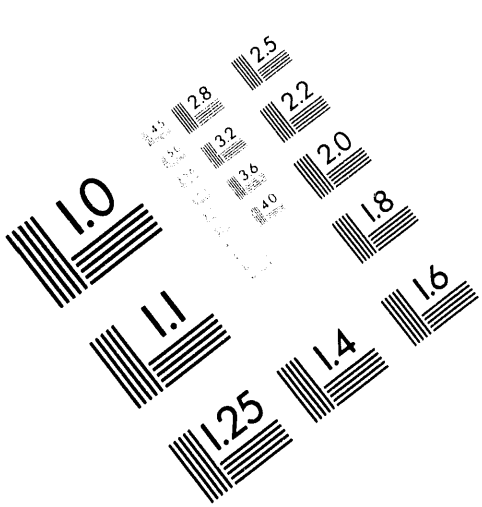

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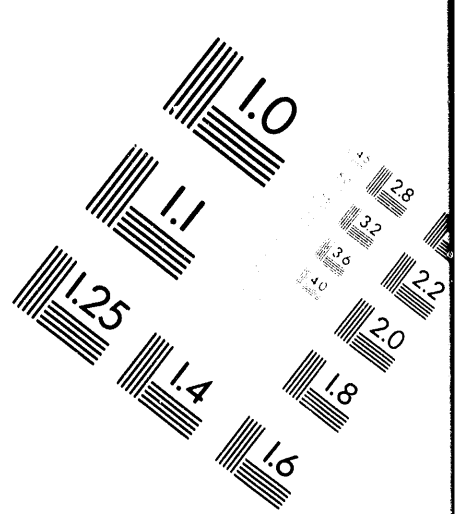

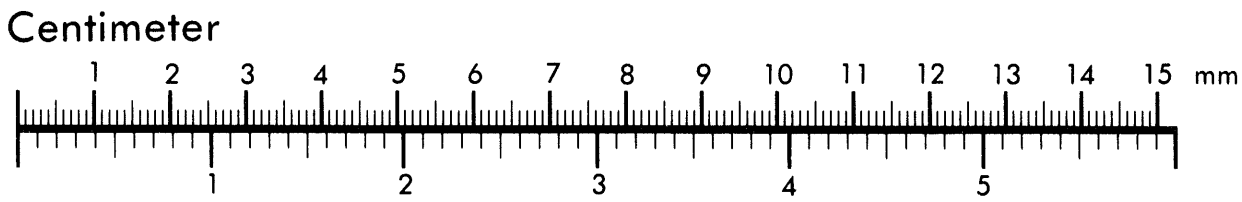


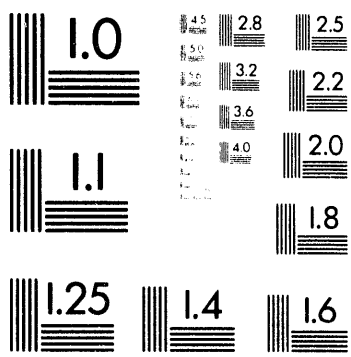

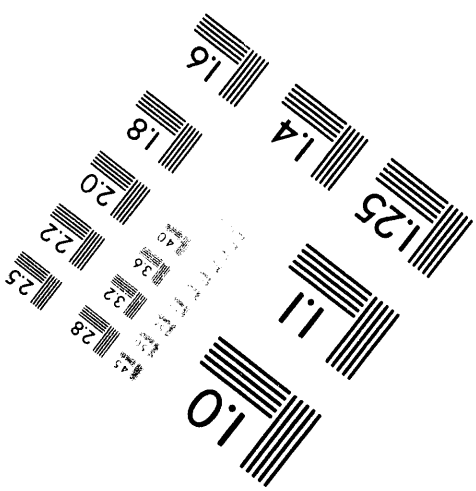

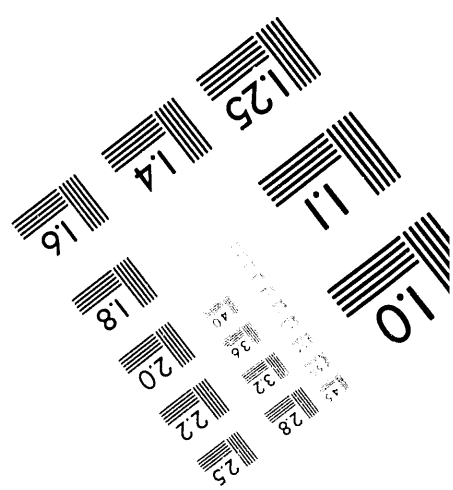

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# DEVELOPMENT OF A MEMBRANE-BASED PROCESS FOR THE TREATMENT OF OILY WASTE WATERS

Contract No. DE-AC22-92MT92005

February 3, 1994

Contract Date: March 4, 1992
Anticipated Completion Date: March 4, 1994
Government Award for FY1992: $294,200
Program Manager: Scott B. McCray
Principal Investigator: Scott B. McCray
Technical Project Officer (COR): Gene Pauling
Reporting Period: June 5 to September 4, 1993

from
Bend Research, Inc.
64550 Research Road
Bend, Oregon 97701-8599

NOTE: US/DOE Patent Clearance is **not** required prior to the publication of this document.

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None.

## *EXECUTIVE SUMMARY*

This is a quarterly report from Bend Research, Inc., (BRI) to the U.S. Department of Energy (DOE) for work performed under Contract No. DE-AC22-92MT92005, titled "Development of a Membrane-Based Process for the Treatment of Oily Waste Waters." This report covers the period from June 5 to September 4, 1993.

The overall goal of this program is to develop a system based on reverse-osmosis (RO) membranes that can treat oily water economically. This system will be based on the use of thin-film-composite (TFC) membranes that consist of a selective coating placed on a solvent-resistant hollow-fiber support. For this program, we plan to develop solvent-resistant hollow-fiber supports and coat them with a "loose-RO" coating. We developed the TTM coatings used in this program in previous work for the treatment of oily waste waters.

During this reporting period, work was focused on operating the demonstration test unit at a test site near Houston, Texas. During the next reporting period, we plan to continue long-term testing at the demonstration test site. The completion of the demonstration test, preparation of the final report, and technology transfer are the only tasks remaining in this program.

## *I. INTRODUCTION*

This is a quarterly report from Bend Research, Inc., (BRI) to the U.S. Department of Energy (DOE) for work performed under Contract No. DE-AC22-92MT92005, titled "Development of a Membrane-Based Process for the Treatment of Oily Waste Waters." The purpose of this program is to develop a system based on reverse-osmosis (RO) membranes that can treat oily water economically. This system will be based on the use of thin-film-composite (TFC) membranes that consist of a selective coating placed on a solvent-resistant hollow-fiber support. For this program, we plan to develop solvent-resistant hollow-fiber supports and coat them with a "loose RO" coating. We developed the TTM coatings used in this program in previous work for the treatment of oily waste waters. This report covers the period from June 5 to September 4, 1993.

During this reporting period, work was focused on performing a demonstration test of this technology. Long-term tests were performed during this reporting period.

## *II. PROJECT DESCRIPTION*

This program is divided into seven tasks. A summary of the work to be performed in this program follows.

### *Task 1: Develop Hollow Fibers*

Hollow-fiber supports will be made from high-strength, solvent-resistant polymers. These fibers will be physically robust and have 1) high permeability to assure high fluxes, and 2) smooth lumen (interior) surfaces to assure uniform coating of the hollow-fiber support with the permselective coating.

### *Task 2: Evaluate Hollow Fibers*

The fibers made in Task 1 will be evaluated in a series of tests to ensure they are suitable for this application. These tests include 1) examining the texture of the lumen surface, 2) measuring the permeability of the fibers, 3) measuring the strength of the fibers, and 4) measuring the solvent resistance of the fibers.

***Task 3: Make Small-Scale Modules***

Small-scale hollow-fiber modules will be made using the fibers, and the lumens of the fibers will be coated with our loose-RO TTM coatings. The modules will be evaluated in standard tests to ensure the integrity of the coating.

***Task 4: Test Small-Scale Modules***

The small-scale modules made in Task 3 will be tested in the laboratory under controlled conditions. The modules will be evaluated on feed streams of oily waste waters obtained from various sources. Parametric and long-term tests will be conducted.

***Task 5: Construct Large-Scale Modules***

Large-scale modules will be constructed using standard module-preparation procedures developed at Bend Research. These modules will be constructed for use in a demonstration unit to be provided by the contractor.

***Task 6: Operate Demonstration Unit***

The effectiveness of this technology will be demonstrated by operating the large-scale modules on actual oily waste waters. Field-test sites will be identified and prepared for the demonstration of this technology. A test plan will be developed before the demonstration is performed.

***Task 7: Technology Transfer***

Journal articles and conference and symposia presentations will be prepared. This technology will be transferred to the oil and gas industry and the scientific community.

## *III. PROJECT STATUS*

During the previous reporting period, our commercialization partner, AquaAir Environmental, Inc., (Bend, Oregon) transported the demonstration unit to Friendswood, Texas, the site of the demonstration test. Figure 1 shows a simplified schematic of the demonstration unit. We also initiated parametric tests. During this reporting period, we completed our parametric tests and initiated long-term tests at the demonstration test site. These results are described below.

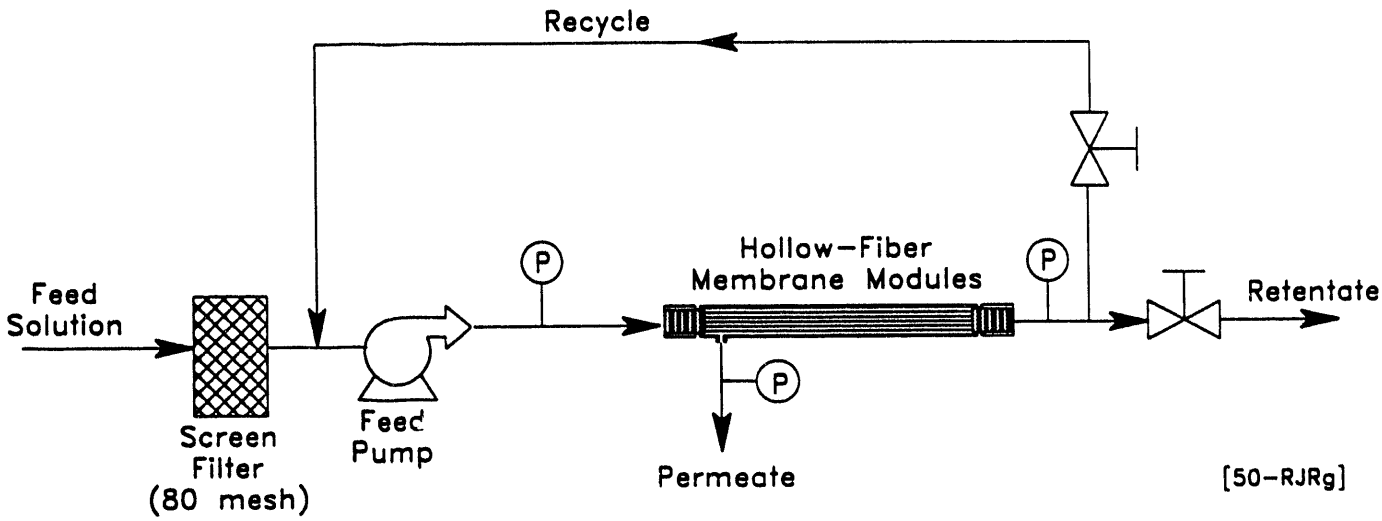


Figure 1. Simplified Schematic of the Demonstration Unit

During this reporting period, we continued our evaluation of TTM-60 and TTM-20 modules in parametric tests. Figures 2 and 3 show the results of these tests. The feed stream contained approximately 1000 ppm oil and grease and approximately 10,000 ppm salts. The permeate from each module contained less than 7 ppm oil and grease--a rejection of oil and grease of 99.3%. The permeate was of sufficient quality to meet all known discharge regulations in the Gulf Coast area.

Figure 2 shows the water permeability of the membrane plotted versus transmembrane pressure. As these data show, the water permeability was not affected by transmembrane pressure during these tests. This was as expected based on our previous studies with the TTM-60 and TTM-20 membranes. These data indicated that, when operated on an oily water feed, the performance of the membranes should be similar to that of modules in our laboratory "control" tests on oily water feeds.

Figure 3 shows the water permeability of the membranes plotted versus time. These data were from the start of our long-term test with the demonstration unit. As the data show, the flux of the TTM-20 module declined slightly—likely due to a build-up of a layer of oil on the surface of the membrane. This was expected, and we anticipate that the flux will stabilize at a water permeability of approximately 0.4 gal/ft$^2$-day-100 psi. These tests will be continued during the next reporting period.

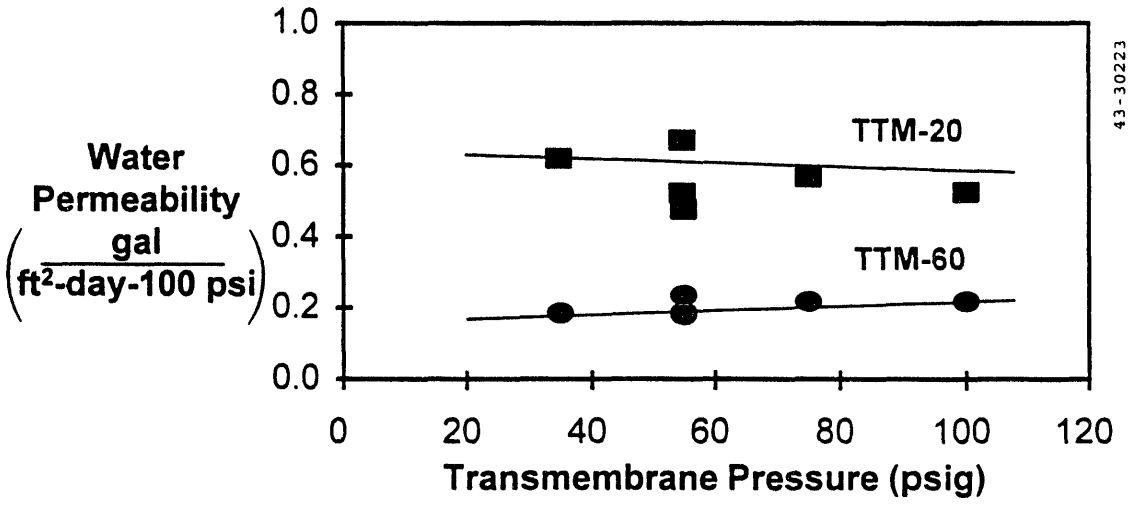


Figure 2. Water Permeability Versus Transmembrane Pressure for TTM-20 and TTM-60 Hollow-Fiber Modules

Conditions: Feed: ~10,000 ppm salts (mostly $Ca^{+2}$)
~1,000 ppm oil and grease
Permeate: <7 ppm oil and grease

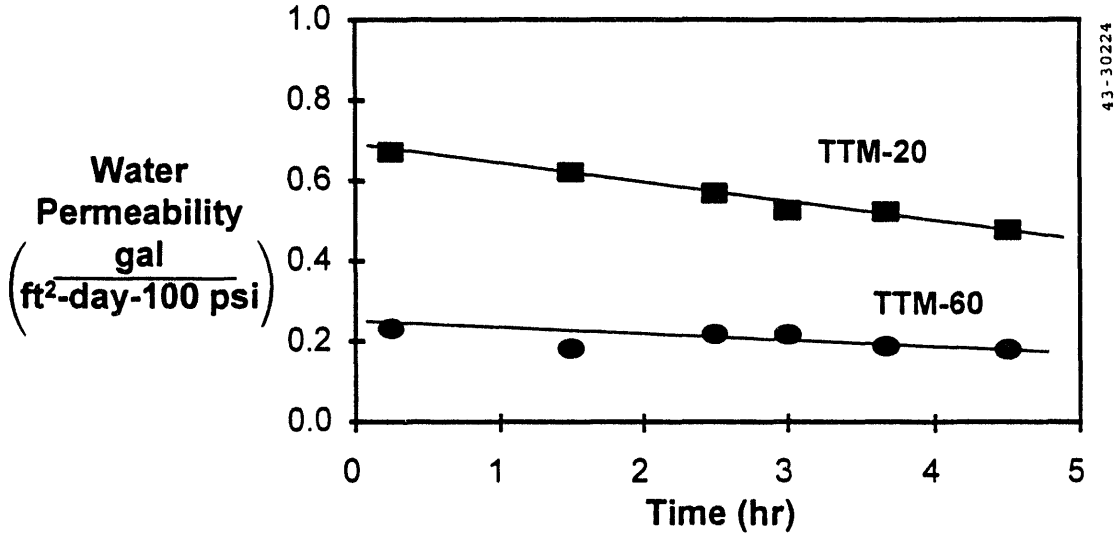


Figure 3. Water Permeability Versus Time for TTM-20 and TTM-60 Hollow-Fiber Modules

Conditions: Feed: ~10,000 ppm salts (mostly $Ca^{+2}$)
~1,000 ppm oil and grease
Permeate: <7 ppm oil and grease

## *IV. PLANNED ACTIVITIES*

During the next reporting period, we plan to continue long-term testing using the demonstration test unit. The demonstration test, preparation of the final report, and technology transfer are the only tasks remaining in this program.

## *V. SUMMARY*

During this reporting period, we completed parametric tests on the demonstration unit at a test site near Houston, Texas. Additionally, long-term tests were initiated.

Report Distribution List

Three copies to: Document Control Center, U.S. Department of Energy
Pittsburgh Energy Technology Center, P.O. Box
10940, MS 921-118, Pittsburgh, PA 15236-0940

References:

None.

Publications

No new publications or presentations of this technology were prepared during this reporting period.

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