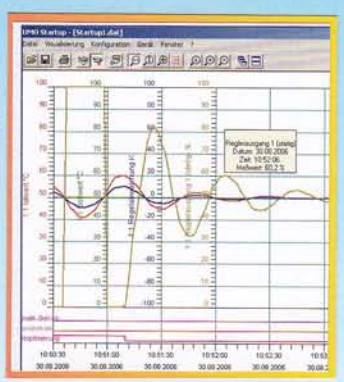
ITEM#50.LP – LP HEAT EXCHANGE FOULING MODULE WITH STAND

BASIC OPERATIONAL PRINCIPLE

The temperature sensor located in the heating cartridge in contact with the jacket and in the middle is driven by a temperature controller. As the heat exchange tube gets fouled, the cooling efficiency of the water stream decreases, thus the temperature of the cartridge jacket increases. Under constant flow conditions, such a temperature increase represents a direct measurement of the heat transfer efficiency.

HEATING ELEMENT DRIVE UNIT

INTER-FACE → USB



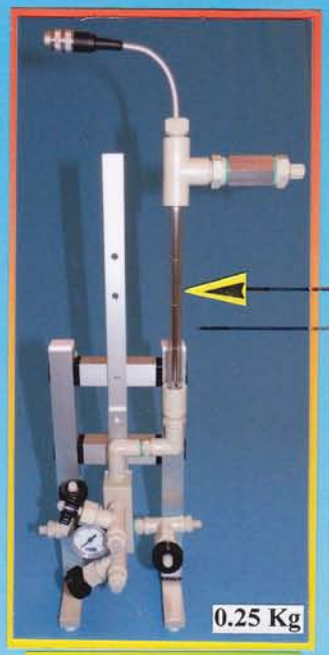
ITEM#60 – HEATING ELEMENT DRIVE UNIT

The Heating Element Drive Unit consists basically of a microprocessor temperature controller. The set value is increased in such a way that heating takes place under continuous basis. The hysteresis is programmed so that if flow stops no overheating can take place.

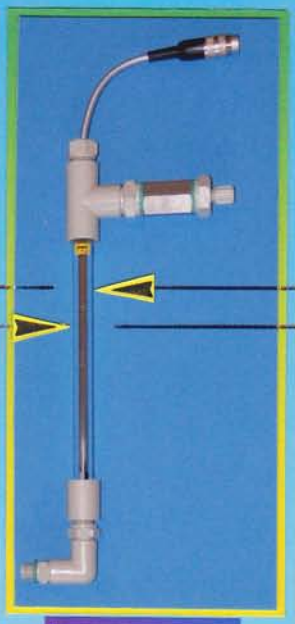
The outlet of the controller is coupled with a potentiometer that allows to adjust the heat flux up to 176 kW/m².

The temperature controller is equipped with an interface and a converter USB/TTL – The windows software delivered consists of a multichannel recording facility with graphic presentation and storage facilities.

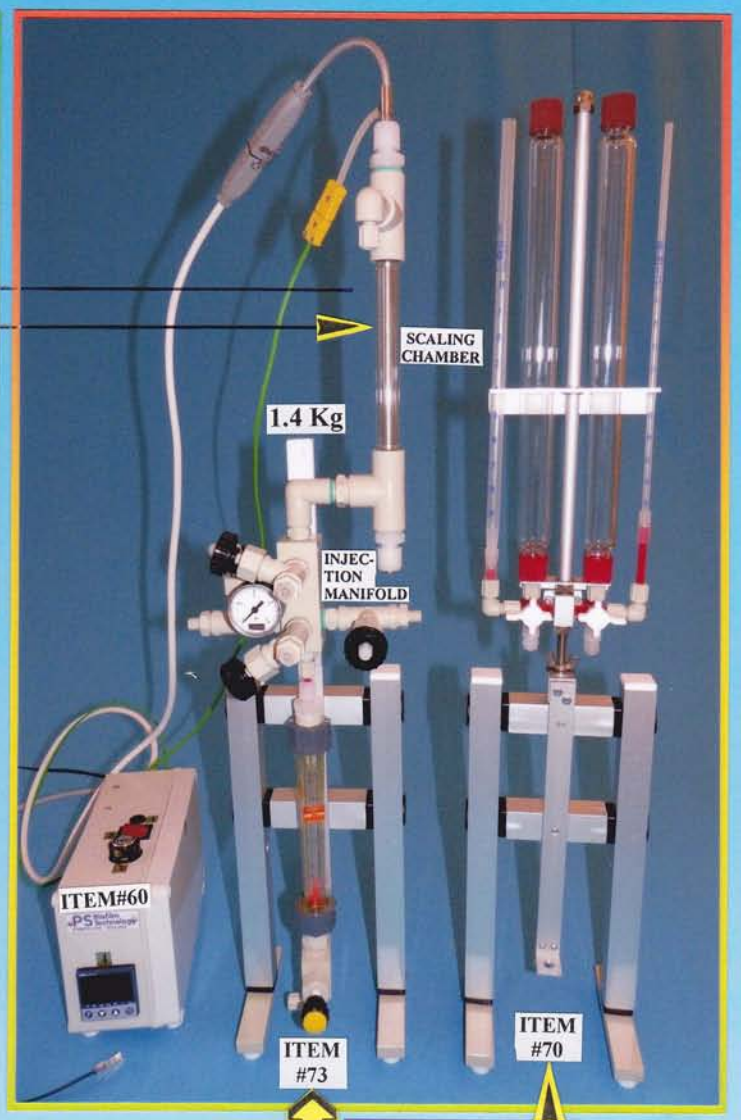
STAND-MODULAR SCREENING FLOW UNITS TO TEST SCALE INHIBITORS, CORROSION INHIBITORS AND BIOCIDES



CORROSON-BIOFILM SCREENING MODULE WITH INJECTION MANIFOLD + STAND



ITEM#75 CORROSION BIOFILM SCREENING MODULE AS EXCHANGE SINGLE UNIT



COMPARISON BETWEEN HEAT EXCHANGE AND SCALE SCREENING TESTS

Herewith the elementary screening flow units of the Chemical Treatment Simulation Machines (SEE PAGE 18) are offered in a modular version with stand. They are ideal to be used in the laboratory, but if nothing else available they can also be used in the field.

The technique is very similar to the one used in the LP heat exchange modules. Basically, the scaling tests are performed with much higher heat flux, lower flow rates and test durations. The heat exchange simulation tests are used for monitoring, whereas the scaling tests are used for screening purposes.

SCALING SCREENING MODULE +INJECTION MANIFOLD +STAND

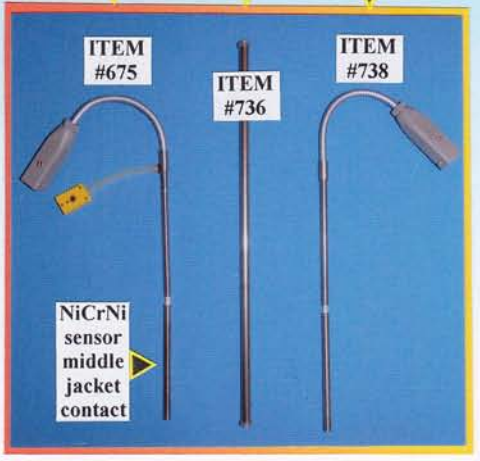
ITEM#73

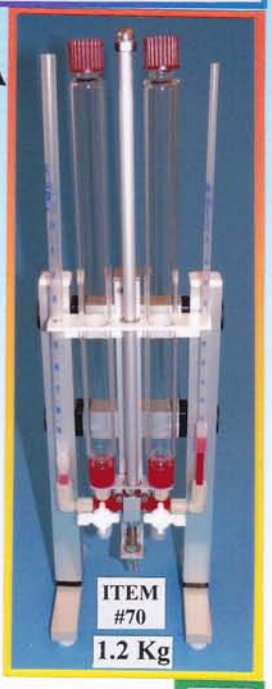
ITEM#70 – RESERVOIR AND METERING FACILITIES WITH STAND

HIGH PERFORMANCE HEATING ELEMENT THERMOCOUPLED 440 W – ¼"X4" 110 or 220 V

SCALING TUBE SSA4 316Ti 32.5 CM 8 MM 6.49 MM

HIGH PERFORMANCE HEATING ELEMENT NO SENSOR 350W – ¼"X4" 110 or 220 V





SURFACE DETERIORATION CYCLE

DYNAMIC IN-FLOW TESTING

COMPLETE PACKAGE for FIELD + LAB

Microbiologically Influenced Corrosion

Electrochemical Corrosion

Biofouling

LEAKING

PLUGGING

Heat Exchange Fouling

Microbial Induced Reservoir Souring

Scale

#555 HP+LP

#551 HP+LP

#135

HP #131 LP

#157+162

#675

#738

#736

#421

#431

Arrays and Probes

FIELD

LAB

Interexchangeable

As such detrimental phenomena are so closely related, it makes a lot of sense to study them together

ITEM#90 - VERTICAL RACK EMPTY ARRAYS+PROBES

ITEM#91 – FLAT RACK EMPTY FOR ARRAYS+PROB.

Variety of Arrays Probes and Sensors

Lid Housing

When doors or box covers become an obstacle → Take them off

No housing, no instruments.

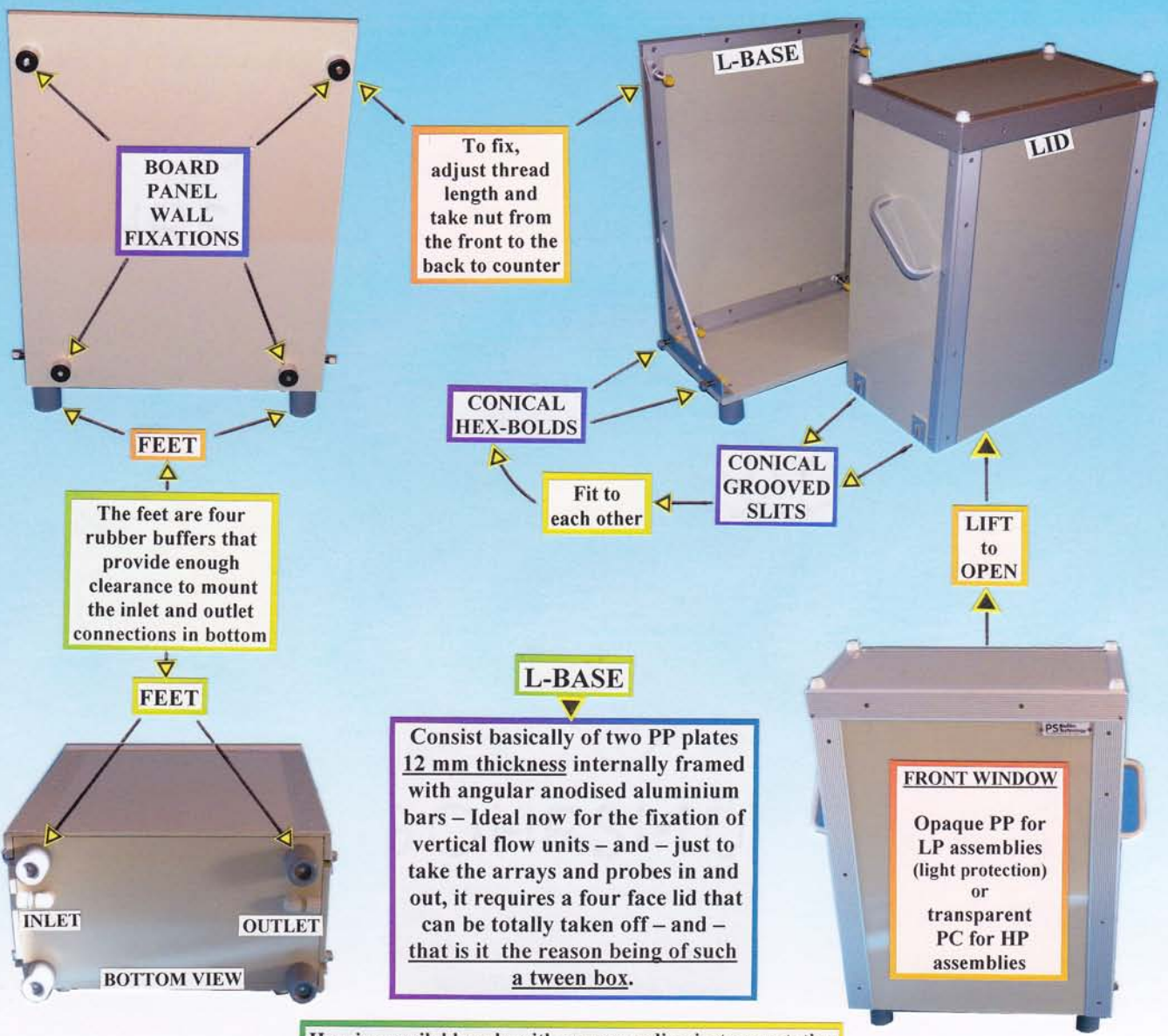
The majority of efforts have been invested developping the smallest components presented in the previous page and the biggest ones herewith described.

Basically there are three types of lid housing models:

- T-HOUSING: See Page 24, developed for the Flow-Loops.
- L-HOUSING: In this page, developed for field installation. The base is L-shaped: LID CABINETS.
- FLAT_HOUSING: Next page, the base is a flat board: LID CASES, also socalled SHIELD CASES.

The common feature of all three, is the fact that lids can be taken totally off, thus avoiding the inconvinience of box covers that become an obstacle to work on it – It is so important to be able to reach all parts with the hands, and, specially for the flat housing, to be able to work from all sides.

LID CABINETS



Housing available only with corresponding instrumentation

LID CASES

Lift to take lid off

CONICAL GROOVED SLITS

Fit to each other

LOCKING CONICAL HEX-BOLDS

The five face shield can now be used to store all parts not required – It is not appropriate to sit on it. A stool is much better

Wall thickness 8-12 mm

LEAD

It is important to be able to take lead and wheels off, they are seldom needed

Tablet to install lid with wheels on

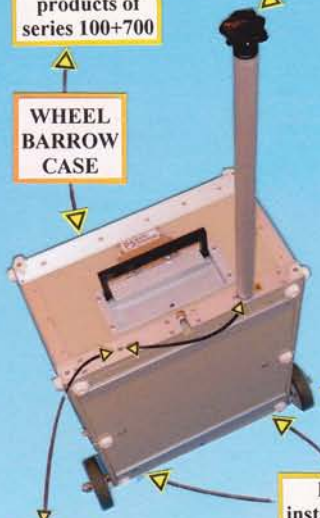
SNAP IN LEADING WHEEL

Brake

TRACTOR CASE
Delivered standard only with ITEM#791

Delivered standard with products of series 100+700

WHEEL BARROW CASE

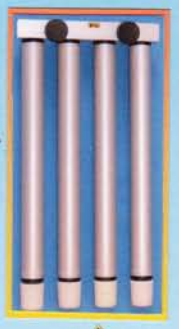


TRANSPORT ACCESSORIES
Packed extra in a black cotton bag

The tractor version can carry two additional lid cases. Stacking is possible due to the anti-skidding rubber buffers. It is also possible to load other gear or luggage up to 70 Kg.

LEFT or RIGHT

Leg installation position

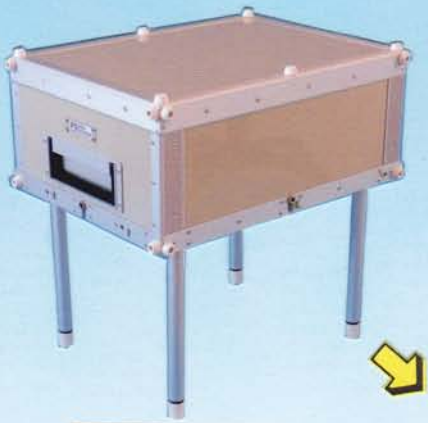


FLAT _HOUSING

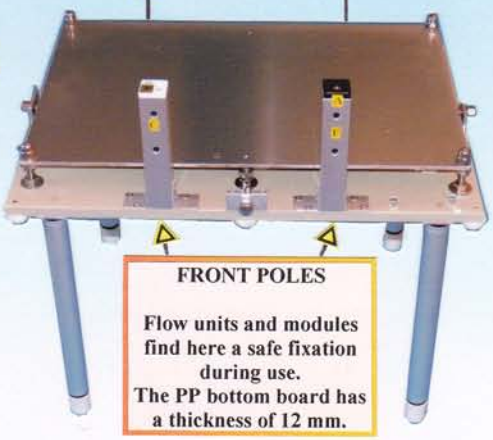
so-called

Because the base is a flat board

The 4 legs are packed in the bottom-behind



The 4 legs make a table out of it. They are adjustable to an uneven ground



FRONT POLES

Flow units and modules find here a safe fixation during use.
The PP bottom board has a thickness of 12 mm.

In such instrumentation the flow units and modules require a double fixation:
-One for transport+packing.
-One for display and work.
All units and parts have its corresponding double label numeration. Thus everything finds its right place very easy.

WHEEL BARROW OR TRACTOR versions can also be delivered with products of series 200, 300 and 1000 upon request as extra

Users Guides Instructions Manuals

The users guides are delivered in A4 folders. each sheet is protected by a transparent anti-static cover – The whole content can be scrolled very easily.

Few users guides are presented in numerical code – Each part of the instrumentation is labelled with corresponding number. Others are presented in pictures or diagrammes as shown hereunder.

The users guides are also available in pdf format – After delivery of the instrumentation, not before.

ELEMENTARY MAINTENANCE:
-Keep the instrumentation clean
-Keep it dry inside after use
-Keep original order

A Glance at the Temperature and Chemicals Resistance of Plastics and Elastomers Used in the Instrumentation

Herewith the resistance to following chemicals is given:
IPA – HCl-37% – HCl-10% – N-Gasoline – Xylene – Acetone. As representative of common types.
(+)=Totally resistant – (*)=Short exposure (washing purposes) – (-)=Avoid any contact

-PE (Polyethylene): -40°C+90°C – Resistant except to Xylene(*) – Used as hose.
-PP (Polypropylene): -25°C+111°C – Resistant except to Xylene(-) and N-Gasoline(*-) – Extensively used for housing and connections.
-PVDF (Polyvinylidenfluoride): -60°C+150°C – Totally resistant, inert – Used for connections.
-PTFE (Polytetrafluorethylene): -200°C+260°C – Totally resistant – Hoses.
-PC (Polycarbonate): -100°C+135°C – Non resistant – IPA(*), HCl-10%(*-) – Used for transparent front windows – Wash with cleaning tissues and dry with microfibre tissues.
-PVC (Polyvinylchloride): -45°C+70°C – Acid and IPA resistant – Acetone, N-Gasoline and Xylene(-) – Only used for micropump hoses (Tygon) to inject diluted chemicals – FPM hoses are also available.
-PMMA (Polymethylmethaacrylate, Acrylglass): -60°C+80°C – Non resistant, Aceton soluble – Only used to pack coupon arrays and probes.
-PFA (Perfluoralkoxy Polymer): -200°C+200°C – Totally resistant, superior – Used for hoses and connections.
-PEEK (Polyarylether Etherketon): -65°C+250°C – Totally resistant, superior, noble – Used for plastic material of coupon arrays and probes (inserts and isolators).
-ECTFE (Copolymer of Ethylene+Monochlorinetrifluorethylene): 150°C – Superior resistance - Used for probe coatings.

-IIR (Butyl Rubber): -30°C+130°C – Xylene and N-Gasoline(-) – Gas tight – Used as septum and seal for bottles.
-FPM (Fluor Rubber): -20°C+200°C – Resistant except to HCl-37%(*) and Acetone(*).
-MQ (Silicon Rubber): -60°C+200°C – Non resistant – Used for tools as hand protection – Clean with IPA or cleaning tissues.


MAASTRICHT
NEDERLAND
Pays-Bas
Netherlands
A44
A4
KÖLN
Cologne
AACHEN
Aix-la-
Chapelle
LÜTTICH
LIEGE
BELGIË
Belgien
BONN
A3
Nordrhein-Westfalen
North Rhine-Westphalia
Westerwald
A61
Rhine
A1
KOBLENZ
Coblence
LIMBURG
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Hesse
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Rhineland-Palatinate
A48
Mosel
Eifel
FRANKFURT
AM MAIN
WIESBADEN
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Rhein
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MAINZ
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Kell am See
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HEIM
LUXEMBURG
Schengen
Saarland
Sarre Saar
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Saar
Moselle
LUDWIGS-
HAFEN
A1
HEIDEL-
BERG
A8
FRANCE
Frankreich
SAARBRÜCKEN
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Sarrebruck
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LORRAINE
Lothringen
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Württem-
berg
ALSACE
Elsass
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