PMI ADVANCED

Membrane Distillation Machine

MDM-FS-HF-1

Porous Materials, Inc.

Not just products... Solutions !

PERVAPORATION
PRINCIPLE

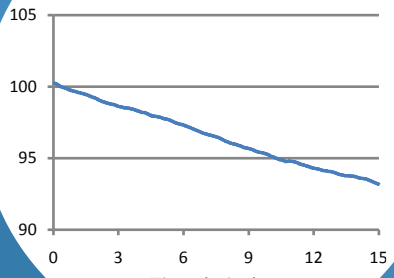
Salt water flows across one side and salt free water flows across the other side of hydrophobic membranes at pressures less than the breakthrough pressure of the membrane. Water does not penetrate the pores of the membrane. Salt free water is maintained at temperatures less than the temperature of the salt water. The vapor pressure of salt free temperature water is lower than the vapor pressure of salt water. Water vapor flows from the salt water side to the fresh water side, condenses in the salt free water and gets carried away from the membrane by the flowing water. In place of salt free water, gases with low vapor pressure (low humidity) can flow across the membrane.

The water vapor flowing through the membrane from the salt water side is carried away from the membrane by the flowing gas. In place of salt free water or gas, vacuum is maintained on the other side of the membrane and water vapor from the salt water flows to the vacuum chamber. The vapor can be collected from the vacuum side.

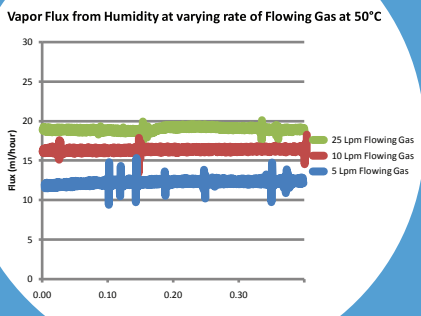
PERVAPORATION
APPLICATION

The PMI Pervaporation machine is capable of measuring rate of formation of water from salt solutions under a wide variety of experimental conditions including pressure, flow rate and temperature. Clean water may be collected in flowing water, in flowing gas or under vacuum.

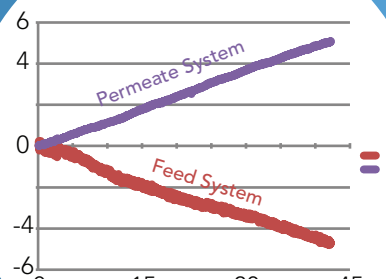
Liquid - Vacuum Penetrometer



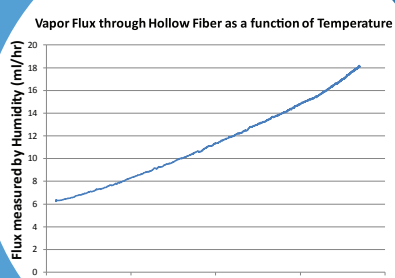
Difference of Flow



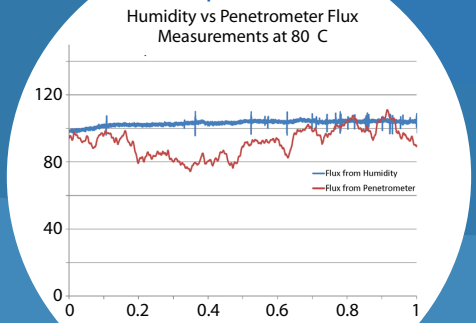
Liquid - Liquid



Difference of Temperature



Liquid - Gas



Typical Results

PERVAPORATION

UNIQUE FEATURES

Salt Water Feed Side and Salt Free Water Permeate Side:

- *Temperature Range: 5 – 85 °C*
- *Flow Rate: Up to 9.6 gallons/min*
- *Pressure Range: Up to 120 psi*
- *Independent measurements with conductivity sensor and penetrometer to crosscheck results*

Gas Permeate Side:

- *Temperature Range: 5 – 85 °C*
- *Flow Rate: Up to 9.6 gallons/min*
- *Pressure Range: Up to 120 psi*

Vacuum Permeate Side:

- *Temperature Range: 5 – 85 °C*

Complete Automation:

- *All data collected and recorded*
- *Software computes all the required information*

SPECIFICATIONS:

- *Temperature Range: 5-85°C*
- *The instrument is capable of investigating flat sheet membranes as well as hollow fiber membranes.*

PERVAPORATION

THE PROCEDURE

The salt water side is gravity filled with salt water of desired strength. Any air in the system is removed. Required temperature, pressure and flow rates are maintained. The same procedure is used to activate the fresh water side. The rate of increase of volume, measured by the penetrometer, yields rate of production of fresh water. Conductivity sensor shows the absence of salt in the permeate side.

For the sweeping gas test, air at the desired pressure, temperature and flow rate is allowed to flow through the permeate side of the sample chamber. The temperature of the permeate side of the sample chamber is maintained at the desired constant temperature. The flow rate, pressure, temperature, and humidity are measured. From the gain in humidity and the flow rate, the transfer rate is computed.

In the vacuum distillation test, the temperature of the permeate side of the sample chamber is maintained at the desired constant temperature. Temperature and pressures are measured. The rate of increase of pressure due to transfer of vapor after the vacuum cycle yields rate of production of water. The rate of decrease of volume in the penetrometer on the feed side also yields the rate of loss of water due to evaporation.

PERVAPORATION
INSTRUMENT

The instrument has three sections for direct water contact membrane distillation, sweeping gas membrane distillation, and vacuum membrane distillation.

Direct Water Contact Membrane Distillation : *The layout is shown in Figure 1. Salt water maintained at a constant temperature is circulated through the sample chamber. Its flow rate and pressures are also maintained at desired values. Temperature of the feed side of the sample chamber is also maintained at the constant temperature. Temperatures and pressures of incoming and outgoing salt water, and conductivity and volume change of salt water are measured. From these measurements rate of water vapor transfer are computed. Salt free water maintained at a constant temperature in a tank is circulated through the sample chamber at the desired pressure and flow rate. Temperature of the fresh water side of the sample chamber is also controlled. Temperature and pressure of incoming and outgoing salt free water from the sample chamber are measured. The conductivity and volume change of water in the salt free water tank are measured. The rate of fresh water formation is computed.*

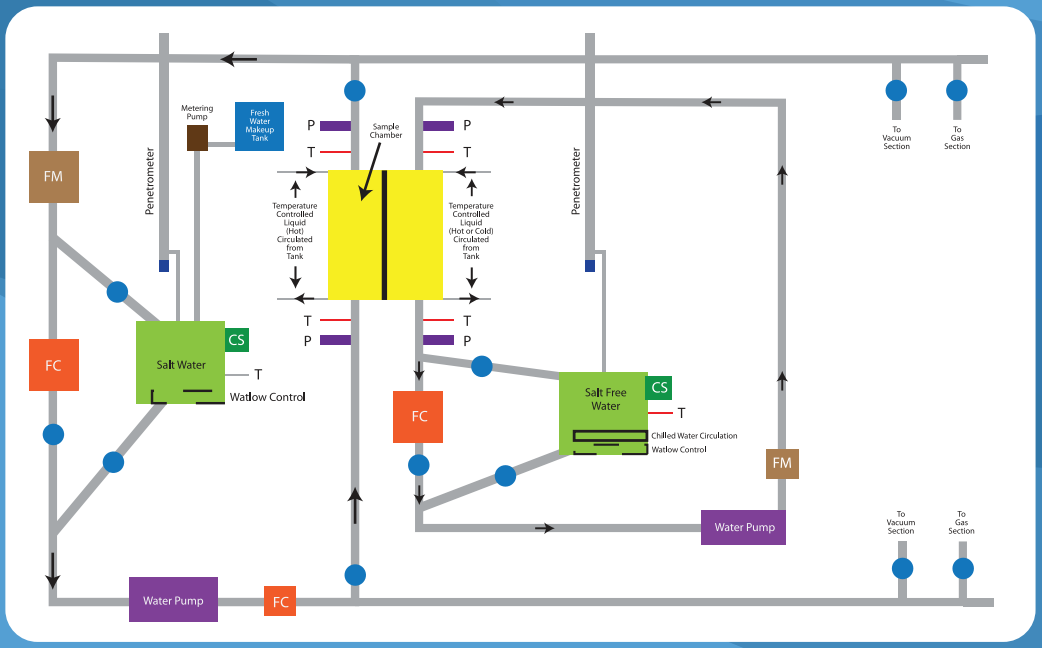


Figure 1. Membrane Distillation with direct contact with fresh water

Vacuum Membrane Distillation : *The layout is shown in Figure 2. Salt water is circulated through feed side of the sample chamber. Vacuum side of the sample chamber is maintained at a constant temperature. The chamber is evacuated to the desired pressure. Evacuation is then stopped and increases of pressure in the system due to transfer of vapor is measured. When specified pressure is reached the chamber is evacuated again. The procedure is continued. Transfer rate can be computed from the rate of pressure increase. Integration can yield total transfer. Feedside penetrometer also yields the rate of transfer.*

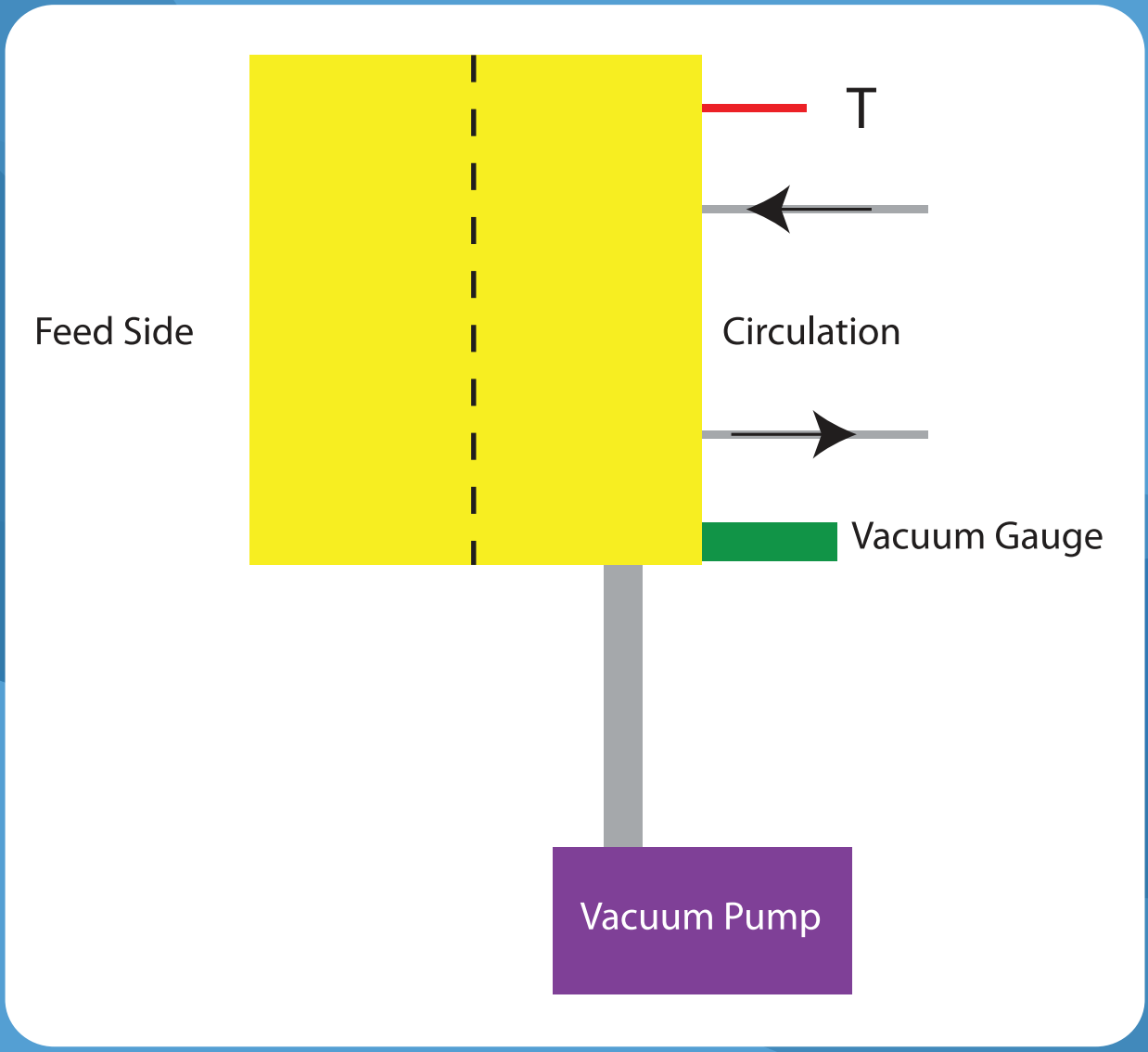


Figure 2. Vacuum Membrane Distillation

Sweeping Gas Membrane Distillation : *The layout is shown in Figure 3. Salt water is circulated through feed side of the sample chamber. Air at desired pressure, temperature and flow rate flows through the permeate side of the sample chamber. Temperature of the permeate side of sample chamber is controlled. Flow rate of gas is measured. Humidity and temperature of the incoming and outgoing air are also recorded. From these measurements the rate of generation of water vapor is computed.*

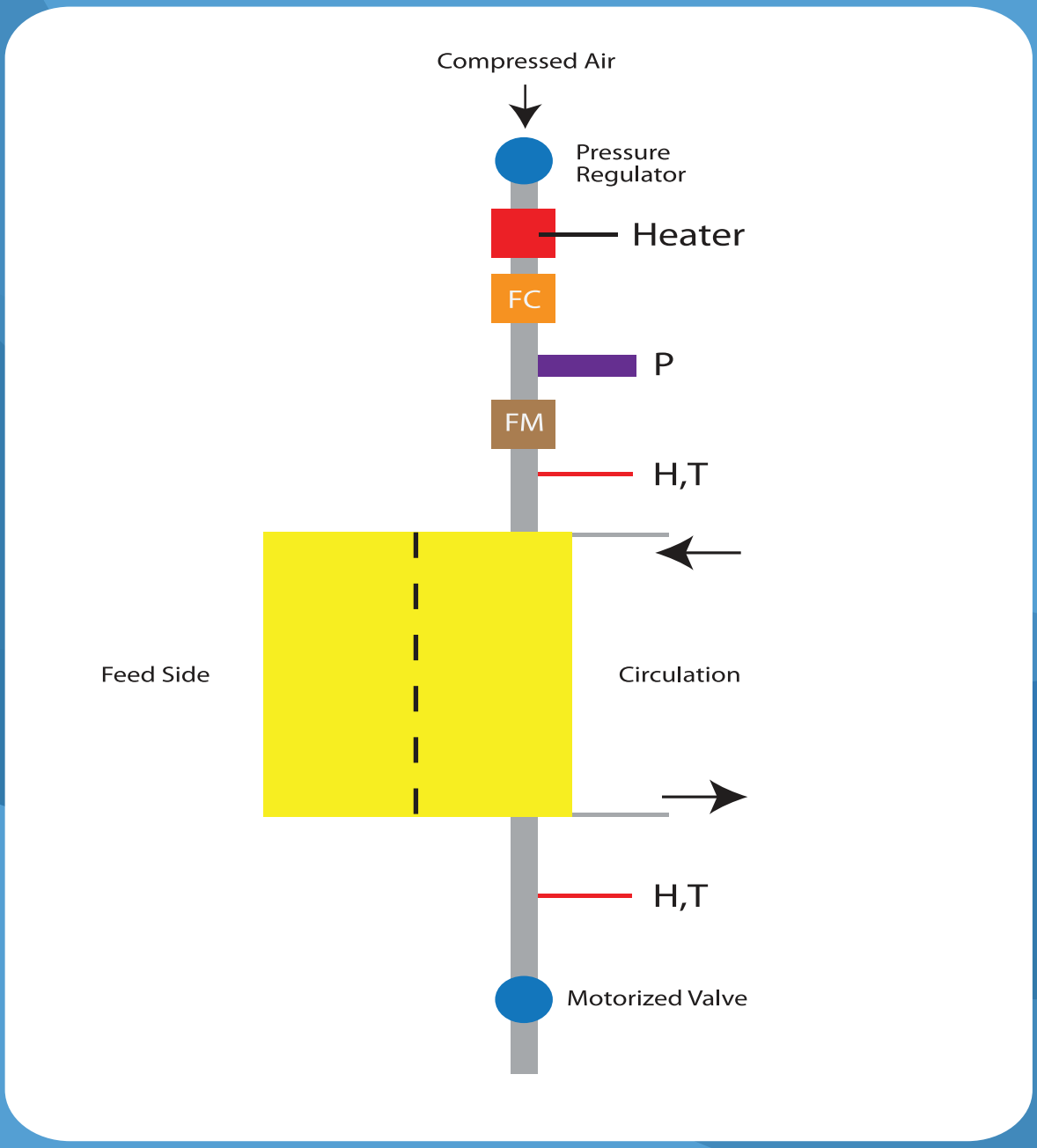
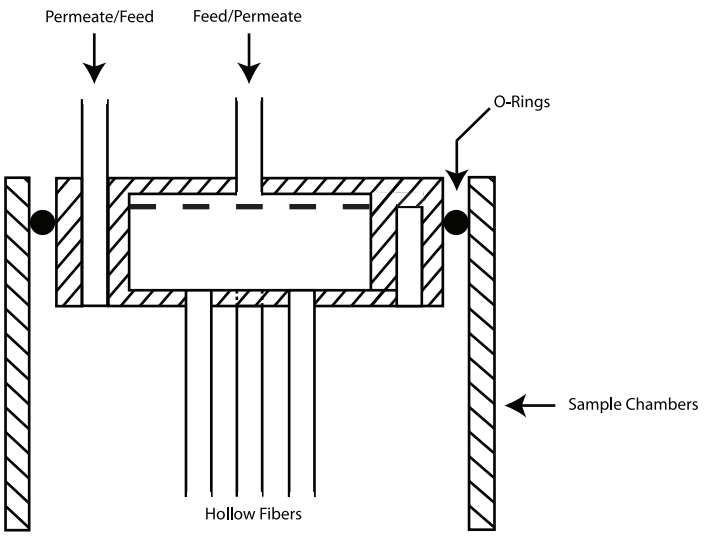


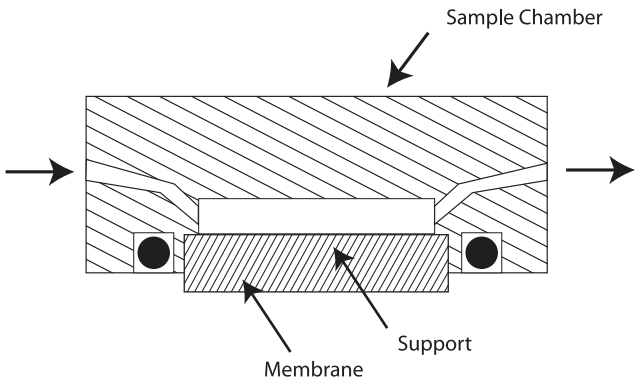
Figure 3. Sweeping Gas Membrane Distillation

PERVAPORATION SAMPLES

The instrument is capable of investigating flat sheet membranes as well as hollow fiber membranes. The sketch in Fig.4 illustrates the sample chambers.



Hollow Fiber Sample Chamber



Half of the Sample Chamber for Flat-Sheet Membranes

Figure 4. Sample Chambers

PMI

SALES & SERVICE

Our sales team is dedicated to helping our customers find which machine is right for their situation. We also offer custom machines for customers with unique needs. To find out what we can do for you, contact us. We are committed to customer support including specific service products, short response times & customer specific solutions. To quickly & flexibly meet our customer's requirement, we oller a comprehensive range of services.

Customize your machine today!

The most advanced, accurate, easy to use and reproducible Membrane Distillation Machine in the world

Celebrating

of solutions

PMI Porous Materials, Inc.

20 Dutch Mill Rd, Ithaca, NY 14850, USA
Toll Free (US & Canada): 1-800-TALK-PMI (1-800-825-5764)
Phone: 607-257-5544 Fax: 607-257-5639

Email: info@pmiapp.com www.pmiapp.com

PROUDLY MADE IN USA