

<DIALOG File 103: >

01101517 EDB-83-001517

Literature 25

Title: *American Petroleum Institute's work on oil spill prevention, containment and cleanup*

Author(s): Haxby, L.P.

Affiliation: Shell Oil co.

Conference Title: Offshore technology conference

Conference Location: Houston, TX, USA Conference Date: 30 Apr 1973

Source: Offshore Technol. Conf. (United States) v 1:OTC-1749. Coden: OSTCB

Publication Date: 1973 p 1.258-1.260

Report Number(s): CONF-7304108-

Document Type: Journal Article; Conference literature

Language: English

Journal Announcement: EDB8010

Country of Origin: United States

Abstract: Since 1968, API has supported an extensive research program directed toward improving the industry's capability of preventing oil spills and improving response and capability of oil-spill cleanup should a spill occur. These efforts have ranged from studies that determined industry's current oil-spill response capability to new equipment demonstrations and basic research on fate and effect of spilled oil. Emphasis also has been placed upon the generation of harbor cooperatives to provide first-line defense capability and implementation of studies and organization of insurance plans to provide coverage for the expensive costs involved in an oil-spill disaster. More recently, API's efforts have concentrated on improvement of oil-spill recovery in high sea conditions. Full-scale sea trials have been conducted on several systems, concentrating most heavily on new concept methods for oil-spill recovery under these adverse conditions. The study provides a report of the most recent trials of this type of equipment. ;

Major Descriptors: *OIL POLLUTION CONTAINMENT; *OIL SPILLS -- CLEANING; *OIL SPILLS -- RESEARCH PROGRAMS

Descriptors: COST; PETROLEUM INDUSTRY; RECOVERY; SKIMMERS; WATER POLLUTION CONTROL

Broader Terms: CONTAINMENT; CONTROL; EQUIPMENT; INDUSTRY; POLLUTION CONTROL; POLLUTION CONTROL EQUIPMENT

Subject Categories: 020900* -- Petroleum -- Environmental Aspects

520200 -- Environment, Aquatic -- Chemicals Monitoring & Transport -- (-1989)

<DIALOG File 103: >

03208178 NEDO-91-950434; EDB-91-135614

Literature 26

Title: *Influence of oil spillage on marine environment*

Original Title: Abura ryushutsu to kaiyo kankyo eno eikyo

Author(s): Iwamoto, K. (Environment Agency, Tokyo (Japan))

Source: JETI (Japan Energy and Technology Intelligence) (Japan) v 39:5. Coden: J

ETIE ISSN: 0289-4343

Publication Date: 1 May 1991 p 156-160

Document Type: Journal Article

Language: In Japanese

Journal Announcement: EDB9120

Subfile: ETD (Energy Technology Data Exchange). NEDO (Japan (sent to DOE from))

US DOE Project/NonDOE Project: NP

Country of Origin: Japan

Country of Publication: Japan

Abstract: This report investigates the influence of oil spillage on marine environment. As for the oil behavior in the ocean, the oil starts to change physico-chemically and ecologically by natural conditions just after spilled in the sea, evaporation of its light component is promoted by waves in a short period of time, and residual oil becomes mousse type emulsifying oil mixed with sea water. Then, the emulsifying oil disperses, dissolves, settles, oxidizes photochemically, or decomposes with microorganisms. Since crude oil and petroleum products consist of various kinds of hydrocarbon and settle, dissolve, or float on the sea after spillage, their influences on marine organisms become physically and chemically complex. Once the oil spills into the ocean, its impact on marine environment is greater as the site is closer to the shore where a lot of flora and fauna live. It takes a long time to restore the ocean after the spillage oil is controlled, disposed, or extinguished naturally. Continuous survey is used to judge when the ocean is recovered. 1 fig., 3 tabs.

Major Descriptors: *BIOLOGICAL VARIABILITY -- CHEMISTRY; *BIOLOGICAL VARIABILITY -- PHYSICS; *OIL SPILLS -- EMULSIONS; *OIL SPILLS -- PETROLEUM; *OIL SPILLS -- SEAS; *SEAS -- ENVIRONMENT

Descriptors: AQUATIC ORGANISMS; MICROORGANISMS

Broader Terms: COLLOIDS; DISPERSIONS; ENERGY SOURCES; FOSSIL FUELS; FUELS; SURFACE WATERS

Subject Categories: 540300* -- Environment, Aquatic -- (1990-)

<DIALOG File 8: >

01540678 E.I. Monthly No: E18407073065 E.I. Yearly No: E184135785 Literature 27

Title: *CONCENTRATION POLARIZATION, MEMBRANE FOULING AND CLEANING IN ULTRAFILTRATION OF SOLUBLE OIL.*

Author: Lee, Soobok; Aurelle, Yves; Roques, Henry

Corporate Source: INSA, Lab de Chimie et Genie de l'Environnement, Toulouse, Fr

Source: Journal of Membrane Science v 19 n 1 Apr 1984 p 23-38

Publication Year: 1984

CODEN: JMESDO ISSN: 0376-7388

Language: ENGLISH

Journal Announcement: 8407

Abstract: Concentration polarization in ultrafiltration of soluble oil was investigated, and the characteristics of the gel obtained at the end of the experiments were analyzed. It was found that the oil content of the gel was approximately 40 vol. % and was almost independent of pressure. The gel was a concentrated oil/water emulsion. Membrane fouling was also analyzed in terms of critical surface tension, wettability of the membrane and capillary pressure. Fouling was mainly due to adsorption of oil on the membrane structure, which modified the critical surface tension and the wettability, as well as the effective pore diameter, resulting in reduced membrane permeability. 13 refs.

Descriptors: *WATER POLLUTION; MEMBRANES; INDUSTRIAL WASTES--Treatment

Identifiers: SOLUBLE OIL

Classification Codes: 453 .(Water Pollution); 631 .(Fluid Flow & Hydrodynamics)
45 .(POLLUTION & SANITARY ENGINEERING); 63 .(FLUID DYNAMICS & VACUUM TECHNOLOGY)

<DIALOG File 8: >

00797645 E.I. Monthly No: E17903017945 E.I. Yearly No: E179051246

Title: *EVALUATION OF DISPERSANCY BY ANALYTICAL METHODS.*

Author: Badiali, F. L.; Berti, F.; Cassiani Ingoni, A. A.; Pusateri, G.

Corporate Source: Assoreni, Pet Prod Dep, Milan, Italy

Source: SAE Preprints n 780932 for Meet Nov 13-16 1978 13 p

Publication Year: 1978

CODEN: SEPPAB ISSN: 0560-6160

Language: ENGLISH

Journal Announcement: 7903

Abstract: Test severity, inhibition and oil discrepancy: these are factors which influence the formation of sludge and the extent of its settling in the engine. By appropriate used-oil analyses it is possible to calculate indices of the oil's performance which are largely independent of the type of engine used and the test procedure followed. The ASTM D 893 test procedure is inapplicable to a large number of modern motor oils. An alternative method based on the filtration of used oils over membrane filters has been of great help in recent years. However, a newly developed photometric method seems promising in overcoming most present analytical difficulties. The indices obtained from used-oil analyses can become the only feasible test method in the development of long drain oils. 5 refs.

Descriptors: *LUBRICATING OILS--*Analysis; PARTICLE SIZE ANALYSIS--Applications; AUTOMOBILE ENGINES--Lubricating Oils

Identifiers: DISPERSANCY INDEX

Classification Codes: 607 .(Lubricants & Lubrication): 421 .(Materials

<DIALOG File 8: >

00644088 E.I. Monthly No: E17708062079 E.I. Yearly No: E177092100 Literature 28

Title: CONCENTRATIONS OF OIL IN SEA WATER RESULTING FROM NATURAL AND CHEMICALLY INDUCED DISPERSION OF OIL SLICKS.

Author: Cormack, D.; Nichols, J. A.

Corporate Source: Warren Spring Lab, Stevenage, Hertfordshire, Engl

Source: Oil Spill Conf, Proc, New Orleans, La, Mar 8-10 1977 Publ by API (Publ n 4284), Washington, DC, 1977 p 381-385

Publication Year: 1977

Language: ENGLISH

Journal Announcement: 7708

Abstract: Results are presented on the factors relating to the dissipation of oil spills at sea, including evaporation, emulsion formation, spreading, and natural dispersion into the water column. For Ekofisk oil, 20% evaporates in about 7.5 hours and, while emulsion formation is as rapid as for Kuwait crude, the resulting viscosity is low and insufficient to allow interference with the natural spreading and dispersion rates. No significant deleterious effects were found to result from the dispersion of oil slicks at sea using low toxicity dispersant chemicals; also it was noted that, in any case, substantial quantities of oil can be expected to enter the sea before oil recovery operations can be mounted. 5 refs.

Descriptors: *WATER POLLUTION--*Oil Spills; ENVIRONMENTAL IMPACT

Identifiers: OIL CLEANUP TECHNIQUES

Classification Codes: 453 .(Water Pollution); 901 .(Engineering Profession)
45 .(POLLUTION & SANITARY ENGINEERING); 90 .(GENERAL ENGINEERING)

#000003* JICST COPYRIGHT

CN 90A0269406, K90060800

Literature 29

TI 廃業した廃油再生設備の地下での地下水汚染の除去

ET Removal of the groundwater pollution
below an abandoned waste oil
refinery.

AU RIPPER P, FRUECHTENICHT H (Dr Trischler
and Partner, Darmstadt, DEU)

JN A0070A (WSTED) (0273-1223) Water Sci Technol

VN VOL. 21, NO. 12 PAGE. 1841-1844 1989

CI (A) (a1) (EN) (GBR) (写図5)

AB HanauのPintsch地点では1984年まで廃油の再生が行なわれていた。
。同地の地下水の油汚染が発覚したので、地下水処理プラントを建設した。地下水
の汲上げ、油水分離、エアストリッピング、凝集沈殿、活性炭ろ過を組合わせた。
脂肪族塩素化合物、芳香族炭化水素はエアストリッピングで除去される。処理水は
河川放流か地下へ再注入している

CC YE01030Y (662:628.2/.3)

KW 地下水汚濁; 廃油; 下水処理施設; 復旧; 油水分離; 凝集処理; 活性炭処理; 脂肪
族塩素化合物; ストリッピング; 芳香族炭化水素; 地下水; 化学工場

#000026* JICST COPYRIGHT

Literature 30

CN 90A0138768, A90162002, K90080427

TI 北海における1987年Forties原油試験結果
ET Results of the 1987 forties crude oil
trial in the North Sea.

AU HURFORD N, BUCHANAN I (Warren Spring La
b., Hertfordshire, GBR)

JN I0573A Proc Oil Spill Conf

VN VOL. 1989 PAGE. 525-532 1989

CI (C) (al) (EN) (USA) (写真9, 表8, 参12)

AB 流出した原油の挙動を知るため, 1987年7月, 52°10', 02°23E地
点から20tのForties原油を流し, その後40日間にわたり, 油層の移動
, 拡散状態を追跡した。また一定時間間隔で油層試料を採取し, 油の物性変化を調
べた。風速5~10m下にもかかわらず72時間後, かなりの量が海上面を浮遊し
た。最初の24時間で75%の原油が分散された。蒸散と浮化により物性が変化し
た。これら結果を各種モデル予測と比べた

CC SB02040B (614.777(26))

KW 海洋汚濁; 油汚染; 原油; 油漏れ; 拡散; 移流; 空中探査; 気象条件; 流跡線; 分
散度; 北海

13)

Literature 31

#000002* JICST COPYRIGHT

CN 86A0069651, A88042249, C86052079, K86020409

TI バーレーン, RA' S Abu Jarjurの46, 000m³/day逆浸透プラントの建設と運転

ET Construction and operation of 46, 000 m³/day reverse osmosis desalination plant, Ra's Abu Jarjur, Bahrain.

AU AL-ARRAYEDH M (Water Supply Directorate Ministry of Works Power and Water, Bahrain); ERICSSON B (SWECO, Stockholm); OHTANI M (Sasakura Engineering Co. Ltd., Osaka)

JN B0934A (DSLNA) (0011:9164) Desalination

VN VOL. 55 PAGE. 319 - 342 1985

CI (A) (d3) (EN) (NLD) (写図5, 表5)

AB このプラントはバーレーン政府が水需要に対応するために建設したものでささ倉機
械(株)と住友商事(株)との協力によって'84年10月に完成した。このプラ
ントは原水として高塩濃度の地下水を用いているが海水脱塩用の膜を用いているプ
ラントとしては世界最大規模である。30日間の信頼性テストの結果と最適運転方
法の検討結果を示した

CC SC02030T, XD02120Z (628.161, 66.06/.07:532.71)

KW バーレーン; 逆浸透; 脱塩装置; 工場建設; 運転試験; 地下水; 半透膜; プライン

<DIALOG File 8: >

00451920 E.I. Monthly No: E17505035098 E.I. Yearly No: E175082713

Title: *CRUDE OIL SPILLS: DISAPPEARANCE OF AROMATIC AND ALIPHATIC COMPONENTS FROM SMALL SEA-SURFACE SLICKS.*

Author: Harrison, Wyman; Winnik, Mitchell A.; Kwong, Paul T. Y.; Mackay, Donald

Corporate Source: Argonne Natl Lab, Ill

Source: Environmental Science and Technology v 9 n 3 Mar 1975 p 231-234

Publication Year: 1975

CODEN: ESTHAG ISSN: 0013-936X

Language: ENGLISH

Journal Announcement: 7505

Abstract: Experimental data are presented for the weathering of five small (1.04 m²) ocean spills of South Louisiana crude oil. The oil was spiked with cumene and the concentrations of cumene and several alkanes were measured for up to 5 hr after the spill. An approximate model of the evaporation-dissolution process is derived which suggests that cumene is lost principally by evaporation. The effects of whitecapping and the existence of different weathering rates in the same spill are described. 13 refs.

Descriptors: *WATER POLLUTION--*Oil Spills; SEAWATER--Analysis; PARAFINS

Identifiers: CUMENE

Classification Codes: 453 .(Water Pollution); 471 .(Marine Science & Oceanography); 803 .(Chemical Agents & Basic Industrial Chemicals); 804 .(Chemical Products)

45 .(POLLUTION & SANITARY ENGINEERING); 47 .(OCEAN TECHNOLOGY); 80 .(CHEMICAL ENGINEERING)

<DIALOG File 6: (COPR. 1992 NTIS)>

1087240 NTIS Accession Number: PB84-238328

Developing Methods for Analyzing Oil Dispersants in Seawater
(Final rept. Apr 80-Apr 82)

Haynes, D. L. ; Kelly, D. G. ; Smith, J. H. ; Fernandez, E. L.
SRI International, Menlo Park, CA.

Corp. Source Codes: 055876000

Sponsor: Municipal Environmental Research Lab., Cincinnati, OH.

Report No.: EPA/600/2-84/144

Aug 84 36p

Languages: English

Journal Announcement: GRA18425

NTIS Prices: PC A03/MF A01

Country of Publication: United States

Contract No.: EPA-R-807059

An analytical method was sought for determining the concentrations of dispersants in seawater contaminated with oil in both field and laboratory situations. Methods of analysis for surfactants found in the literature included spectrophotometry, gas chromatography (GC), thin-layer chromatography (TLC), and high performance liquid chromatography (HPLC). References to collection, concentration, and cleanup methods included liquid/liquid extractions, gas stripping, and solid sorbents. Of seven dispersants tested, one contained solely anionic surfactants, three contained only nonionic, and three contained both anionic and nonionic surfactants. HPLC normal phase, reverse phase, and ion exchange column techniques were tried. Detection methods included (1) direct measurement of the surfactants by tensammetry and ultraviolet (UV) spectrometry, and (2) derivation of the surfactant with phenyl isocyanate with subsequent measurement by UV spectrometry. The most promising method of those tested was analysis of the phenyl isocyanate derivative of POE nonylphenol by normal phase HPLC using UV spectrometric detection. A method of collection, concentration, and cleanup of seawater solutions of dispersants containing oil was developed using the solid sorbent SEP-PAK C18 cartridge. This sorbent successfully removed compounds that interfered with colorimetric tests.

Descriptors: *Water analysis; *Dispersants; *Sea water; *Surfactants; Gas chromatography; Thin layer chromatography; Ultraviolet spectroscopy; Ion exchanging; Water pollution; Chemical analysis

Identifiers: *Oil pollution detection; *Water pollution detection; High performance liquid chromatography; NTISEPAORD

Section Headings: 7D (Chemistry--Physical Chemistry); 680* (Environmental Pollution and Control--Water Pollution and Control); 99A* (Chemistry--Analytical Chemistry)

#000012* JICST COPYRIGHT

CN 86A0007893, C86012477, G86012000

TI 海上での油水分離

ET Separating oil from water offshore.

AU DELAINE J (John Delaine & Co., UK)

JN D0791A (CMERA) (0302-0797) Chem Eng (London)

VN NO. 419 PAGE. 31 - 34 1985

CI (A) (b2) (EN) (GBR) (写真8, 表1)

AB 海上採油の際の排水の油水分離技術を展望。40mg/lの油の含有が許容されているが、より低水準であることが望まれる。場所の制約があるため、コンパクトな機械が必要。板状分離装置、粒状ろ材を用いたろ過、気ほうによる浮上分離、金網や多孔性セラミックおよびプラスチックを用いた凝集装置などの特性と応用を概説

CC XE03000E, UA10010K (66:541.18/.2, 622.276.01)

KW 海上採油; 廃水処理; 油水分離; 砂ろ過; 浮上法; 凝集処理; 邪魔板; コアレッセ
ンス; 油水分離装置

K90110315

TI Cabo Pilar号座礁および油流出
 ET The Cabo Pilar grounding and oil
 spill.
 AU PIZARRO F
 JN T0573A Proc Oil Spill Conf
 VN VOL. 1989 PAGE. 61-64 1989
 CI (C) (ai) (EN) (USA) (写真3, 参3)
 AB 1987年10月にマゼラン海峡で座礁したタンカーからの油流出について解説し
 た。特に、油によって影響を受けた地域、分散剤の散布の様相、回収浄化作業など
 について述べ、さらに、それらの問題点、効果、そのコストについて解説した。装
 置のレンタル代、人件費、分散剤、船、浄化および環境調査に使われた全コストは
 400,000米ドルであった
 CC SB02040B, RA02040X (614.777(26), 614.8 OTHERS)
 KW 海洋汚濁; 油汚染; 原油タンカ; 海難; 流出油; チリ; 災害対策; 汚染防止; 分散
 剤; 油濁処理剤; 浄化; 環境インパクト; 環境被害; 経済計算; 座礁

LI ANSWER 4 OF 5 COPYRIGHT 1991 ACS
AN CA80(18):99923q
TI Oil separation by air bubbling method using high polymer coagulants.
1
AU Kondo, Goro; Asakura, Mitsuaki; Tanaka, Minoru
CS Kobe Univ. Merc. Mar.
LO Kobe, Japan
SO Mizu Shori Gijutsu, 14(11), 1161-9
SC 60-2 (Sewage and Wastes) L-k
SX 51, 37, 46
DT J
CO MSYGAO
PY 1973
LA Japan
AN CA80(18):99923q
AB Oil sepn. by aeration is markedly accelerated by the addn. of inorg. salts. This method is suitable for treating tanker waste water, e.g. sea water ballast, but aggregation is slow in fresh water, e.g. industrial wastes. The aggregation of fine oil droplets is accelerated by the addn. of trace amts. of high polymer coagulants at 1-2 ppm and pH 3-4. The tested coagulants are primarily acrylamide.

1. まえがき

逆浸透膜造水装置に導入される海水中に油分が混入されることを想定し、造水装置の運転に支障の無い様に海水中の油分を除去する技術の開発を目的として、海水中の油分の性状を把握する為に基礎実験を行いその結果をとりまとめたものである。

2. 実験要領

海水に混入した油分が分散し、浮上も沈降もしない安定な状態になる条件を実験により求め、その条件における油分の濃度、油分の溶解（一定条件のろ過により通過する油分量）、油分の粒径分布および凝集剤による油分の除去テストを行う。

3. 実験方法

3.1 海水中への油分混入テスト

海水中へ混入した油分が浮上も沈降もしない安定な状態を保つ条件を見つける為のテストで、表1に示す様に海水と油との混合比および攪拌条件を替え、海水中へ混入する油分の時間的濃度変化を求める。

その試験条件を表1に示し、テストのフローを図1～図2に示す。

表1 海水中への油分混入テストの試験条件

テストNo.	海水※1	油分※2	攪拌条件	海水混合	攪拌	静置時間
(A)	1.5 ℓ	10 ml	M.S ※3 1hr	1.5 ℓ	0.5 hr	1,5,10,24 hr
(B)	1.5 ℓ	10 ml	M.S 24hr	1.5 ℓ	0.5 hr	1,2,4,6 hr
(C)	1.0 ℓ	20 ml	M.X ※4 15min	9 ℓ	0.5 Hr	1,2,4,8,24,48,70hr

注) ※1 海水；瀬戸内海沿岸より採取し、GFP (TOYO GA-200 孔径1 μm) を用いてろ過したものを用いる。

※2 油分；A重油 (成分表は別添資料参照方)

※3 M.S；マグネットスターラー

※4 M.X；ミキサー

3.2 海水中に溶解する油分濃度の測定

油分が海水に溶解するか否かの問題と、また、その溶解の定義づけと確認の方法には難しい面があり、今回は油濁水を一定の条件下でろ過し通過水する油分を溶解油分とみなし測定する。

図3にそのテストフローを示す。

注) テストに使用する試験水は3.1の海水中への油分混入テストで確認した安定な油分濃度を試験水として使用する予定であったが、油分濃度の安定した油濁水を調製するには、海水と油分との攪拌条件および静置時間によりバラツキの生じることが判明し、試験水にはその都度油分濃度を同時に測定しておくこととした。

3.3 凝集剤添加による油分の除去テスト

海水中に分散した油分が淡水化装置の前処理に使用されている凝集剤により凝集除去することが出来るか否か確認の為テストを行う。

図4にそのテストフローを示す。

3.4 海水中に分散して安定な油分の粒径測定

3.1のテスト(C)により調製した試験水の静置2Hrおよび70Hr後のサンプルについて光学顕微鏡で3視野写真撮影($\times 200$)し、その写真より粒径および個数を読み取り粒径分布を求める。

図5にそのテストフローを示す。

4. 実験結果

4.1 海水中への油分混入テスト

海水中への油分混入テストの実験結果を表2に示す。

表2 海水中への油分混入テスト実験結果

静置時間 \ テストNo.	(A)	(B)	(C)
1 (Hr)	2.0 (mg/ℓ)	19.3 (mg/ℓ)	69.5 (mg/ℓ)
2		14.9	68.1
4		11.4	66.7
5	1.0		
6		8.3	
8			42.4
10	1.2		
24	1.2		14.9
48			8.0
70			6.1

4.2 海水中に溶解する油分濃度の測定

海水中への油分混入テストでテストNo. (A) に類似した試験水およびテストNo. (C) の試験水について実験を行った結果を表3に示す。

表3 海水中に溶解する油分濃度の測定結果

テスト	試験水調製	静置時間	試験水濃度	ろ過水濃度
①	テストNo. (A)	1 Hr後	7.5 mg/ℓ	0.4 mg/ℓ
②	テストNo. (A)	2 Hr後	7.4 mg/ℓ	0.3 mg/ℓ
③	テストNo. (C)	70 Hr後	6.1 mg/ℓ	0.2 mg/ℓ

4.3 凝集剤添加による油分の除去テスト

4種の凝集剤による油分の除去テストを行った結果を表4に示す。

表4 凝集剤添加による油分の除去テスト結果

凝集剤名	添加量 (ppm)	pH調整	試験水濃度 (mg/ℓ)	処理後油分濃度 (mg/ℓ)
塩化鉄 $FeCl_3$	5	7.0	テストNo.(A) ;1 hr 11 ~ 13	0.5
	10			0.2
	50			0.5
	10		テストNo.(C) ;4 hr 67	0.3
硫酸バンド $Al_2(SO_4)_3$	5	6.0	テストNo.(A) ;1 Hr 11 ~ 13	0.6
	10			0.5
	50			0.5
ポリ塩化 アルミニウム PAC	5	未調整 (7.5)	テストNo.(A) ;1 hr 11 ~ 13	0.4
	10			0.5
	50			0.5
ヒドロキシ エチルセルロース	2		テストNo.(A) ;1 hr 11 ~ 13	0.7
	5			0.5
	10			0.8

4.4 海水中に分散して安定な油分の粒径測定

テストNo. (C) により調製した試験水について2 Hrおよび70 Hr静置後の状態について、光学顕微鏡にて写真撮影した結果を写真1および写真2に示し、写真を基にして油分の粒径分布を測定した結果を表5に示す。

表5 油分の粒径分布測定結果

粒径範囲 (μ)	静置 2 Hr後		静置 70 Hr後	
	個数	粒径分布率 (%)	個数	粒径分布率 (%)
1~2	303	39.6	112	59.6
2~3	212	27.7	38	20.1
3~4	108	14.1	24	12.8
4~5	55	7.2	3	1.6
5~6	31	4.1	7	3.7
6~7	18	2.3	3	1.6
7~8	12	1.6	1	0.6
8~9	5	0.6		
9~10	5	0.6		
10~11	6	0.8		
11~12	2	0.3		
12~13	1	0.1		
13~14	4	0.5		
14~15	0	0		
15~16	0	0		
16~17	2	0.3		
17~18	1	0.1		
18~19	1	0.1		

(備考) 粒径分布は添付の写真(3視野)の平均値で表示。

5. 実験結果の要約と考察

4.の実験結果を要約すると次の様である。

5.1 海水中への油分混入テスト

海水中へ油分を混入させる場合、海水と油との混合比および攪拌条件により、混入する油分濃度が異なり、また、静置後に海水中に分散する油分の濃度は静置の時間と共に変化することが確認された。

5.2 海水中に溶解する油分濃度の測定

今回のテストは東洋ろ紙No.5 Cおよびメンブランフィルター 0.45 μ でろ過処理し、通過する油分を溶解した油分とみなしテストを行ったものである。その結果 0.2~0.4mg/ℓ程度の油分が溶解（ろ紙を通過）することが判明した。

5.3 凝集剤による油分の除去テスト

凝集剤として一般に使用されている塩化鉄、硫酸バンドおよびPACについてはいずれもかなりの凝集効果があり、10数 mg/ℓ濃度の試験水でいずれも0.5mg/ℓ以下の濃度に除去出来ることが判明した。

除去率については、処理する油分濃度に関係することとなるが、試験水約70 mg/ℓについて塩化鉄10 ppmの添加で処理した場合でも0.5mg/ℓ以下に迄処理出来ることも確認出来た。

ヒドロキシエチルセルロースについては使用方法に問題があるものと思われるが、前記の無機凝集剤に比べ若干除去の程度は良くない様であった。

5.4 海水中分散して安定な油分の粒径測定

ミキサーで混合した油濁水を海水に希釈、分散させ、一定時間（2 Hrおよび70 Hr）静置後、海水中に分散している油分の粒径を顕微鏡で確認した結果、ほとんどが粒径5 μ 以下であることが判明した。

以上の実験結果より次の様な事が考察される。

海水中に安定して分散する油分濃度は、油の種類、物性（比重、粘度）および水温により異なることは充分考えられ、また海水中に混入し、分散した油分が浮上も沈降しない安定な状態になるには次の条件が必要とされる。

- 1) 油分の充分なエマルジョン化
- 2) 長時間の静置

その為、同一条件（油分濃度）の試験水で種々のテストを行うことは難しく、試験水の調製法としてはテストNo. (C) の方法、すなわち高濃度のエマルジョン化した油濁水を大容量の容器に希釈し、一定時間静置した後下層部より試験水を抜き取り、テストごとに用いる試験水の油分濃度を確認し、テストを行う方法が良いのではないかと判断される。

6. まとめ

今回実施した海水中の油分の性状調査（基礎実験）により試験油濁水の調製方法、油分濃度の測定方法、および凝集剤による凝集ろ過の効果の程度が確認された。

今後はこの基礎実験結果をもとに本実験として、砂ろ過装置のモデル試験を行い、基礎実験で効果のあった凝集剤を用い、砂ろ過装置へ油分の混入した場合のろ過性能の変化について確認する必要があると考えられる。

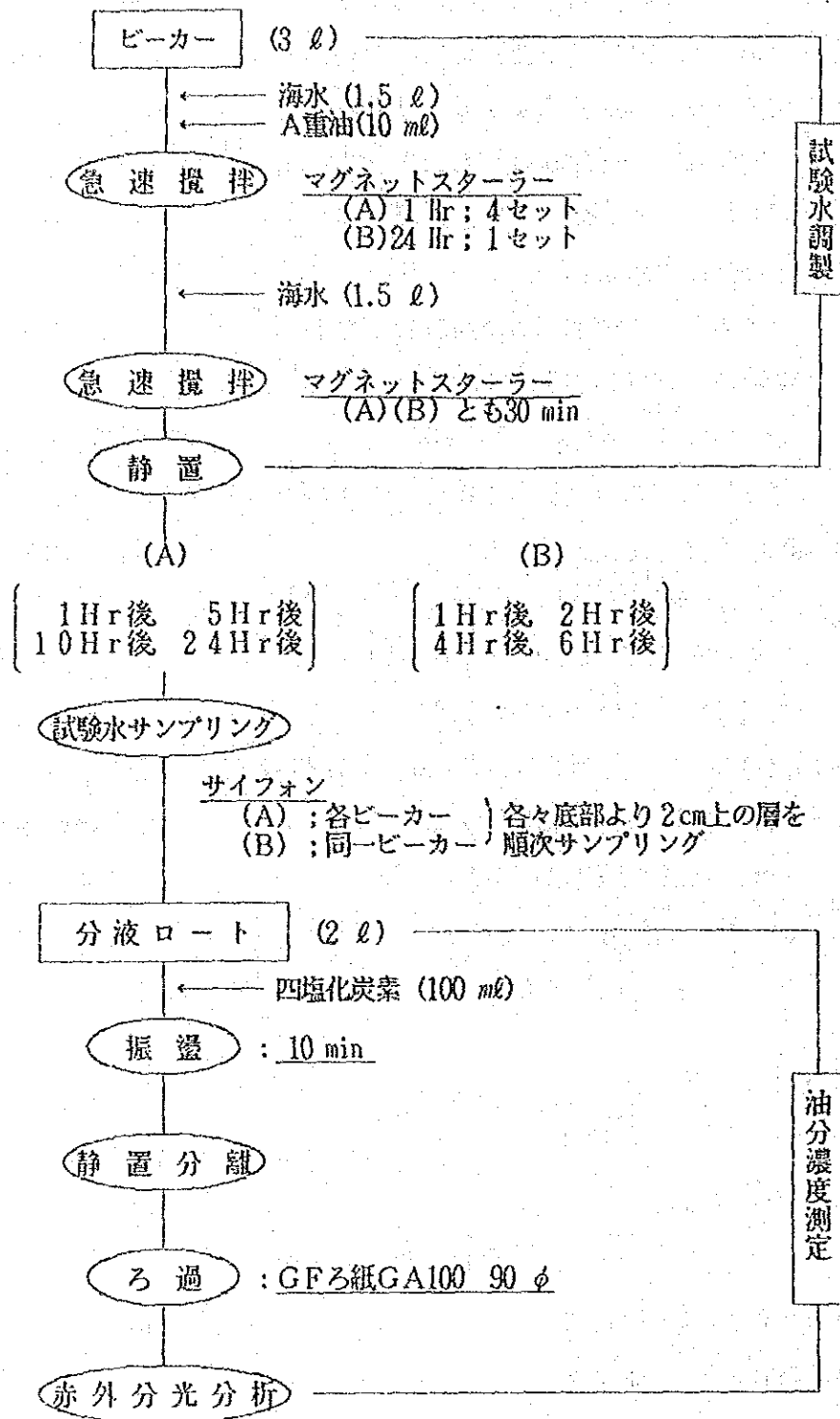


図1. 海水中への油分混入テストのフロー
〔テストNo. (A)(B)〕

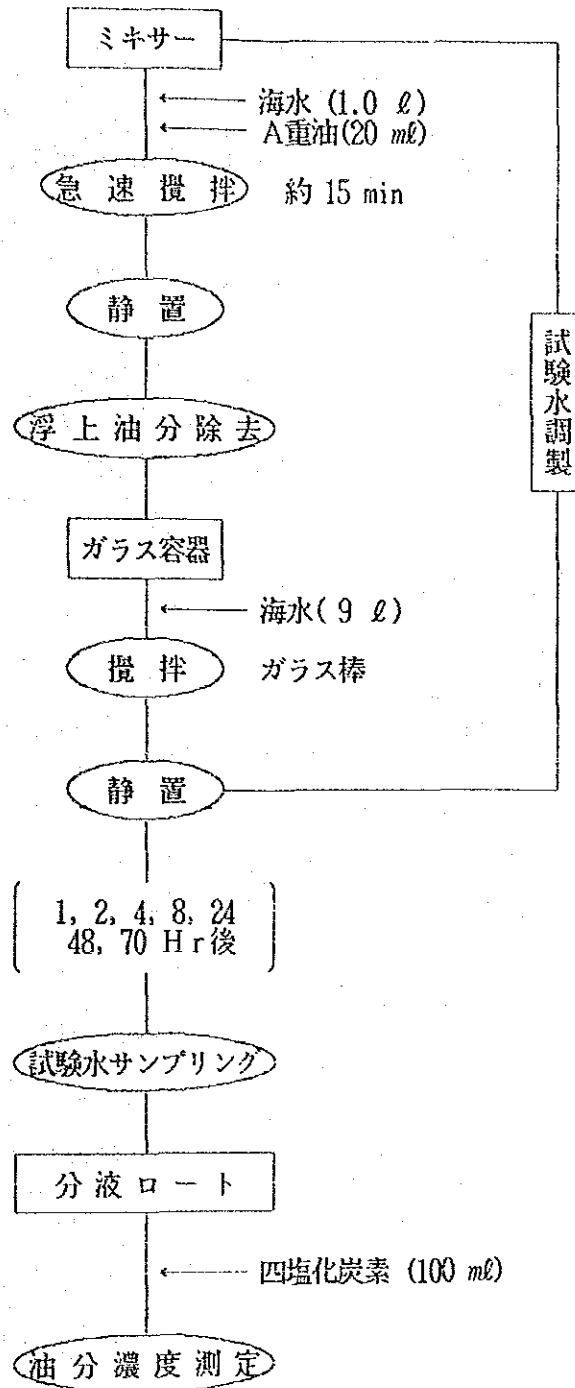


図2. 海水中への油分混入テストのフロー
〔テストNo. (C)〕

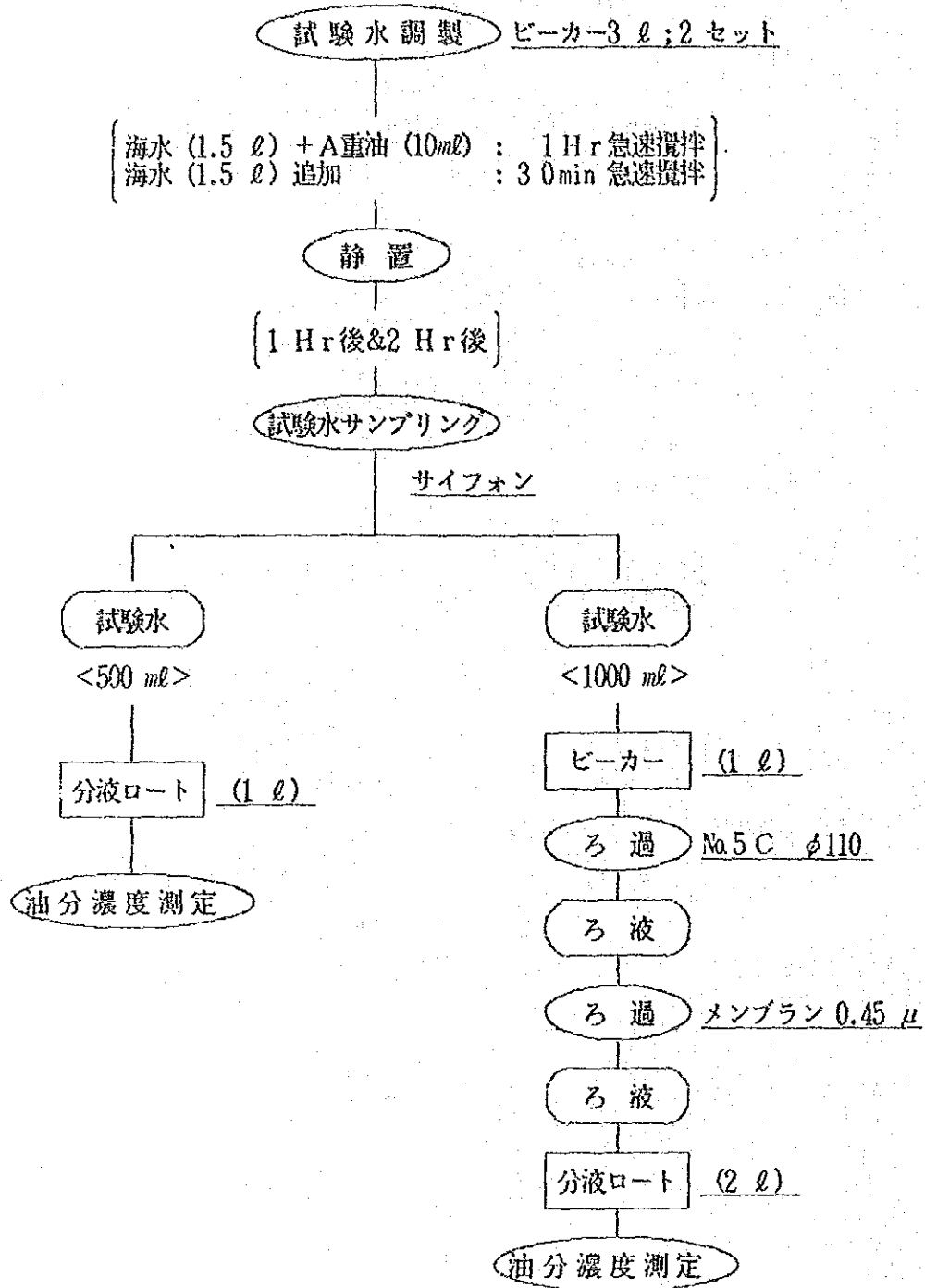


図3. 海水中に溶解する油分の測定のプロフロー

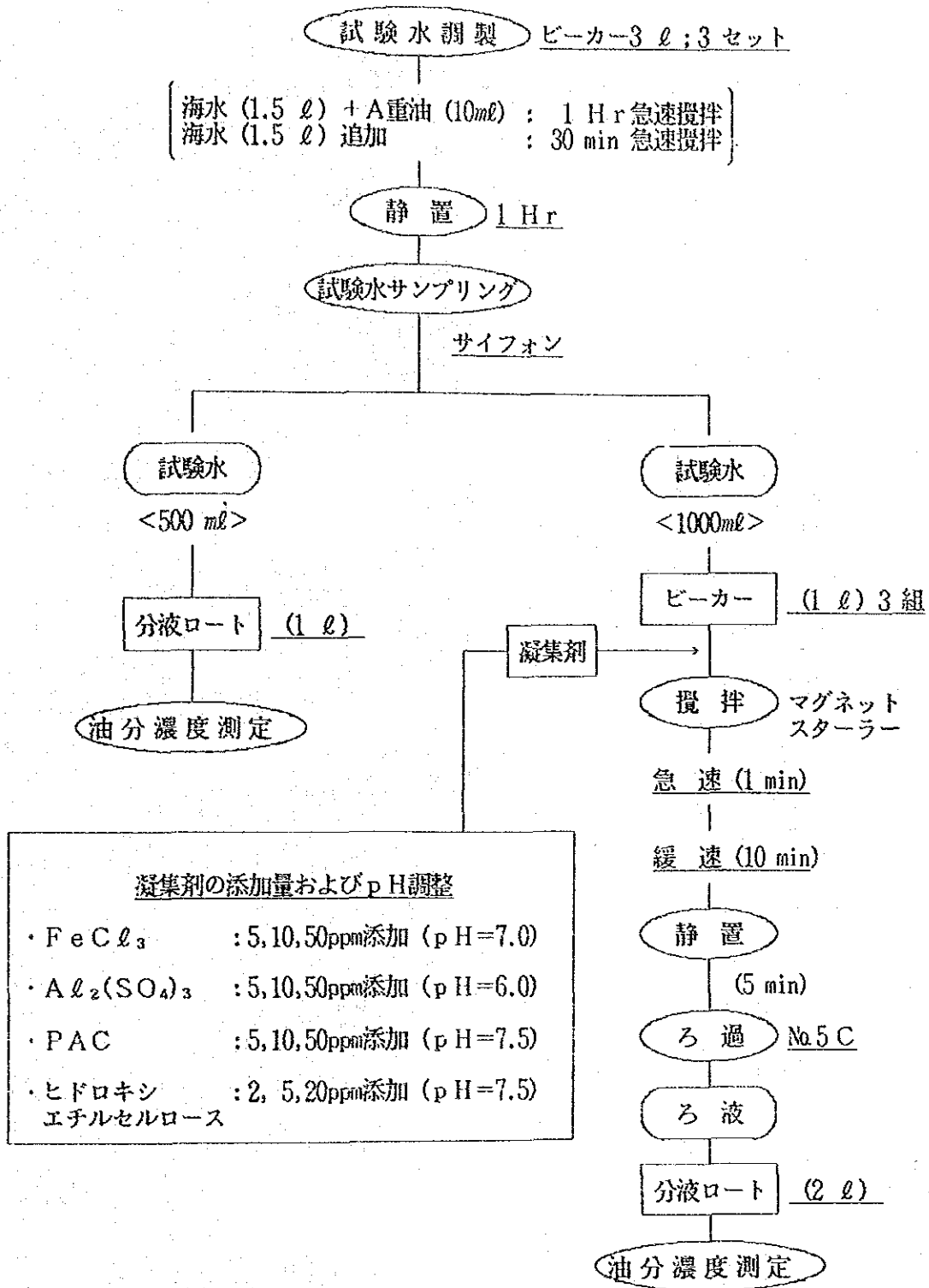


図4. 凝集剤添加による油分の除去テストフロー

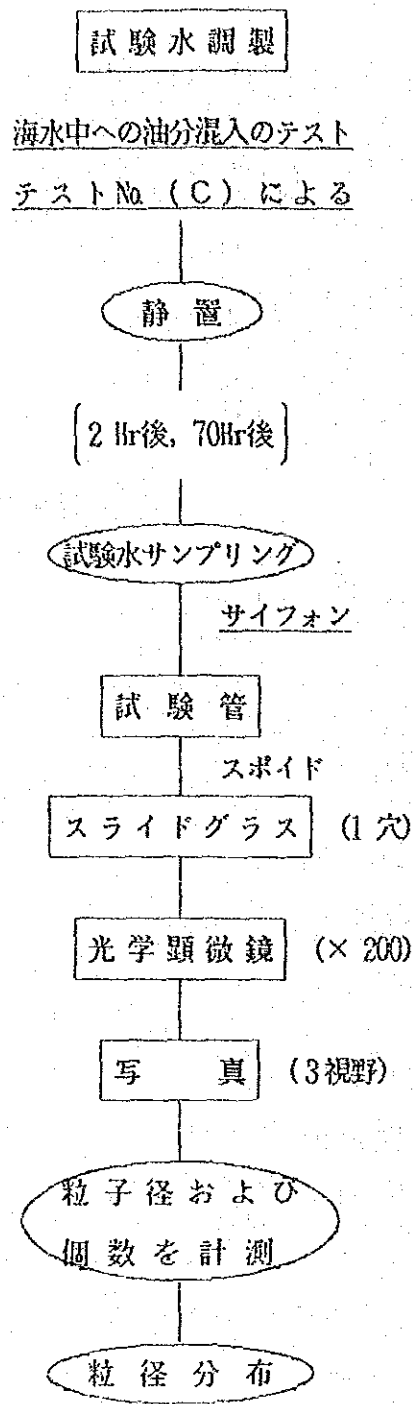
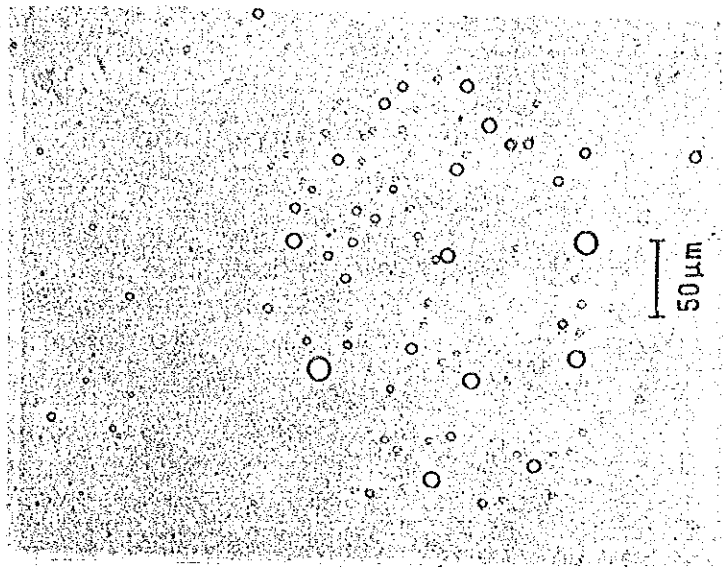
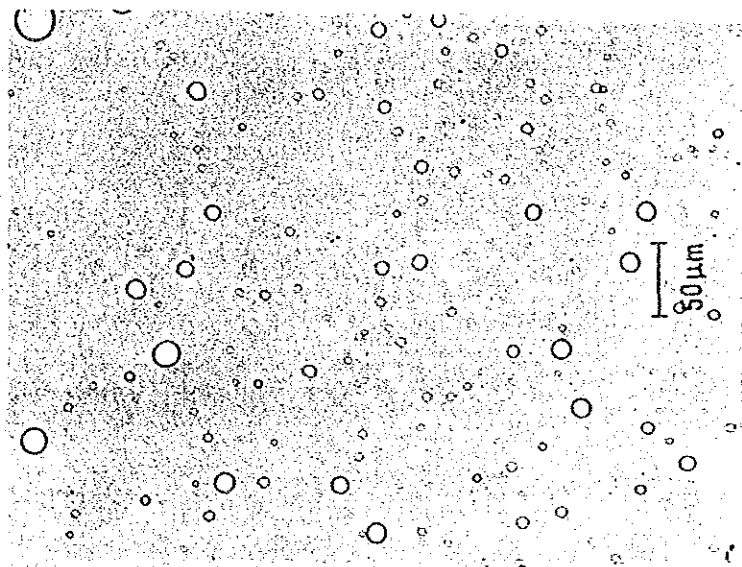


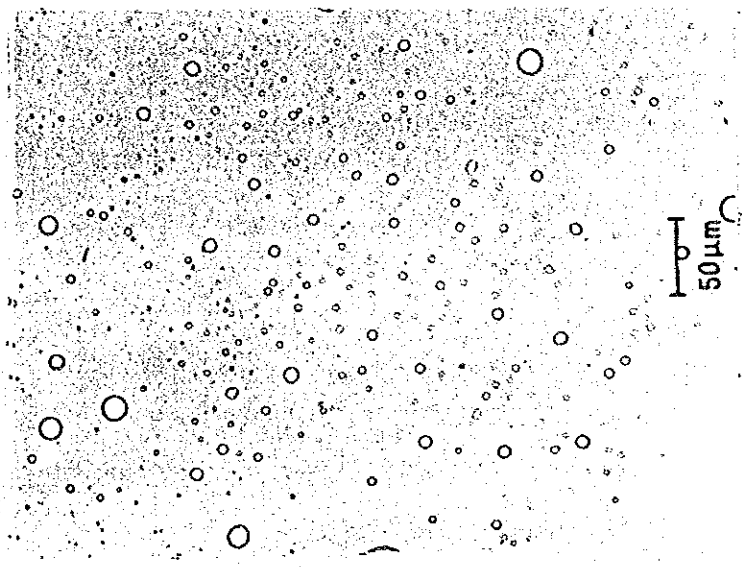
図5. 海水中に分散して安定な油分の
粒径測定のプロロー



a) 2 H r 静置 × 200



b) 2 H r 静置 × 200

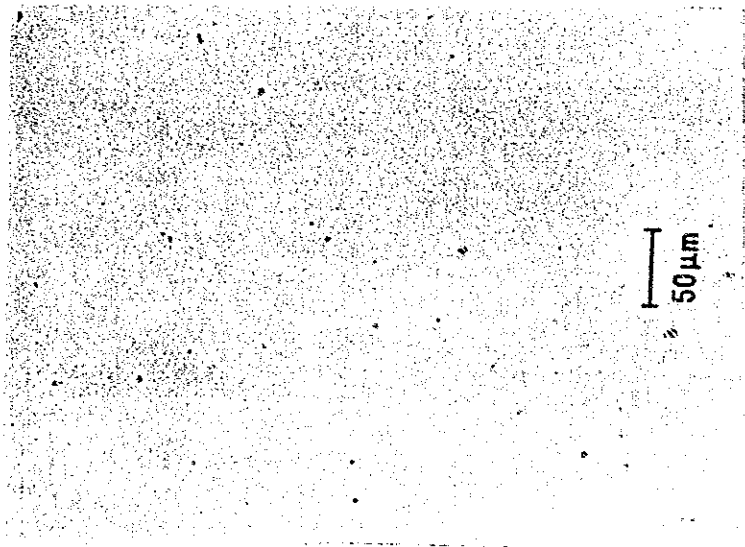


c) 2 H r 静置 × 200

写真1 海水中油分の顕微鏡拡大写真



d) 70 Hr 静置 × 200



e) 70 Hr 静置 × 200



f) 70 Hr 静置 × 200

写真2 海水中油分の顕微鏡拡大写真

今回実験に使用したA重油の 炭素数ごとの組成比測定

1. 方法

試料を二硫化炭素に溶かして10%(v/v)とし、1 μ l をガスクロマトグラフに注入した。得られたクロマトグラムを、同じ炭素数の炭化水素のうちで n-alcane が最も遅く溶出するという仮定のもとに炭素数ごとに分割し、各炭素数の総ピーク面積の、クロマトグラムの総ピーク面積(二硫化炭素のピークは除く)に対する百分率を求めた。

2. 装置

GC分析条件

Instrument : Shimadzu GC-14APF
 Column : Fused silica capillary column CBP-1
 50m \times 0.20mm i.d. 0.25 μ m film thickness
 Temperature : Column 35 $^{\circ}$ C(1.5min.) \rightarrow 310 $^{\circ}$ C 5 $^{\circ}$ C/min.
 Injection 280 $^{\circ}$ C Detector 310 $^{\circ}$ C
 Carrier gas : Inlet press 2.0 Kg/cm 2
 Split : 1/50
 Detector : FID ; Range 10 2 ; Air 0.5Kg/cm 2 400ml/min.
 ; H $_2$ 0.5Kg/cm 2 40ml/min.

3. 結果

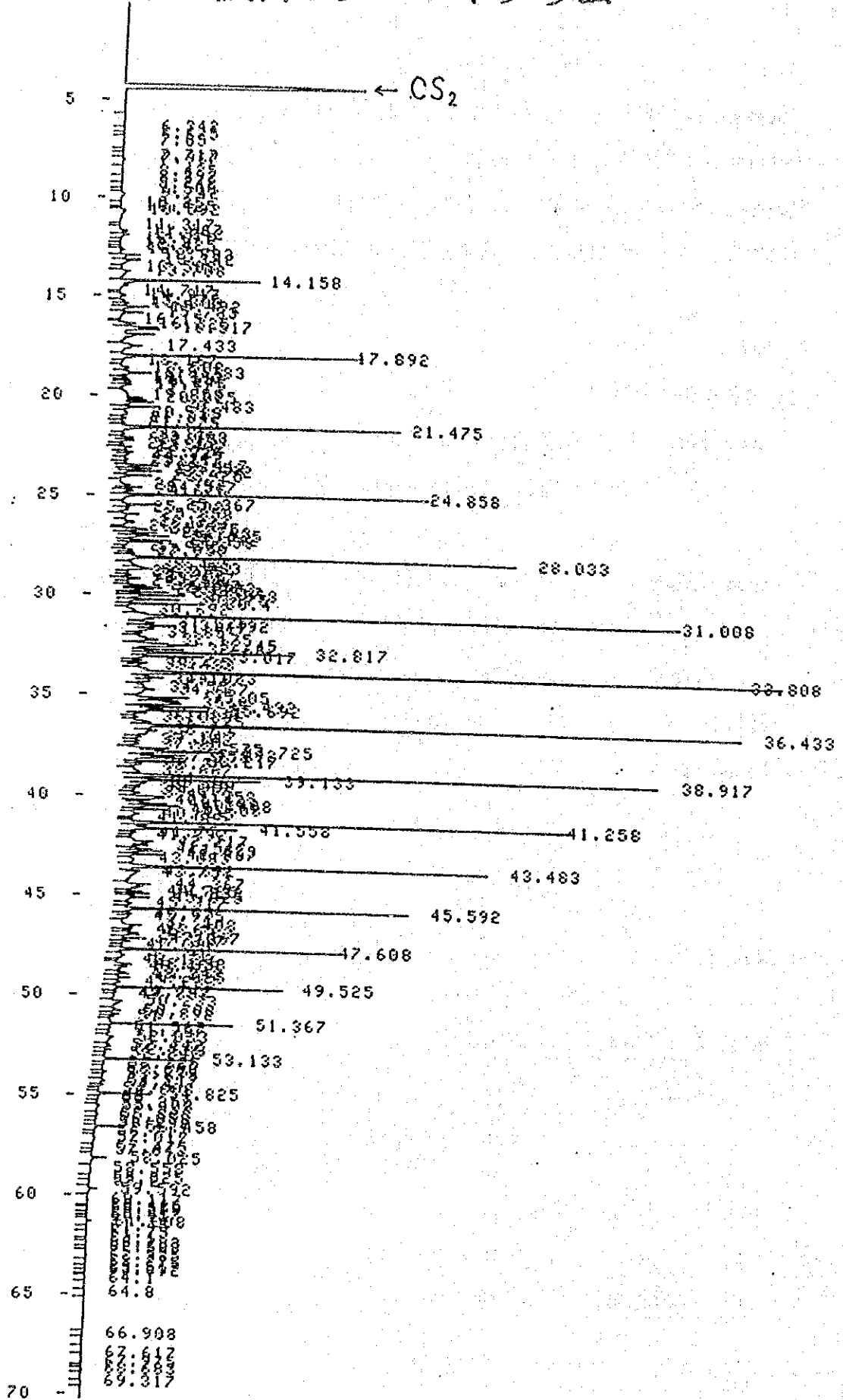
炭素数ごとの組成比を次表に示した。単位は%

炭素数	組成	炭素数	組成	炭素数	組成	炭素数	組成
8以下	0.22	14	8.19	20	6.14	26	1.09
9	1.90	15	10.69	21	5.07	27	0.65
10	3.48	16	10.66	22	4.07	28	0.31
11	4.28	17	9.06	23	3.05	29	0.18
12	4.88	18	8.42	24	2.42	30	0.08
13	5.86	19	7.68	25	1.59	31以上	0.02

クロマトグラムを参照してください。

ANAL 1,3

試料のクロマトグラム



5. R3 添付資料 (膜洗浄排水の処理に関する研究)

R 3 - 1	文献検索式	5- 1
R 3 - 2	原報解析より選択された文献及びファイル	5- 7
R 3 - 3	主要文献の要約	5- 13
R 3 - 4	ホルマリン及びホルマリンを含む排水の処理 についての文献調査	5- 17

1) DIALOG検索式

検 索 式	セット件数	備 考
? B411 ? S ((RO+REVERSE?()OSMO?)*(SEA()WATER+BRIN?)* *(DE()SALT?+DESALT?+PURIF?+RINS?+DRAIN?+ RELEAS?)*PY = 1976:1991 ? SAVE TEMP Temp Search Save "TB014"stored ? B245, 117, 399, 28, 44, 8, 41, 6, 144, 96	164 ファイル についてファ イル別該当件 数が揭示され る。	<ul style="list-style-type: none"> ・ DIALINDEX に接続し、システム中の各々のファイルにおける収録件数を調査する。 ・ 逆浸透膜法による海水淡水化処理に関するデータを、1976年以降最新のものまで抽出する。 ・ 前出の検索式を記憶する。 ・ "TB014" のコードでシステムが記憶を受理。 ・ 文献の収録件数の多いファイルについて、主要10ファイルに接続
? EXS TB014	S1 915	<ul style="list-style-type: none"> ・ 前出の検索式を実行し、915 件がヒット。
? S S1 AND PY = 1981:1991 ? PR S2/5/ALL	S2 579	<ul style="list-style-type: none"> ・ 調査期間を1981年以降に絞り、579 件がヒット。 ・ 上記579 件について全件をオフラインプリントを発注
? B350, 351		<ul style="list-style-type: none"> ・ 世界特許ファイル(WPI, WPIL)に接続。
? EXS TB014	S3 213	<ul style="list-style-type: none"> ・ 記録された検索式を実行し、213 件がヒット。
? S S3 AND IC = BOID-013	S4 147	<ul style="list-style-type: none"> ・ 国際特許分類で件数を絞る。

検 索 式	セット件数	備 考
? S S4 NOT (PC = SU AND NP = 001) ? PR S5/7/ALL ? LOGOFF	S5 146	・ソ連だけに出願されたものを除外する。 ・146件について全部をオフラインプリント発注。

2) JOIS 検索過程

[1] S: 136, 393 タンスイカ&

U: ギャクシントウマク& OR ハントウマク&

[2] S: 2, 970 ギャクシントウマク&+ハントウマク&

U: センジョウ

[3] S: 32, 281 センジョウ

U: KW: ハイスイ (ハイシュツ)

[4] S: 8, 401 KW: ハイスイ (ハイシュツ)

U: DESALINAT&

[5] S: 723 DESALINAT&

U: SEMIPERMEABLE (1W) MEMBRANE?

[6] S: 34 SEMIPERMEABLE (1W) MEMBRANE?

U: CLEANING OR LINS

[7] S: 3, 268 CLEANING&LINS

U: RINSE?

[8] S: 119 RINSE?

U: DRAINAGE OR DRAINING

[9] S: 2,766 DRAINAGE OR DRAINING

U: 1+5 タンスイカ

[10] S: 136,608 1+5 タンスイカ

U: 2+6 ギャクシントウ

[11] S: 2,976 2+6 ギャクシントウ

U: 3+7+8 センジョウ

[12] S: 34,072 3+7+8 センジョウ

U: 4+9 FERE

[13] S: 10,099 4+9 FERE

U: 11*13*12*10

[14] S: 0 11*13*12*10

U: 10*11

[15] S: 521 10*11

U: 15*(12+13)

[16] S: 22 15*(12+13)

U: ¥P A

<省略>

S: 出力終了しました (SSNo [16] から22件)

U: REVERSE (1W) OSMOSIS

(17) S: 803 REVERSE (1W) OSMOSIS

U: RO

(18) S: 2,703 RO

U: 17*1

(19) S: 208 17*1

U: 19* (12+13)

(20) S: 5 19* (12+13)

U: 18*1

(21) S: 146 18*1

U: 21* (12+13)

(22) S: 5 21* (12+13)

U: (20+22) #16

(23) S: 3 (20+22) #16

U: ¥P A

<省略>

S: 出力終わりました (SSNo [23] から3件)

U: ハイスイ

(24) S: 18,062 ハイスイ

U: 19+21+15

(25) S: 97 19+21+15

U: 25 * (12 + 13 + 24)

(26) S: 9 25 * (12 + 13 + 24)

U: ¥P A

<省略>

S: 出力終了しました (SSNo [26] から9件)

R 3 - 2 原報解析より選択された文献及びファイル

ファイル No.	整理 No.	論文名 (著者名)	資料名 巻、号、発行年、ページ
117 (010, 011)	1	Operating Experiences on a Reverse Osmosis Plant which Converts Sea Water into Boiled Feed Water (Vera I.)	Industrial Water Engineering Vol. 18, No. 16, 1981, P22-29
117 (NTIS 6)	2	Development of New Cleaning Techniques for Reverse Osmosis Membranes (Jolaine A. Jonson and Thomas M. Leahy)	Available from the National Technical Service as PB83-146746 Append. OWRT C-80152-S(8519)(1) 14-34-0001-8519 30, Mar., 1982 183pp.
117 (96)	3	Solution of Contradictory Problem of Simultaneous Desalination and Concentration in Reverse Osmosis (C. A. Yagodin, et al.)	Desalination Vol. 46, 1983, p171-177
117 (96)	4	Development of an Improved Cleaning Solution for RO WPU Units (Clyde B. Milstead and Robert L. Riley)	Available from the National Technical Service as AD-A1196 Report No. SST-88-01 Department of the Army Contract DAA K-87-006 11, Apr. 1988 245pp.

ファイル No.	整理 No.	論文名 (著者名)	資料名 巻、号、発行年、ページ
117 (28, 44)	5	High Recovery Reverse Osmosis (Bruce M. Watson)	Desalination Vol. 78, No. 1, 1990, p91-97
117 (44)	6	Reclaiming Reverse Osmosis Blowdown with Electrodialysis Reversal (Eugene R. Reahl)	Desalination Vol. 78, No. 1, 1990, p77-90
28 (44)	7	Pre-and Post-Treatment at the RO Plant at RA's Abu Jarjur, Bahrain (M. Al Arrayedhy)	Desalination Vol. 63, 1987, p81-94
28 (44)	8	Trace Metal Fouling and Cleaning of Sea- Water R.O. Membranes (G. Peplow, F. Vernon)	Desalination Vol. 66, 1987, p271-284
28 (117, 44)	9	Preface (O. K. Buros)	Desalination Vol. 78, 1990, p1-2
44	10	Energy recovery from the reject brine of Reverse Osmosis System (S. C. May et al.)	PBNo. 83-209031 Report No. W83-03113 Selected Water Resources Abstracts Mar. 1981, pp. 71

ファイル No.	整理 No.	論文名 (著者名)	資料名 巻、号、発行年、ページ
4 4	1 1	Drinking Water from the Sea:Reverse Reverse Osmosis, the Modern Alternative (J. T. Allanson and R. Charnley)	Trans. Inst. Mar. Eng. (TM) Vol. 95, No. 38, 1983 , pp. 13
4 4	1 2	Future for Desalination by Reverse Osmosis (M. A. Jaward)	Desalination Vol. 72, 1989, p23-28
0 1 0 0 1 1	1 3	イオン交換膜法による廃水処理の実際例 (田中 稔, 糸井 滋)	P P M (公害対策と技術) Vol. 7, No. 3, 1976 p41-52
0 1 0 0 1 1	1 4	高分子系膜分離 (池田 健一)	化学装置 Vol. 32, No. 11, 1990 p88-99
0 1 0 0 1 1	1 5	逆浸透法による海水からの飲料水製造—愛媛県 生名村海水淡水化実験装置 (川俣 深)	荏原インフィルコ時報 No. 83, 1981 p44-49
0 1 0 0 1 1	1 6	長崎県小値賀町六島における海水淡水化の実施 例 (木島 二郎, 国友 充夫)	造水技術 Vol. 8, No. 1, 1982 p39-43
0 1 0 0 1 1	1 7	High Frequency Excitation and Vibration Studies on Hyperfiltration Membranes (Cal. C. Hermann)	Desalination Vol. 42, 1982, p329-338

ファイル No.	整理 No.	論 文 名 (著 者 名)	資 料 名 巻、号、発行年、ページ
010 011	18	Development of Improved Cleaning and Surface Regeneration Methods and Economic Analysis of These Methods for Seawater Membranes (Buros and Roe Industrial Surv. Corp., New Jersey)	PB Rep. PB-81-170607, 1981 114pp
010 011	19	Recovery of Chemicals by Membrane Process (Patric K. NG)	Tutorial Lectures In Electro- Chemical Eng. And Tech. - II Vol. 79, No. 229, 1983 p187-196
010 011	20	汚水処理施設の設計(19) (溝呂木 昇)	水 Vol. 25, No. 3, 1983 p36-40
010 011	21	Electrodialysis Reversal (EDR) for Surface and waste waters desalination (J. W. Van Wely)	Technische Mitteilungen Vol. 78, No. 12, 1985 p255-269
010 011	22	Desalination And Reuse of Power Plant Effluents: From Pilot Plant to Full Scale Application	Desalination Vol. 67, No. 1/2/3, 1987, p255-269
010 011	23	Pilot Experiences on the Recovery of Polluted Reverse Osmosis Membranes (M. Farinas, et al.)	Desalination Vol. 66, 1987, p385-402

ファイル No.	整理 No.	論 文 名 (著 者 名)	資 料 名 巻、号、発行年、ページ
010 011	24	Graphic Evolution of the 24,000 Hours(3 Years) Operating Data of a Desalination Plant, in Las Palmas, Canary Islands, Spain (Enrique Ruiz Saavedra)	Desalination Vol. 76, NO. 1/3, 1989, p15-26
010 011	25	Improving Reverse Osmosis Performance Through Perioic Cleaning (S. I. Graham, et al.)	Desalination Vol. 74, NO. 1/3, 1989, p113-124

No.	論文名、著者名	資料名	内 容									
1 (File No. 010 011)	イオン交換膜法による 廃水処理の実際例 田中 稔 糸井 滋	P P M (公害 対策と技術) Vol. 7, No. 3, 1976 p41-52	<p>膜法による塩水淡水化装置の実例を紹介している。ここで紹介されている膜法は、イオン交換膜を用いた電気透析法によるもので、Benghazi(リビア)、Zilten(リビア)の水道、オランダのビール醸造用水製造に用いられていることが記述されている。</p> <p>本文献は、イオン交換膜法による淡水化装置の紹介であり、RO膜についての記述はない。電気透析法の塩水淡水化の実施例の処理規模は、以下の通り。</p> <table data-bbox="794 936 1246 1099"> <tr> <td>Benghazi市水道</td> <td>19,000</td> <td>m³/日</td> </tr> <tr> <td>Zilten市水道</td> <td>330</td> <td>m³/日</td> </tr> <tr> <td>ビール醸造用水</td> <td>670</td> <td>m³/日</td> </tr> </table>	Benghazi市水道	19,000	m ³ /日	Zilten市水道	330	m ³ /日	ビール醸造用水	670	m ³ /日
Benghazi市水道	19,000	m ³ /日										
Zilten市水道	330	m ³ /日										
ビール醸造用水	670	m ³ /日										
2 (File No. 010 011)	高分子系膜分離 池田 健一	化学装置 Vol. 32, 1990 p88-99	<p>高分子膜分離技術の一般事項を解説した文献。一般論としての膜モジュールの洗浄方法が記述されている。</p> <p>膜の洗浄方法を選択する際には、ファウリング物質の種類、膜モジュールの形態および膜モジュールを構成する分離膜や他の部材の耐性を知ることが必要。</p> <p>著しくファウリングしてから洗浄するよりも、軽いうちに行う方が高い回復率を示すので、洗浄のタイミングが重要。</p> <p>以上の記述の他、洗浄方法の種類などが記述されている。</p>									

No.	論文名、著者名	資料名	内 容
3 (File No. 010 011)	逆浸透法による海水 からの飲料水製造— 愛媛県生名村海水淡 水化実験装置 川 俣 深	荏原インフイ ルコ時報 No. 83, 1981 p44-49	<p>生産水量10m³/日の逆浸透膜海水淡水化実験装置の運転結果を報告している。</p> <p>1)装置の仕様</p> <p>造水方式: 海水1段脱塩逆浸透膜法</p> <p>前処理方式: 複層ろ過器+砂ろ過器+精密ろ過器</p> <p>後処理方式: 脱炭酸塔および石灰石充填カラム使用</p> <p>処理薬品: 滅菌 次亜塩素酸ナトリウム 2~3 mg/l as Cl₂</p> <p>凝集 塩化第二鉄 1.5 ~3.0 mg/l as Fe</p> <p>pH調整 硫酸(重炭酸塩系スケール防止)</p> <p>スケール防止 メタリン酸ナトリウム (石膏系スケール防止)</p> <p>膜仕様: 酢酸セルロース系中空糸膜 (東洋紡 ホローセップ HR-8350)</p> <p>回収率: 30 %</p> <p>2)前処理のろ過器</p> <p>1段ろ過では、F Iを4以下にはできなかった。</p> <p>2段ろ過では、F Iは2~3で運転できた。</p> <p>2段ろ過後のFe濃度は、0.02mg/l程度であった。</p> <p>ろ過器の洗浄頻度は、10m/hの運転で、1次ろ過器が1回/日、2次ろ過器が1/4~5日。</p> <p>凝集剤無添加のろ過は、効果が無かった。凝集剤としては鉄塩が有効で、1.5 mg/l as Feで十分であった。</p> <p>3)排水の処理、洗浄薬液、保存液</p> <p>記述なし</p>

No.	論文名、著者名	資料名	内 容
4 (File No. 010 011)	長崎県小値賀町六島 における海水淡水化 の実施例 木島 二郎 国友 充夫	造水技術 Vol. 8, No. 1 1982 P39-43	<p>製造水量30m³/日の逆浸透膜海水淡水化装置の運転結果を報告している。</p> <p>1)装置の仕様</p> <p>造水方式: 海水2段脱塩逆浸透膜法</p> <p>前処理方式: 圧力式ろ過器+保安フィルター</p> <p>後処理方式: 天然石充填塔通水方式</p> <p>処理薬品: 滅菌 次亜塩素酸ナトリウム</p> <p>凝集 塩化第2鉄</p> <p>pH調整 硫酸</p> <p>膜仕様: 非対称酢酸セルロース、スパイラル型 (東レ SC -5200)</p> <p>回収率: 第1段RO 40%</p> <p>第2段RO 83.3% 総合回収率 35.7%</p> <p>生産水水質:TDS 500ppm 以下</p> <p>2)薬品洗浄について</p> <p>運転開始後1年3ヶ月後にクエン酸による洗浄を実施した。膜には、前処理で使用の塩化第二鉄の影響とみられる鉄付着物質があった。</p> <p>3)排水の処理</p> <p>圧力ろ過器洗浄排水: 無処理</p> <p>濃縮海水: 無処理</p> <p>薬液洗浄排水及び保存液排水: 記述なし</p>

No.	論文名、著者名	資料名	内 容
8 (File No. 010 011)	汚水処理施設の設計 (19) 溝呂木 昇	水 Vol. 25, No. 3 1983, p36-40	<p>汚水処理技術について、連載で解説している文献で、逆浸透膜についても記述している。</p> <p>膜の洗浄の一般的事項として、清水で膜面をフラッシングする方法、化学薬品等で洗浄する方法を紹介し、化学薬品の例として、クエン酸溶液、クエン酸アンモニウム、酵素を含んだ洗剤をあげている。</p>

R 3 - 4 ホルマリン及びホルマリンを含む排水の処理についての文献調査

整理 No.	論文名、著者名	資料名	内 容
26	難分解性有機化合物含有廃水の付着生物膜処理 羽野 忠	ケミカルエンジニアリング Vol. 35, No. 10 1990, p816-821	フェノール類の好気および嫌気分解の速度と、生物膜を用いた処理の研究例を紹介している。この中でフェノールとともにホルムアルデヒドを含む廃水についても、分解速度を述べている。
27	空気局部電池法による電解液中のメタノールホルムアルデヒドおよびギ酸の除去 古屋 長一他	工業用水 No. 381, 1990, p11-16	ホルマリン、ギ酸などのC1化合物を含む廃液(電解めっき廃液など)から、C1化合物を酸化分解する方法を検討したもの。電解液のpHが3以下であれば、電解質の種類と濃度に依存せず、ガス拡散電極上でC1化合物は空気中の酸素と反応して完全にCO ₂ とH ₂ Oに分解可能。
28	空気局部電池法による電解液中のメタノールホルムアルデヒドおよびギ酸の除去 古屋 長一他	工業用水 No. 385, 1990, p55-60	ホルムアルデヒドの分解挙動を、詳細に調べたもの。pH<7では完全に空気で酸化され、CO ₂ とH ₂ Oに分解。pH>7の電解液では、ギ酸を生成。pH>12では、ほぼ100%ギ酸を生成する。
29	活性汚泥によるフェノール・ホルムアルデヒド複合基質の除去 保坂 幸尚他	水処理技術 Vol. 31, No. 4 1990, p205-212	フェノール、ホルムアルデヒド複合基質を活性汚泥で処理する回分および連続実験を行っている。ホルムアルデヒドは、馴養操作を行ってなくても、初期段階から除去される。

整理 No.	論文名、著者名	資料名	内 容
30	付着生物膜法によるフェノール・m-クレゾール・ホルムアルデヒド含有廃水の同時処理 羽野 忠	化学工学会年会 研究発表講演要 旨集 Vol. 55, 1990 p426	アルミナ粒子を担体として用いた三層流動層およびリングレースを担体として用いたろ床の2種類の方法で、フェノール・m-クレゾール・ホルムアルデヒドを含む廃水の生物処理の実験結果を報告している。汚泥は馴養したもの。
31	フェノール・ホルマリオン系複合排水の生物処理 羽野 忠他	水質汚濁学会講演集 Vol. 23, 1989 p85-86	フェノール・m-クレゾール・ホルムアルデヒドを含む複合排水を、懸濁系で好気性生物処理を行った実験結果および微生物を活性炭に付着させ、三層流動層で処理した実験結果を報告したもの。
32	Stoerungen der Funktion biologischer Kläranlagen durch Chemikalien: Vergleich der Grenzkonzentration mit Ergebnissen im Sauerstoffzehrungstest. W. Guhl P. CODE	Vom Wasser Vol. 72, 1989 p165-173	ホルムアルデヒドを含む11の化学物質の混入が、排水の生物処理に対してあたえる阻害性を、実験により測定したもの。

整理 No.	論文名、著者名	資料名	内 容
3 3	Versuche zum Ver- halten microbizider Verbindungen in Klaeranlagen. 3. Mitteilung: Form- aldehyd J. Raff L. Weil W. Hegemann	GWF Wasser Ab- wasser Vol. 130, No. 8 1989, p392-397	活性汚泥に対するホルムアルデヒドの毒性を測定 を測定したもの。また、活性汚泥へのホルムアル デヒドの吸着と、活性汚泥によるホルムアルデヒ ドの分解挙動を明らかにしている。
3 4	A Fenton-like re- action to neutralize formaldehyde waste solutions. A. P. Murphy W. J. Boegli M. K. Price C. D. Moody	Environ. Sci. Technol. Vol. 23, No. 2, 1989, p166-169	ホルムアルデヒドを含有する産業廃液の処理方法 として、フェントン反応に類似の方法を研究した もの。Fe ²⁺ を触媒として、H ₂ O ₂ によってホルムア ルデヒドを酸化するもの。
3 5	The Process Utility of Thermotolerant Methylotrophic Bacteria: I. An Evalu- ation in Chemostat Culture	Biotechnology and Bioengi- neering Vol. 36, 1990 p816-820	耐熱性メタノール資化性菌をケモスタットで定常 連続培養を行うと、メタノールやホルムアルデヒ ドに対し、高い耐性を示した。産業排水に適用す る際は、滞留時間5時間以上、希釈率を0.2/h以 下の条件で、メタノールは完全に消費され、バイ オマスの生成も少なかった。

6. R 4 添付資料 (膜の選定に関する研究)

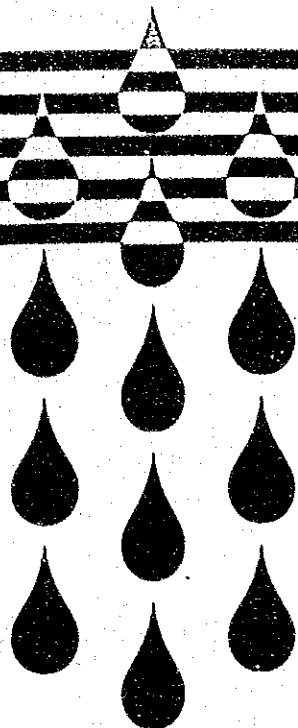
R 4 - 1 Miscellaneous Brochures of Membrane Manufacturer --- 6 - 1



PERMASEP*

Reverse Osmosis Products

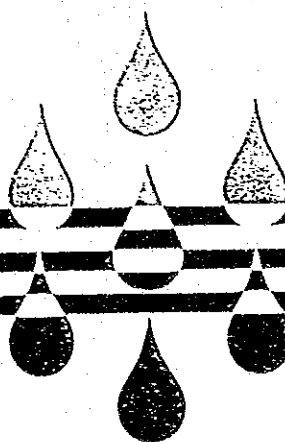
AUGUST, 1991



GENERAL GUIDE TO PRODUCTS AND PROPERTIES


A leader in reverse osmosis water desalination, Du Pont's "Permasep" products were commercialized in 1969. Since that time, they have been used in thousands of installations in dozens of countries around the world for desalination of brackish water and seawater. Over one billion gallons per day capacity (over 4 million cubic meters per day) of "Permasep" products have been purchased since commercialization, well over 20 years ago.

*Du Pont's registered trademark for its reverse osmosis products.



Start
with
DuPont






RO MEMBRANE LEADERSHIP

Today, Du Pont's Permasep[®] Products are the established worldwide leader in RO desalination of brackish water and seawater with more installed capacity† than any other membrane supplier. The lead is even more dramatic in demanding seawater applications with installed capacity† more than twice the nearest competitor.

Underlying this wide acceptance of "Permasep" products is Du Pont's pioneering work more than 20 years ago to develop long-lasting membrane products and applications technology which enables qualified systems suppliers and end-users to ensure successful RO plant operations. End-users can draw upon patented and proprietary Du Pont products and technology through qualified suppliers (Licensees) of complete desalination systems using "Permasep".



WIDE ACCEPTANCE OF "PERMASEP" PRODUCTS:

Water treatment systems incorporating "Permasep" products are used in a broad spectrum of potable, industrial and special water desalination applications. Thousands of installations using "Permasep" products are currently operating throughout the world, producing millions of cubic meters of purified water daily. Although only a representative few are shown in this brochure, they do illustrate how

PRODUCT TYPES & USE

"Permasep" products come in two product types, according to the type of water to be treated. Product specifications for all models available in these two types appear on page three.

Seawater & High Brackish	B-10	A hollow fine fiber, aramid membrane permeator designed for seawater and high brackish applications where long membrane life is needed. Replacement bundles are also available.
Brackish	B-9	A hollow fine fiber, aramid membrane permeator designed primarily for brackish water applications where long membrane life is needed. Replacement bundles are also available.

"Permasep" products have been used to desalinate water economically, including demanding Arabian Gulf seawaters.



POTABLE APPLICATIONS

Reverse osmosis systems based on "Permasep" products are producing drinking-quality water for:

- Municipalities, cities and towns
- Island communities
- Realty developments
- Mobile home parks
- Resorts, hotels and motels
- Offshore drilling and production platforms



INDUSTRIAL APPLICATIONS

"Permasep" products are used by industrial firms to purify water for:

- Rinsing electronic components
- Boiler makeup
- Process water
- High purity water for
 - formulations
 - rinsing and cleaning metals
 - polymerization reactions



SPECIAL APPLICATIONS

Besides purifying water for municipal systems and industrial operations, our customers use "Permasep" products to desalinate water for a great variety of special end uses:

- Water-dispensing equipment
- Car washes
- Small cooling towers
- Humidifiers
- Flower growing
- Ice rinks
- Water treatment for hemodialysis
- Ice manufacture
- Fish culture
- Hydroponic gardening
- Restaurants
- Campgrounds
- Central home systems
- Yachts, ships

†1990 International Desalination Association Worldwide Desalting Plants Inventory Report No. 11

*Du Pont's registered trademark for its reverse osmosis products



PRODUCT SPECIFICATIONS FOR PERMASEP* PERMEATORS AND REPLACEMENT BUNDLES

APPLICATION	SEAWATER				BRACKISH							
PRODUCT TYPE	B-10 ^{1,2}				B-9							
MODEL NO.	6410T	6440T	6845T	6845TR	0410	0420	0440	0840	0840R	0040	0040R	
PHYSICAL CHARACTERISTICS												
MEMBRANE TYPE	ARAMID				ARAMID							
MEMBRANE CONFIGURATION	Hollow Fine Fiber				Hollow Fine Fiber							
DIAMETER, NOMINAL, cm (in)	11.7 (5)	11.7 (5)	21.6 (8)	21.6 (8)	10.2 (4)	10.2 (4)	10.2 (4)	20.3 (8)	20.3 (8)	25.4 (10)	25.4 (10)	
APPROX. LENGTH ³ , cm (in)	58 (23)	126 (50)	150 (59)	150 (59) ⁴	43 (17)	64 (25)	119 (47)	122 (48)	89 (35) ⁴	135 (53)	89 (35) ⁴	
APPROX. SHIPPING WEIGHT kg (lb)	10 (22)	32 (70)	122 (270)	30 (66)	7 (15)	11 (25)	23 (50)	66 (145)	34 (75)	113 (250)	53 (117)	
CONNECTIONS—FEMALE NPT FEED	1/2"	1/2"	3/4"	NA	1/2"	1/2"	1/2"	3/4"	NA	1-1/2"	NA	
PRODUCT	1/2"	1/2"	3/4"	NA	1/2"	1/2"	1/2"	3/4"	NA	1"	NA	
BRINE	3/8"	3/8"	3/4"	NA	3/8"	3/8"	3/8"	3/4"	NA	1"	NA	
SAMPLE	1/8"	1/8"	3/8"	NA	1/8"	1/8"	1/8"	3/8"	NA	3/8"	NA	
OPERATING SPECIFICATIONS												
PRODUCT WATER CAPACITY m ³ /day (GPD) Nominal ⁴	2.46 (650)	6.81 (1800)	26.5 (7000)	26.5 (7000)	5.30 (1400)	9.08 (2400)	15.90 (4200)	60.57 (16,000)	60.57 (16,000)	94.64 (25,000)	94.64 (25,000)	
RANGE	2.09/2.83 (552/747)	5.80/7.80 (1500/2100)	22.52/30.48 (5950/8050)	22.52/30.48 (5950/8050)	4.77/6.09 (1260/1540)	8.18/10.22 (2160/2640)	14.31/18.17 (3780/4620)	54.51/66.62 (14,400/17,600)	54.51/66.62 (14,400/17,600)	85.17/104.10 (22,500/27,500)	85.17/104.10 (22,500/27,500)	
SALT REJECTION (%) Nominal ⁴	99.2	99.2	99.2	99.2	94	94	92	92	92	92	92	
MINIMUM	98.7	98.7	98.7	98.7	90	90	90	90	90	90	90	
OPERATING PRESSURE RANGE KPa (psig)	(5515-8274) 800-1200				2415-2760 (350-400)							
OPERATING TEMPERATURE RANGE °C (°F)	0-40 (32-104)				0-40 (32-104)							
pH RANGE, CONTINUOUS EXPOSURE	4-9				4-11							
BRINE RATE, l/min (gpm) MAXIMUM	9.9 (2.6)	39.4 (10.4)	105.2 (27.8)	105.2 (27.8)	6.4 (1.7)	12.5 (3.3)	25.4 (6.7)	65.9 (17.4)	65.9 (17.4)	106.0 (28.0)	106.0 (28.0)	
MINIMUM SEAWATER	1.1 (0.3)	5.3 (1.4)	15.9 (4.2)	15.9 (4.2)	NA	NA	NA	NA	NA	NA	NA	
HIGH BRACKISH	2.3 (0.6)	8.3 (2.2)	26.5 (7.0)	26.5 (7.0)	NA	NA	NA	NA	NA	NA	NA	
BRACKISH	NA	NA	NA	NA	2.3 (0.6)	4.2 (1.1)	8.3 (2.2)	26.5 (7.0)	26.5 (7.0)	43.5 (11.5)	43.5 (11.5)	
STANDARD CONDITIONS												
FEED, mg/l NaCl	35,000				1,500							
PRESSURE, KPa (psig)	6895 (1000)				2760 (400)							
TEMPERATURE °C (°F)	25 (77)				25 (77)							
CONVERSION %	35				75							

*Du Pont's registered trademark for its reverse osmosis products.
NA = Not applicable

¹Seawater and High Brackish applications

²All B-10 permeators are also available on special orders as "TA" models, i.e. B-10T bundles equipped with shell assemblies rated for 1000 psig

³Bundle length without shipping container

⁴Nominal values are for design purposes

FIELD-PROVEN COST-EFFECTIVE PERFORMANCE

World-class, performance-proven desalination technology can be found in Du Pont's unique Hollow-Fine-Fiber "Permasep" permeator and Aramid polymer membrane:

Compact and Rugged Permeator Designs

Shipped as rugged, high-quality RO devices, the self-contained membrane in each B-9 and B-10 "Permasep" permeator comes ready for "on-specification" start-up, even after years of storage. Permeators require minimum space, are easy to install in RO systems, and easy to operate and maintain. Superior quality and mechanical durability have been demonstrated through shipment and start-up in even the most remote sites. Outstanding long-term operation has been demonstrated under demanding conditions in the world's largest RO plants. And with progress to higher operating pressures in seawater desalination, more cost-effective performance is provided at higher conversions.

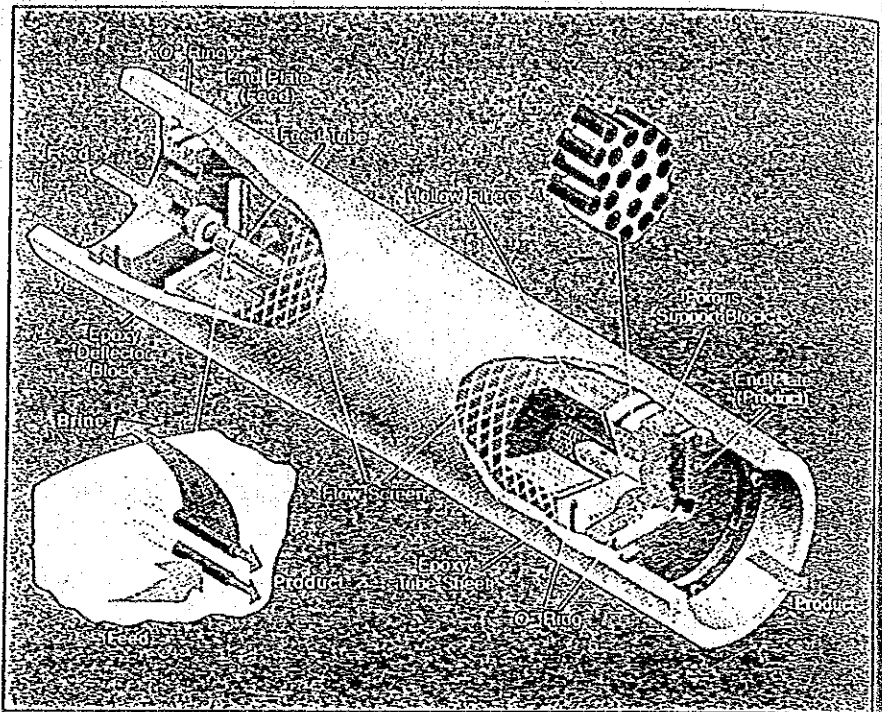
Tough Aramid Polymer Membrane

The Hollow-Fine-Fiber membranes in "Permasep" permeators are made of a tough, highly stable Aramid polymer and behave like durable, thick-walled pipes under pressure. Invented by Du Pont and commercially available for more than 20 years, these homogeneous membranes have the longest intrinsic life

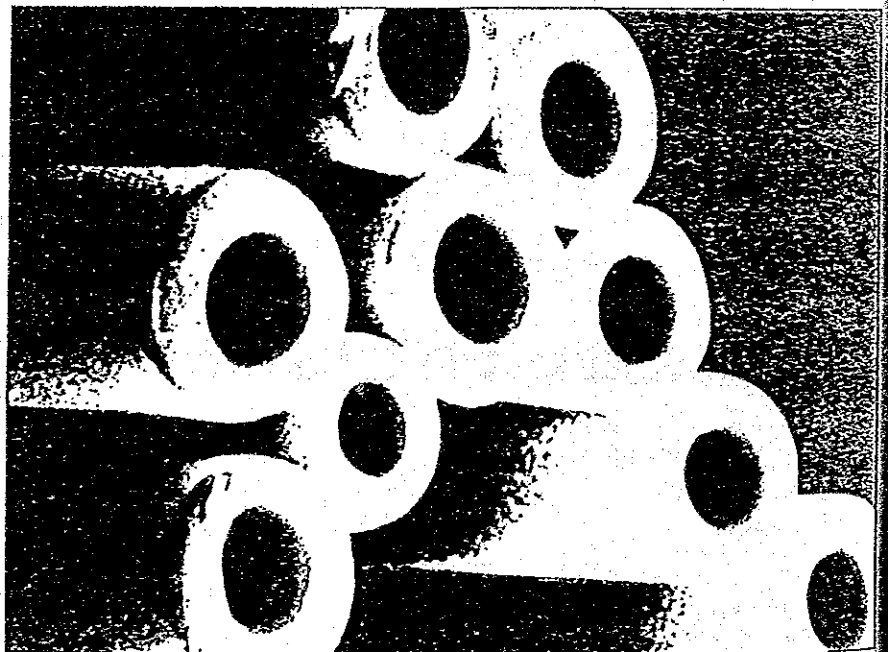
of any RO membrane, as demonstrated by very low replacement rates and very low cost-in-service. In seawater desalination systems, Du Pont offers additional technology to ensure consistent high salt

rejection even under the most demanding high salinity and high temperature conditions of the Arabian Gulf, including surface water intakes.

*Du Pont's registered trademark for its reverse osmosis products.



B-9 and B-10 Hollow-Fine-Fiber "Permasep" Permeators



Tough Aramid Polymer Membrane (photomicrograph)



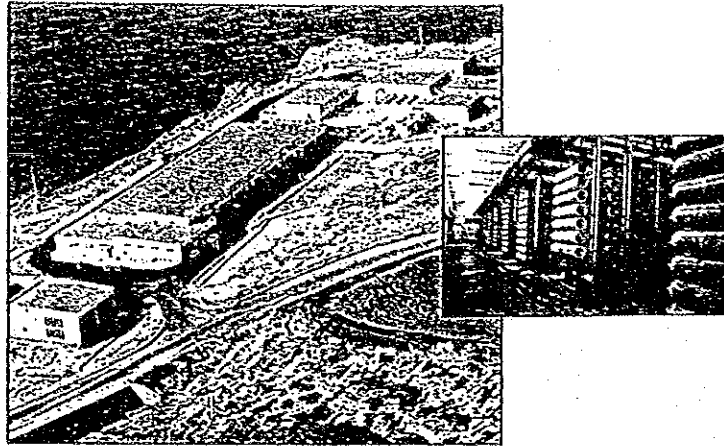
LARGE PLANT EXPERIENCE

1. This 24,000 m³/day (6.3 million GPD) seawater plant at Ghar-Lapsi, Island of Malta uses B-10 "Permasep" permeators. The total B-10 seawater desalination capacity installed on Malta is now 80,000 m³/d (21 million GPD) and provides 60% of the island's total water needs.

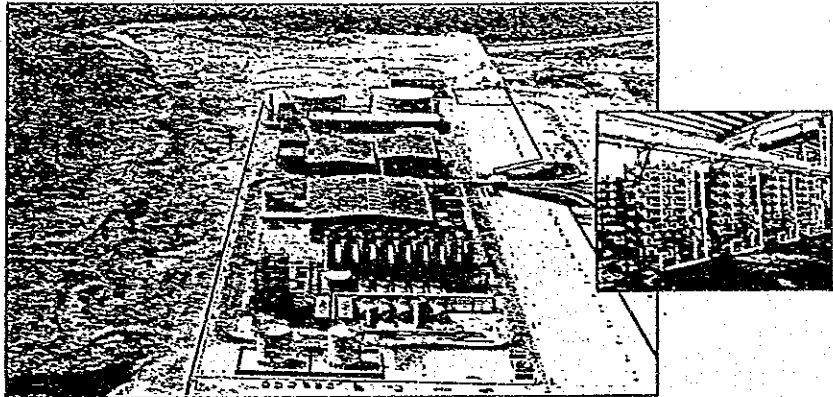
2. "Permasep" B-10 permeators produce 46,000 m³/day (12.2 million GPD) of fresh water at one of the world's largest RO plants at Ras Abu Jarjur, Bahrain.

3. Sarasota, Florida, U.S.A., 17,000 m³/day (4.5 million GPD) plant uses B-9 "Permasep" permeators to desalt brackish water.

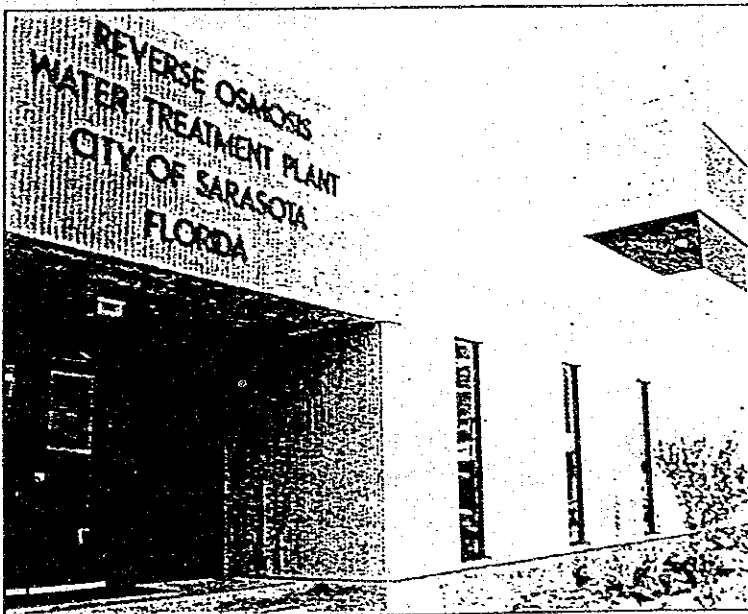
4. This B-10 mobile unit, one of the largest of its kind, produces 480 m³/day (125 thousand GPD), or more, of drinking water from seawater, or lower salinity feeds.



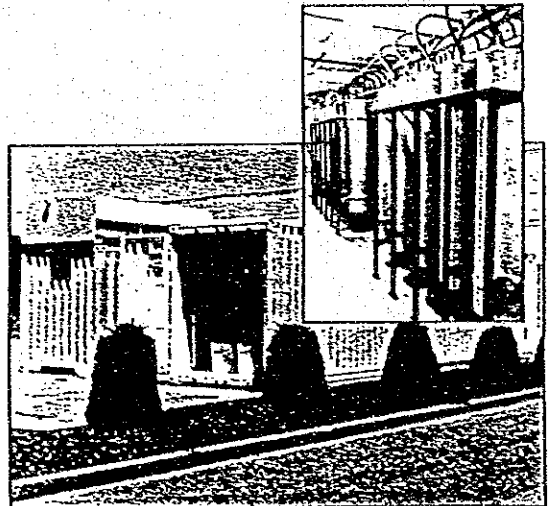
1.



2.



3.



4.



WORLDWIDE OFFICES

For more information about DuPont PERMASEP* Products and how they can meet your water-desalination needs, contact:

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Saudi Arabia

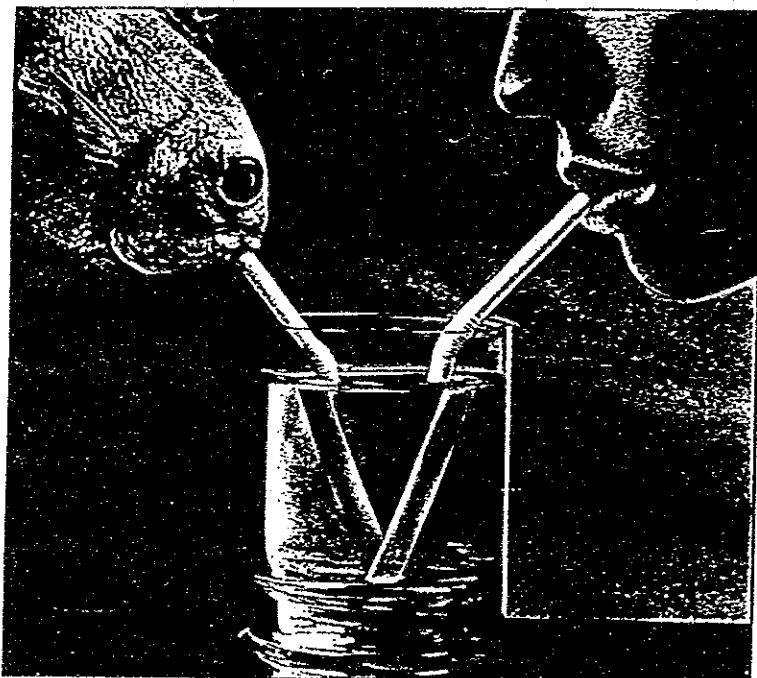
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MICROBIAL CONTROL

AN EVALUATION OF VARIOUS BIOCIDES FOR DISINFECTION OF REVERSE OSMOSIS MEMBRANES AND WATER DISTRIBUTION SYSTEMS

Normal maintenance of RO membranes and water distribution systems requires routine cleaning and disinfection to control bacterial growth. Microbial contaminants commonly found in feedwater will decrease the operating efficiency of RO membranes and lower membrane flux, and thereby increase the cost of producing high purity water. Fouling microorganisms may actually destroy some types of RO membrane by promoting decomposition of the membrane polymer. Bacterial growth acceleration, particularly during periods of shutdown, requires a microbiocidal agent to control growth and thus protect the RO membrane and associated water system.

Organic and inorganic fouling of the RO membrane can be removed with cleaning agents. Sanitization, which must achieve a 3-log reduction of bacteria (1), is usually accomplished post-cleaning to eliminate fouling microorganisms. Since naturally occurring microbial contaminants on the membrane can easily reach levels of 10⁴ colony-forming units per square centimeter (CFU/cm²) (2), sanitization may not completely destroy all the microbial bioburden present. Disinfection, requiring a 6-log reduction of bacteria (3), may be more appropriate.

The biocides historically used for maintenance of RO membranes and their water distribution systems include formaldehyde, bleach, and hydrogen peroxide (4). Hydrogen peroxide requires either extended soak times at low concentrations or else elevated con-

centrations that may be destructive to the RO membrane but necessary for adequate disinfection of the water distribution system. Bleach, while suitable for disinfection of cellulose acetate membranes, is contraindicated for thin-film composite membranes. Formaldehyde, while compatible with both thin-film composite membranes and water distribution systems, presents toxicity and environmental hazards. Additionally, chemicals of the formaldehyde family, although effective for destroying microbial contaminants, do not remove the extracellular material associated with biofilms. This can result in a more rapid refouling of the water system (5).

Minnicare™, a proprietary, stabilized mixture of hydrogen peroxide and peracetic acid, is an oxidizer compatible with thin-film composite membranes. Oxidizers are known to not only kill bacteria but also to effectively remove biofilms (5). In order to evaluate the efficacy of Minnicare™ and other biocides historically used for RO and water system maintenance, the following study was undertaken.

Materials and Methods

Test organism. A *Bacillus subtilis* var. *niger* (ATCC 9372) aqueous spore suspension (North American Science Associates, Inc.) was used as the test bioburden. While spore-forming bacteria are not the predominant microorganisms associated with RO systems, they are highly resistant to disinfectants and were therefore chosen as the challenge organism for this study. A sufficient concentration of spores, in 0.1-milliliter (mL) volumes, was added to the following biocides to achieve a final concentration of 2 x 10⁶ spores/mL: Minnicare™ at 1% concentration; formaldehyde at 2% concentration; sodium hypochlorite (bleach) at 0.001% concentration; and hydrogen peroxide at 0.2%, 5%, and

10% concentrations. Biocide/spore mixtures were equilibrated to 20 °C.

Aliquots of each biocide/spore mixture were removed for analysis of surviving spores at 0, 15, 30, and 60 minutes, and 2, 4, 6, 12, and 24 hours. Each sample was neutralized, as described below, and then diluted and plated (0.1 mL of each neutralized sample and dilutions as necessary) on Tryptic Soy Agar (DIFCO) using the pour plate technique. Plates were incubated at 35 °C for 7 days. Colonies derived from surviving spores were counted and reported as CFU/mL. It should be noted that since 0.1-mL samples were analyzed, the minimum number of survivors detectable per mL was 10 CFU.

Neutralization. The activity of each biocide was neutralized at the time each sample was drawn to ensure that survivors detected at each time interval accurately represented the killing power of the biocide for that exposure. The neutralizing agents used are shown in Table A.

Validating the neutralization. A separate test was done to validate the effectiveness of the neutralizers chosen. Test biocides, at use concentration and equilibrated to 20 °C, were sampled at the time intervals selected for efficacy testing. Each sample was mixed with the appropriate volume and type of neutralizing agent to achieve the final concentrations given in Table A. A 0.1-mL sample of each biocide/neutralizer mixture was plated using the pour plate technique and Tryptic Soy Agar. Ten *B. subtilis* spores were then added to each plate. Controls were set up without biocides and without biocide or neutralizer, to ensure that the neutralizers were not toxic to the spores. Plates were incubated at 35 °C for 7 days. At the end of 7 days, all plates showed recovery of

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all *B. subtilis* spores added, demonstrating in each case that neutralization was achieved.

Generating D-values. A D-value was generated for each biocide tested. The log of the number of surviving spores at each time frame tested was plotted, and a "best fit" line was generated by log regression analysis. The slope of the regression line in each case was determined. The negative reciprocal of the slope of each line is the D-value in minutes. A 6 D-value is determined by multiplying the D-value by 6 to give the time required to achieve a 6-log reduction of the spore population. The 5% and 10% hydrogen peroxide efficacy data showed only a 1-log reduction in 60 and 30 minutes respectively, but <10 CFU/mL thereafter. Therefore, using the data only up to the 60- and 30-minute time frames, respectively, but excluding the <10 CFU/mL data, would give a D-value far larger than that actually reflected by the total data. A value of zero for the <10 CFU/mL could not be used, since the log of zero is undefined. Therefore, a value of 10 CFU/mL was assigned at the 60-minute time frame for 5% hydrogen peroxide and at the 30-minute time frame for 10% hydrogen peroxide. This was not necessary for the other biocides tested since there was sufficient data, covering at least 3 log reductions of the spore population, to generate a reliable D-value.

Results

Disinfectant efficacy. The results of efficacy testing are shown in Table B. Minncare™, at a 1% concentration, showed a 5-log reduction of bacterial spores in 30 minutes. By contrast, 2% formaldehyde required 12 hours, and 0.001% sodium hypochlorite (bleach) required 6 hours to achieve a 5-log reduction. Hydrogen peroxide, at 10%, 5%, and 0.2% concentrations, required approximately twice the amount of time as Minncare™ and as much as 24 hours to exhibit the same 5-log reduction. Figure 1 graphically presents the level of efficacy (log reduction achieved) in a 30-minute exposure of the *B. subtilis* spores to each biocide. Minncare™

exhibited the best log reduction, showing a 5-log reduction of the *B. subtilis* spores in 30 minutes. Hydrogen peroxide (10%) showed only a 1-log reduction, and bleach (0.001% sodium hypochlorite) a 0.3-log reduction in the same time frame. No reduction in the spore population was evident after a 30-minute exposure time with either the 0.2% or 5% hydrogen peroxide or the 2% Formaldehyde.

Survival curves, regression analysis, and D-values. Survival curves for each biocide, based on the log of the number of CFU/mL of spores surviving at various exposure times, is presented in Figure 2. The regression lines generated from each survival curve are also plotted for each biocide (Figure 3). The D-values, resulting from the regression analyses as described in the Materials and Methods section of this paper, reflect the diversity of effectiveness seen among the biocides tested. The D-values are listed at the bottom of Table B.

Minncare™ had the smallest D-value of 6 minutes, while the other test biocides gave D-values ranging from 11 minutes for 10% hydrogen peroxide to 69 minutes for sodium hypochlorite, and 113 minutes for formaldehyde.

The 6 D-value is an indicator of the time necessary for a 6-log reduction in the bacterial population, giving a 1 in 6 log probability of having an organism survive the disinfection cycle. Minncare™, with a 6 D-value of 36 minutes, would achieve the theoretical disinfection level (6 D) in the shortest period of time. The other biocides would require between 66 minutes and 25 hours (1,500 minutes) to achieve the same 6-log reduction.

Conclusions

Minncare™, at a 1% concentration, was the most effective biocide tested, as compared to the other commonly used biocides for disinfecting reverse osmosis membranes and their associated water distribution systems. A 5-log reduction of *B. subtilis* spores was achieved in 30 minutes only with Minncare™. Formaldehyde, hydrogen peroxide, and bleach all required far

longer exposure times. Minncare™ can be used to disinfect both the water distribution system and the RO membranes at the same 1% concentration. Disinfection at a 6-log reduction probability can be achieved in less than one hour only with Minncare™. Thin-film composite and cellulose acetate membranes are both compatible with Minncare™. Its use eliminates the problems commonly associated with both hydrogen peroxide and formaldehyde. Thus Minncare™ appears to be a suitable alternative to the traditionally recommended biocides for rapid disinfection of RO membranes and water distribution systems. ■

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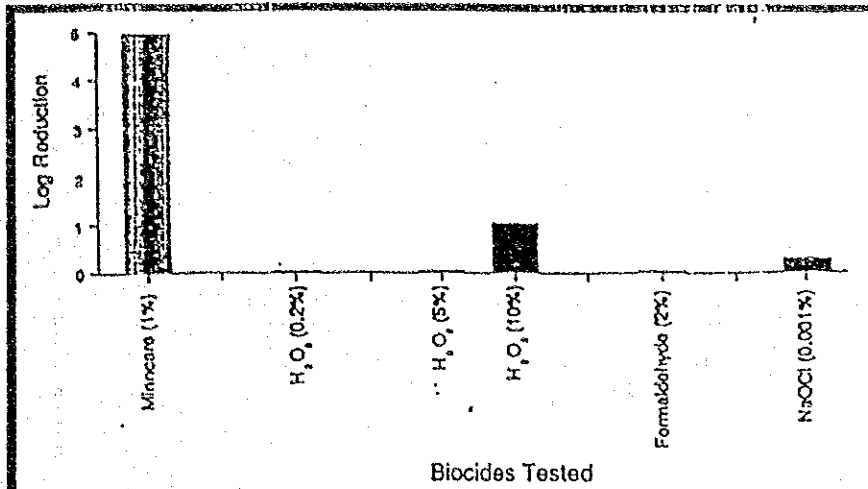


Figure 1. Log reduction of *B. subtilis* var. niger (ATCC 9372) spores after 30 minutes of exposure to various biocides.

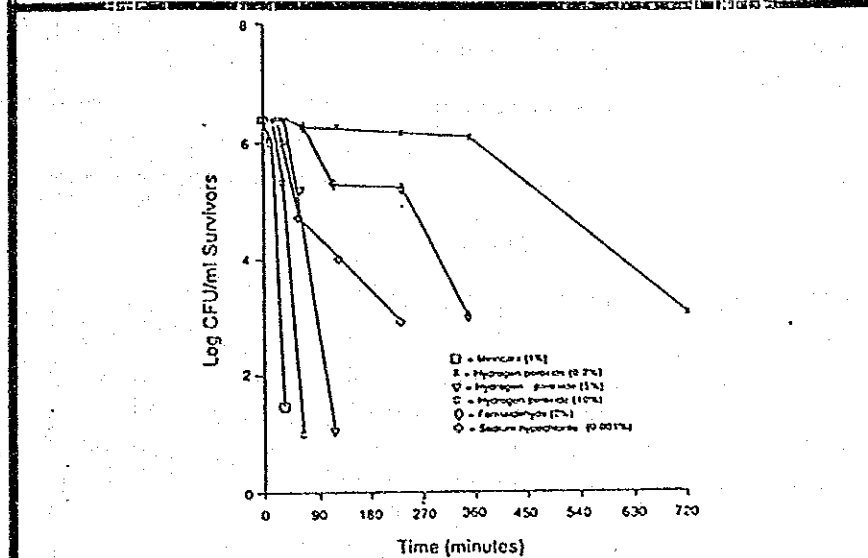


Figure 2. Survival curves for biocides tested for efficacy by suspension test against *B. subtilis* var. niger (ATCC 9372) spores.

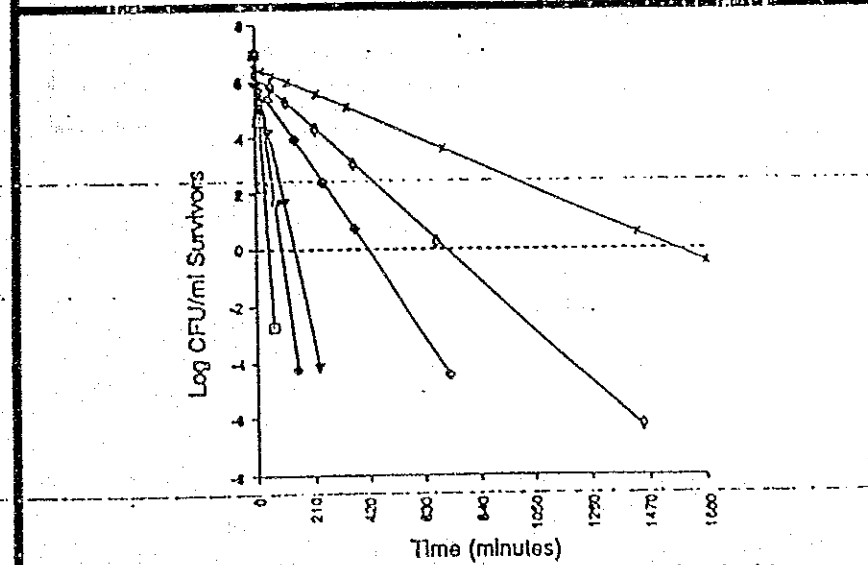


Figure 3. Log regression lines from analysis of survival curves for biocides tested for efficacy by suspension test against *B. subtilis* var. niger (ATCC 9372) spores.

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TABLE A
Neutralizing Agents and Concentrations

Biocide	Neutralizing Agent	Final Concentration ¹
Minnicare	D/E Neutralizing broth ²	100X dilution
Formaldehyde	Sodium bisulfite	1% Aqueous
Sodium hypochlorite	Sodium thiosulfate	Equimolar
Hydrogen peroxide	D/E Neutralizing broth ²	100X dilution

¹Final concentration of neutralizing agent when combined with biocide/spore sample.

²DIFCO, Cat #0819-17-2

TABLE B
Biocide Efficacy Results

Exposure Time	Minnicare (1%)	Formaldehyde (2%)	Sodium hypochlorite (0.001%)	Hydrogen peroxide (0.2%)	Hydrogen peroxide (5%)	Hydrogen peroxide (10%)
0 minutes	2.3×10^8	2.3×10^8	2.1×10^8	2.2×10^8	2.1×10^8	2.0×10^8
15 minutes	1.1×10^8	2.3×10^8	2.2×10^8	2.3×10^8	2.0×10^8	2.0×10^8
30 minutes	3.0×10^7	2.1×10^8	1.1×10^8	2.3×10^8	2.0×10^8	2.0×10^8
60 minutes	<10	2.0×10^8	4.0×10^7	2.0×10^8	1.0×10^8	<10
2 hours	<10	1.5×10^8	1.0×10^8	2.0×10^8	<10	<10
4 hours	<10	1.2×10^8	1.0×10^8	1.5×10^8	<10	<10
6 hours	<10	1.0×10^8	<10	1.0×10^8	<10	<10
12 hours	<10	<10	<10	1.0×10^8	<10	<10
24 hours	<10	<10	<10	<10	<10	<10
D-values	6 minutes	113 minutes	69 minutes	250 minutes	22 minutes	11 minutes
6D	36 minutes	678 minutes	414 minutes	1500 minutes	132 minutes	66 minutes

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TABLE I COMPARISON SHEET FOR VARIOUS RO MEMBRANE (SEA WATER USE)

MANUFACTURER	DUPONT USA	TOYODO J	FILMTEC USA	UOP USA	TOKAY JP
MATERIAL	POLYAMIDE	CELULOSE TRI-ACETATE HOLLOW FIBER	POLYAMIDE SPIRAL	SYNTHETIC COMPOSIT SPIRAL	AROMATIC POLYAMIDE SPIRAL
TYPE	HOLLOW FIBER	HOLLOW FIBER	SPIRAL	SPIRAL	SPIRAL
MODEL NO	B-10 6840T	HM 9255FI	SW 30 HR 8040	TFC 2021 SS	SU-810
STD. CONDITION					
PRESSURE	56 KG/CM2	55 KG/CM2	55 KG/CM2	56 KG/CM2	56 KG/CM2
NACL	35000 PPM	35000 PPM	35000 PPM	32800 PPM	35000 PPM
CONVERSION	35 %	30 %	-- %	7 %	12 %
TEMPERATURE	25 °C	25 °C	25 °C	25 °C	25 °C
CAPACITY					
NOMINAL	23+15% M3/D	For 2 element	For 1 element	For 1 element	For 1 element
MINIMUM	---	35 M3/D	15.14+15% M3/D	15.14+15% M3/D	16 M3/D
SALT REJECTION					
NOMINAL	99.2 %	99.4 %	99.5 %	---	99.4 %
MINIMUM	98.7 %	99.2 %	99.2 %	99.2 %	99.2 %
DIMENSION					
DIAMETER	226 MM	360 MM	295 MM	330 MM	316 MM
LENGTH	1499 MM	2660 MM	6392 MM	6451 MM	6267 MM
WEIGHT	102 KG	310 KG	290 KG	472 KG	477 KG
MAX. OPERATING PRESS.	18.7 KG/CM2	70 KG/CM2	70 KG/CM2	70 KG/CM2	70 KG/CM2
MAX. TEMPERATURE	40 °C	40 °C	45 °C	45 °C	45 °C
MAX. SDI	37	5	5	(COLLECTOR U)	
PII RANGE					
MAXIMUM	4	3	2	4	3
MINIMUM	9	8	11	11	9