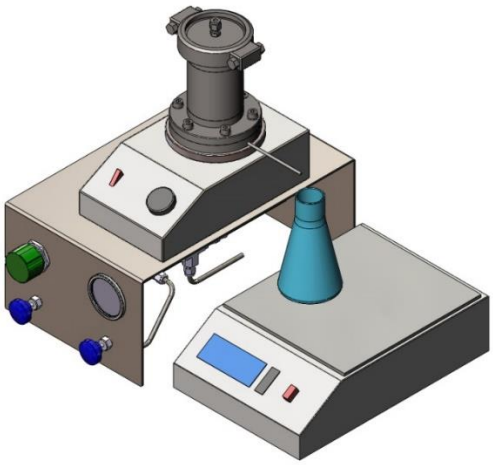
Operating Manual – MemTester



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Content

1 Introduction

This manual describes basic operating procedure, safety instructions and maintenance of the MMS system.

NOTE, the operating manual is intended to be used with the information provided in the component manuals, which are located in the main equipment folder. These manuals should provide complete and accurate information to meet your operating and service requirements based on the information available at the time of publication. MMS assumes no responsibility for the technical content of the component manufacturers literature.

The information in this manual may not cover all operating details or variations or provide for all conditions in respect to installation, operation and maintenance. Please contact MMS Service Department in case of questions, which are not addressed in this manual.

MMS reserves the right to make engineering refinements that may not be reflected in these manuals. The material in these manuals is for informational purposes and is subject to change without notice.

2 General Description

2.1 System Specifications

MemTester

Membrane type	Flatsheet membrane (disk Ø 75 mm)
Membrane area	28 cm^2
Feed volume	500 ml
System dead volume	10 ml
Working pressure	1 - 60 bar, system pressure through compressed Nitrogen *(compressed nitrogen provided by the customer)*
Working temperature	5 - 80 °C (*polystat required*), limited due to membranes (50 – 60 °C)
Cross-flow	0,5 –1,0 m/s
Space requirement	130 x 130 x 150 mm (L x W x H)
Weight	3 kg
Seals & O-Rings	EPDM
Components	Stainless steel 316L

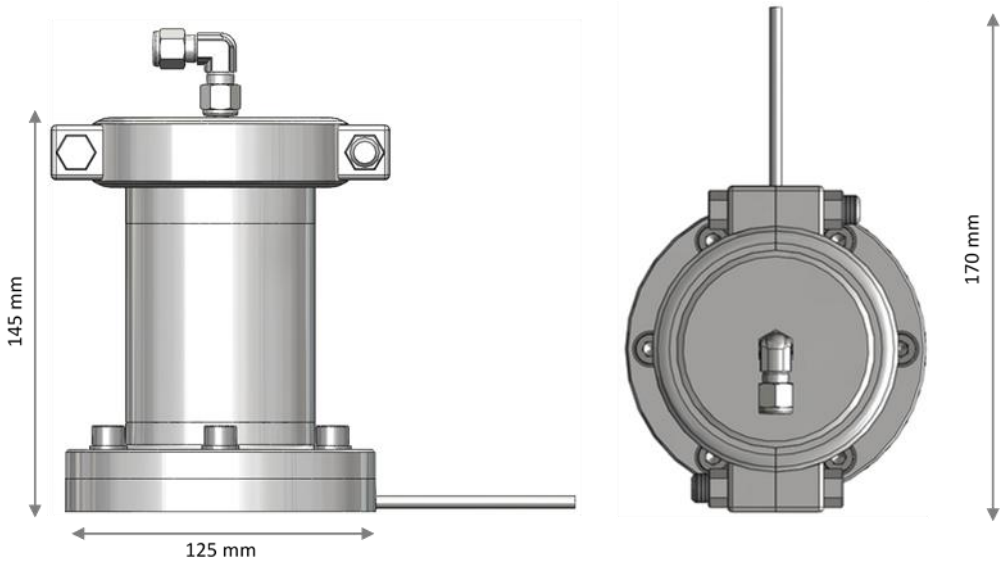

Figure 1: MMS MemTester

2.2 Optional Equipment

Pressure Regulation Unit

The driving pressure for the MMS MemTester is delivered by compressed N2 (provided by the customer). A pressure regulation unit (optionally available equipment from MMS) is used to control the inlet pressure of the MMS MemTester unit. The pre-pressure of the regulation unit should not be set higher than 60 bar.

Operating temperature	5 – 30 °C
Operating pressure	1 - 60 bar
Dimensions	400 x 280 x 200 mm (l x w x h)
Weight	5.8 kg

Magnetic Stirrer

A magnetic stirrer (optionally available equipment from MMS) is used as a driving force for the magnetic stirring bar, which is located inside the MMS MemTester unit. The variable speed option allows different rpm settings to control the membrane cross flow.

Balance

The balance (optionally available equipment from MMS) is used to measure the amount of permeate passing through the membrane during the filtration process.

3 Safety

Symbols

Danger 	Draws attention to a direct and dangerous threat. It may lead to a serious injury or even death if precautions are not taken.
Warning 	Draws attention to a potentially hazardous situation. It may cause a serious injury if precautions are not taken.
Caution 	Draws attention to a potentially hazardous situation. It may cause minor injuries or damage materials if precautions are not taken.

Operator Training

It is recommended that only qualified operators are authorized to operate the system. A standard operating procedure for production and CIP processes should be established based on the recommended steps in this manual. MMS can offer operator training if required.

Hot Surfaces

Caution: ➢ The unit may have hot surfaces during membrane cleaning or the production process. ➢ The operator should not touch pipes and take the necessary precaution when operating at higher temperatures.	**Caution** 

High Pressure

Warning: ➢ The system can operate at up to 40 bar (optional 60 bar). ➢ In no circumstances should any service or maintenance be performed when the unit is in operation or if the pump is running.	**Warning** 

CIP Chemicals

Warning: ➢ High concentration of caustic and acid cleaners may be used for cleaning ➢ The operator should take the necessary precautions and wear personal protection equipment.	Warning 

Moving Parts

Warning: ➢ The unit includes a pump with moving parts. ➢ The system power should be switched off from the main electrical cabinet prior to the pump maintenance.	Warning 

Electrical Parts

Danger: ➢ The electrical cabinet should be at all times closed during production, CIP or standby to prevent liquid from entering. ➢ Only qualified electricians should maintain or service the electrical cabinet.	Danger 

Emergency-Off

Danger: ➢ Some units are equipped with an emergency stop button, which should be used in case of dangerous situations. ➢ The on/off switch should be used alternatively if no emergency stop button is available	Danger 

4 Process Terms

Feed	The liquid, which is separated by the membrane into permeate and retentate.
Permeate	The filtrate, which passes the membrane.
Retentate	The concentrate containing compounds, which are rejected by the membrane.
Transmembrane pressure (TMP)	Pressure, which creates flow through the membrane, s: $$TMP = \frac{(P_1 + P_2)}{2} - P_3$$
Pressure drop (dp)	The dp is created by the crossflow over the module. It is defined as the difference between inlet pressure and outlet pressure: $$dp = P_1 - P_2$$
Flux	Flux is the permeate flow rate Q_P per membrane area A, defined as: $$Flux = \frac{Q_P}{A}$$
Crossflow	Crossflow is the liquid flow tangential to the membrane surface. It creates a shear force to reduce concentration polarization and fouling on the membrane.
Volumetric concentration ratio (VCR)	The VCR in a batch process is defined as the ratio of feed and retentate volume: $$VCR = \frac{V_F}{V_R}$$
Rejection coefficient (R)	The rejection coefficient is defined as the separation effect on the membrane for a solute i. $$R_i = 1 - \frac{C_{Pi}}{C_{Ri}}$$
Diafiltration (DF)	Diafiltration is the process of diluting the retentate to maintain or lower the concentration and enable further purification of the retentate or increase of the permeate yield.
Cleaning in Place (CIP)	Cleaning in place is a procedure for removal of foulants from the system without dismantling it.
Clean Water Flux (CWF)	CWF is a flux through the membrane of water at defined operating parameters (pressure, temperature, water quality). It is a measure of membrane regeneration after cleaning.

5 System Installation

The system should be installed according to the MMS recommendations below. MMS can offer installation support if required.

5.1 Placing the System

- The system should be positioned to allow access for operation and service. MMS recommend at least 1 m from each side of the system.
- The system should be installed indoors in a room with temperature above freezing and below 30 °C, humidity level below 80 %.
- **WARNING** humidity higher than the recommended level may damage the electrical components.

- Please refer to system drawings in the main folder for a suggestion for the system set-up.

5.2 Connections

Utility	Description
Nitrogen	External nitrogen supply should be connected to the nitrogen regulation unit.
Electrical	Electrical power should be connected to the magnetic stirring plate and the balance (power supply specification 230 VAC +/- 10%, 50Hz).
Permeate outlets	Install flexible hose on the permeate outlet piping of the cell(s) if required

WARNING if the MMS N_2 regulation unit is not purchased, controlled depressurisation of the N_2 line and MemTester Cell will have to be facilitated by the customer.

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6 System Use

6.1 Assembling MemTester

MemTester is assembled in the following order:

1. Fit the larger O-ring into the grove in the bottom plate and the smaller one into the grove of the tank.
2. Polymer membranes: place the distance holder, followed by the permeate spacer and the polymer membrane in the depression of the bottom plate. The shiny side of the membrane should face up. Be careful during membrane handling not to scratch the surface.
   Ceramic membranes: place the permeate spacer followed by ceramic membrane in the depression of the bottom plate (no distance holder required). The shiny side of the membrane should face up.

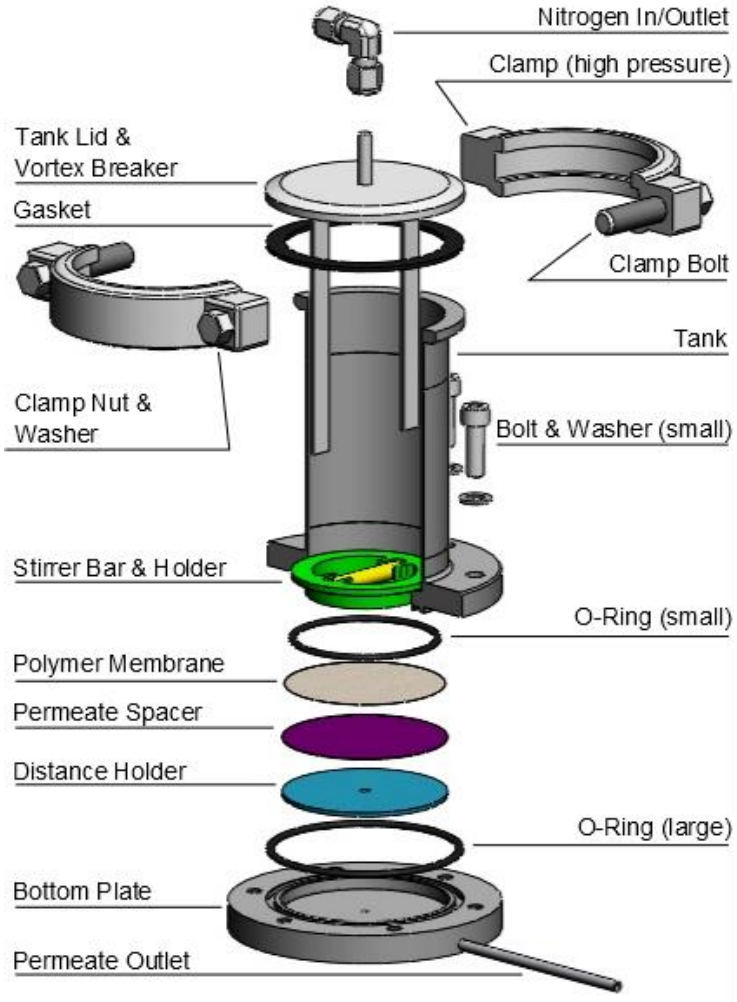

Figure 2: MemTester Assembly

3. Mount the tank on the bottom part using the six bolts (tighten the bolts uniformly cross-wise).
4. Place the magnetic stirring bar inside the holder and put the combination into the tank.
5. Put the lid gasket on the top of the tank and close the lid using the high pressure clamp. The Clamp bolts should be fitted in the indentations of the clamp parts. Make sure that the two bolts are installed in opposite directions (tighten the bolts uniformly cross-wise).

6.2 Membrane Conditioning

New membranes are usually impregnated with a solution of glycerol or sodium bisulfite. Therefore it is recommended to carry out a standard cleaning with caustic cleaning agent prior to the first use. Used membranes should also be cleaned before processing (ch. 6.9).

6.3 Prior to Start-Up

1. Ensure that all parts of the unit have been in CIP recently and that membranes are conditioned for production.
2. Assemble the MMS MemTester according to 6.1 steps 1 – 4, and fill a desired amount of feed material (≤ 300 ml) in the tank.
3. Place the MMS MemTester unit centred on the magnetic stirring plate and check if the stirring bar can rotate easily.
4. Connect the hose for the nitrogen supply to the MMS MemTester lid and close the lid (6.1 step 5). Always connect and disconnect the hose together with the elbow piece to avoid stressing the hose connection. Furthermore bending of the hose should be avoided.
5. Direct the permeate outlet to a collecting container using a flexible hose if necessary.

6.4 Production

1. Switch on the magnetic stirrer and increase the speed slowly to maximum about 250 rpm (value 6 on MMS supplied stirring plate).

Caution

2. Close vent valve V0.2 and open the nitrogen inlet valve V0.1. Open slowly the pressure regulation valve RV0.1 and make sure to increase the pressure slowly to the desired operating pressure. Extreme pressure fluctuations can damage the MMS MemTester. Make sure that the safety relief valve is adjusted to less or equal than 60 bar.

3. During production note down the required process parameters for analysis at regular intervals. It is recommended to log:
    - permeate weight
    - operating pressure
    - stirrer speed
    - permeate parameters such as conductivity or °Brix etc.
4. Diafiltration step can be added to improve product purity. Diafiltration is performed by adding buffer (ex., DI water) to the MMS MemTester unit to dilute the retentate. This way the target components in the retentate are purified by washing them out into the permeate further without increasing VCR and retentate concentration.

6.5 System Shut-Down

The process can be stopped when the desired/maximum VCR is reached or the flux drops too low.

1. Close the pressure regulating valve RV0.1 fully.
2. Open the pressure release valve V0.2 slowly in order to depressurize the system.
3. Open the lid and collect the retentate if necessary.

6.6 Cleaning in Place (CIP)

The system should be cleaned after each production to remove remaining product.

1. Flush the system with hot water (50 °C) and drain.
2. Add cleaning solution to the tank (50 °C) and close the lid.
3. Pressurize the system.
4. Circulate for 15-30 minutes and shut down system.
5. Flush the system with hot water (50 °C) and drain.

Caution

Change temperature gradually when working with ceramic membranes.

6.7 Clean Water Flux

It is recommended to measure clean water flux (CWF) between cleaning steps in order to monitor their effectiveness. Clean water flux is measured after performing a CIP as described above using clean water and standard operating parameters such as TMP, temperature, crossflow, and water quality.