

LABORATORY AND MESOSCALE TESTING
OF ELASTOL^{T.M.} AND BRAND M DEMOUSSIFIER*

24529

M. Bobra and P. Kawamura
Consultchem
Ottawa, Ontario

M. Fingas and D. Velicogna
Environment Canada
Ottawa, Ontario

ABSTRACT

Recently, 2 promising oil spill treating agents have been developed. They are: Elastol, a viscoelastic enhancing agent, and Brand M Demulsifier/Demoussifier. Preliminary testing of the products were encouraging and as a result, the U.S. Minerals Management Service and Environment Canada decided to conduct further testing on a larger scale. These planned tests included wave basin testing and an offshore ocean trial.

Results from laboratory and tank testing of Elastol were presented at the 1987 AMOP Conference. Complete results from that study are presented in Bobra et.al.(1987a). This paper starts off with a brief summary of those findings and then presents a summary of the work performed to develop applicators suitable for mesoscale use for the 2 treating agents and to test the effectiveness of the products when thus applied.

SUMMARY OF PREVIOUS FINDINGS

The bulk of the work presented at the 1987 AMOP Conference was performed within the laboratory and on a small scale. The first phase of that work examined what effect Elastol had on specific oil properties and its effect upon the physical processes which occur to spilled oil. A simple and portable "die swell" apparatus was constructed in order to obtain a quantified characterization of the elastic component of treated oils. Die swell is a physical phenomenon associated with elastic fluids and manifests itself when the fluid is forced through a small opening (or die); the diameter of the extrudate swells to a diameter greater than the die opening. By measuring the degree of die swell exhibited, a relative indication of elasticity could be obtained.

^{T.M.} Elastol is a registered trademark of General Technology Applications Inc.
* Brand M is a surfactant based demulsifier formulated by Environment Canada.

A series of bench-scale experiments were performed to determine the viscosity and elasticity of Elastol-treated oils at different concentrations, temperatures and mixing times. Elastol was applied to a 7.4 mm thick layer of oil contained in a covered crystallizing dish and then the oil was either subjected to no mixing or to mixing at 80 RPM on a gyratory shaker table. Eight crude oils and a diesel fuel were tested. Each exhibited viscoelastic behaviour when treated with 600 to 6000 ppm of Elastol. All oils exhibited some degree of elasticity within 15 minutes of Elastol application. The time for Elastol to dissolve and take effect, and the degree of elasticity was different for each oil. Generally, the more viscous oils attained a higher degree of elasticity but took longer to react than the less viscous oils. It was found that both mixing and higher temperatures improved the rate of dissolution and the degree of elasticity attained.

The application of Elastol to oil had no effect upon the flash point and caused only a very minor reduction in the rate of evaporation.

Experiments were performed in which Elastol was applied to oil contained within a boomed area upon a water surface. Time and Elastol concentration were varied. The final spill area covered by the slick after being released from the boom was compared to the area of an untreated control slick. The effectiveness of Elastol to reduce slick spreading increases with time. It was also found that the time for Elastol to dissolve and take effect was much shorter for a less viscous oil.

The emulsification behaviour of Elastol-treated oils was examined in an apparatus that rotated mixtures of seawater and oil contained in 500 mL Fleakers according to the rotate/rest cycle of Mackay and Zagorski (1982). Elastol was added to the oil one hour prior to starting the rotating. Ten oils of varying emulsion behaviour were tested at 0°C and 15°C. For two of the oils (Amaligak and Tarsiut), the addition of Elastol increased their tendencies to form water-in-oil emulsions. For the other eight oils, the addition of Elastol had either no effect or caused a decrease in the emulsification tendency. In general, the emulsions formed by Elastol-treated oils were observed to have a lower water content than untreated oils. In addition, a limited number of runs were performed where Elastol was added to oil that was already emulsified. These tests indicated that Elastol could still reduce the degree of emulsification.

During the second phase of the study, experiments were performed in a 35 litre tank equipped with an oscillating hoop wave generator. Alberta Sweet Mixed Blend (ASMB) crude and a 50/50 mixture of ASMB and Bunker C were treated with Elastol concentrations of up to 6000 ppm, and tested at two mixing energies, two temperatures, and two water salinities. Each test was 3 hours in duration and both water and oil samples were taken during the run. Water samples were analysed for oil content and oil samples were analysed for water content, viscosity, elasticity as indicated by die swell measurements, and weathering due to evaporation (determined by GC).

In general, the application of Elastol to oil reduced the extent of emulsification experienced by the slick and as a consequence of this, the treated slicks had lower viscosities than untreated slicks which tended to be heavily emulsified. Therefore, the increase in viscosity due to the elasticity imparted by Elastol was small compared to the increase due to emulsification. However, under conditions which are highly favourable for emulsification, the ability of Elastol to limit the extent of emulsification was slight and the subsequent increase in viscosity was not prevented.

All oils tested under the varying conditions exhibited elastic behaviour within 15 minutes of Elastol application. As expected, increasing the concentration of Elastol resulted in a higher degree of elasticity. At 15°C the oils treated with 6000 ppm of Elastol exhibited a high degree of viscoelasticity after 1 to 2 hours. At 0°C, the time required for Elastol to dissolve was longer. It was also found that an oil, like the 50/50 mixture, which has a strong tendency to emulsify, will exhibit less elasticity than an oil which has less of a tendency to emulsify when treated with the same concentration. Therefore, it would appear that in certain circumstances, Elastol can suppress emulsification but that in other circumstances where the oil has a strong tendency to emulsify, the emulsification process may inhibit the development of elasticity.

The results from the small-scale wave generating tank experiments showed that the application of Elastol did not significantly affect the rate of oil evaporation.

The effectiveness of two surfactant-based treating agents were tested on Elastol-treated oil. Tests with Corexit 9527 dispersant in the wave generating tank showed that an Elastol-treated slick was significantly more resistant to chemical induced dispersion. On the other hand, tests in the emulsion formation apparatus showed that Elastol had no effect on the performance of Brand S emulsion inhibitor.

Two days of wave basin tests were performed at the Esso Research Facility in Calgary, Alberta. For each test, 75 litres of Norman Wells crude was placed in a boom and then manually dosed with 6700 ppm of Elastol. The tests ran for 4 hours and wave heights of 25 and 50 centimeters were used. Observations of the slicks indicated that at the wave energies applied, there was no sign of degradation in elasticity and that in fact the slicks became progressively more elastic with time. At the higher wave energy, the time required for Elastol to dissolve was less and the degree of elasticity achieved was greater. Oil recovery from the boomed area was done with a Morris MI-2C skimmer. About 93% of the original volume spilled was recovered and the recovered oil appeared to contain no free water.

The report on the work performed on mesoscale application is comprised of two parts. The first part describes the development and laboratory testing of applicators for the oil spill products. The second part deals with mesoscale wave tank testing using these applicators. Complete results are presented in Bobra et.al.(1987b).

Part 1 - DEVELOPMENT AND TESTING OF MESOSCALE APPLICATORS

INTRODUCTION

This study was undertaken to develop and test methods of applying Elastol and Brand M for mesoscale applications. In particular, the objectives of the study were:

- i. to develop applicators for dispensing Elastol and Brand M;
- ii. to test and adjust these applicators to deliver the desired dose rates with a relatively uniform distribution pattern;
- iii. to measure the effectiveness of Elastol and Brand M when applied by these systems.

APPLICATOR SYSTEMS

An extensive review of potential application systems was conducted. The candidate systems were critically evaluated in terms of the following criteria:

- i. distribution characteristics - the applicator should dispense the treating agent over a relatively large area with a uniform distribution pattern and deliver a flowrate that will dispense the treating agent in an acceptable period of time for the range of Elastol and Brand M doses proposed for the mesoscale trials (500 to 9000 ppm for Elastol and 250 to 4000 ppm for Brand M);
- ii. portability and ruggedness - necessary for field use;
- iii. safety - the equipment must be safe to use in the presence of flammable materials;
- iv. simple to operate.

After careful evaluation, a Campbell-Hausfeld Power Blast Model AT1210 (more commonly known as a sandblaster) was chosen to dispense both spill treating agents. A schematic diagram of the system is illustrated in Figure 1. The system has a 5 gallon (19L) capacity and uses compressed air to dispense its charge. A vented hopper was added to the blaster for the application of Elastol. This was necessary to ensure a continuous flow of Elastol and to ensure that all Elastol placed into the system is dispensed. No system modification was required for Brand M application.

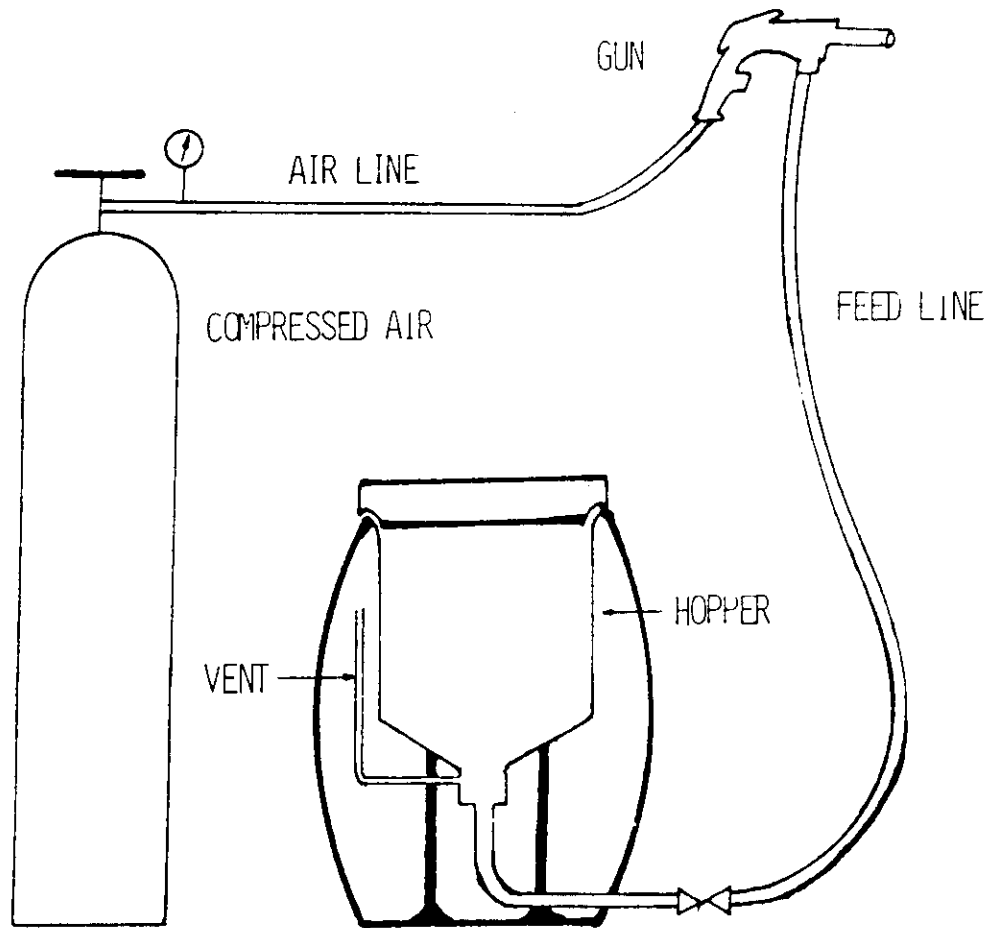


FIGURE 1 . SCHEMATIC DIAGRAM OF APPLICATOR.

During this work, the supply of compressed air came from the lightweight cylinders used for the Scott backpack breathing apparatus. These cylinders have a capacity of 45 ft³ (1.3 m³) at 2216 psi (15,280 kPa). The air pressure regulator was set at 40 psi (276 kPa) for the application of Elastol and at 20 psi (138 kPa) for the application of Brand M. These settings were determined to give the optimum spray patterns and dose rates. One air cylinder provided 7.5 minutes of air for the Elastol applicator and 12 minutes for the Brand M applicator. Two or more cylinders can be used in a cascade configuration for longer application times.

The demulsifier was discharged as a 50% solution of Brand M in a commercial solvent Isopar M. This particular solvent was chosen because of its low volatility and toxicity. The reasons for mixing the demulsifier with solvent were:

- i. to reduce its viscosity in order to improve flow characteristics (pure Brand M has a viscosity of 1200 cP at room temperature);
- ii. to promote better diffusion and mixing of the demulsifier's active ingredients with the spilled oil;
- iii. to increase the volume of the treating agent to be applied and thus the dispensing time, thereby allowing a more thorough and even application of Brand M to the oil slick, especially at the lower demulsifier-to-oil concentrations.

DISTRIBUTION EXPERIMENTS

Procedure

The flowrates and distribution patterns of Elastol and the Brand M solution were determined by conducting a set of indoor experiments in which the spill treating agents were dispensed from a stationary position onto a grid marked floor. For each applicator, two tests were performed: one with the spray gun positioned parallel to the ground and the other with the gun positioned 45 degrees downward. In both tests, the gun was fixed at a height of one metre above the ground. A preweighed dose of treating agent was dispensed onto the grid marked floor, and at the end of the experiment, the amount of treating agent in each square was determined. The total dispensing time was also recorded and the average flowrate calculated. Several tests were conducted outdoors to examine how the applicators would perform when subjected to the influence of wind.

Results

The distribution patterns for the sprayed Elastol and Brand M solution are presented in Figures 2 to 5. From the Figures, it can be seen that over 90% of the dispensed Elastol settled in an area 2 m wide by 4 m long. The area in which most of the Brand M settled was smaller; approximately 92% of the demulsifier solution was collected in an area 1 m wide by 3 m long. The total area covered was greater for Elastol when the gun was pointed horizontal to the ground (26 m²), as opposed to 45 degrees downward (20m²). The mass flux was calculated to be 0.14 g/m²s and 0.18 g/m²s, respectively. On the other hand, the direction of the gun did not affect the total area coverage (and flux) for the demulsifier. The respective values were determined to be 5.5 m² and 0.29 mL/m²s.

The calculated flowrates were 3.6 g/s for Elastol and 1.6 mL/s for the demulsifier solution. The air pressure was set such that the lowest possible flowrates were obtained without compromising the smooth discharge of the treating agents. This was thought to give more flexibility to the operators at the field trial and would allow them to cover the oil slick more evenly, especially at low treatment levels.

The performance of the applicators under calm outdoor conditions (wind speeds of up to 8 km/hr) was observed to be similar to that of the indoor tests. At higher wind speeds, the influence of the wind could be compensated for, in part, by directing the spray more towards the ground.

LABORATORY TANK TESTS

Procedure

Laboratory testing was conducted in an 89 cm diameter tank equipped with an adjustable speed oscillating hoop (85 cm in diameter) wave generator. The tank was filled with 336 L of 33 ppt salt water (water temperature: 15 +/- 2 °C) and the wave generator was set at a speed of 46 RPM.

For the demulsifier tests, the Brand M solution was sprayed onto a 1 mm thick slick of "Emulsifying Mix oil" (50-50 mixture of Alberta Sweet Mixed Blend crude and Bunker C fuel oil) from a height of 1 m above the slick surface. Three separate experiments were performed in which the emulsion breaker was applied at Brand M-to-oil ratios of 1:500, 1:2000 and 1:4000. Oil samples were taken periodically over a 24 hour period to determine the water content of the oil slick and hence the effectiveness of Brand M in inhibiting emulsification.

An additional experiment was performed in which a 1:500 dose of the demulsifier was sprayed onto the oil slick after allowing it to emulsify for 3 hours. A second 1:500 dose was applied at the 4.5 hour mark. The water content was monitored at regular intervals.

For the Elastol tests, the Elastol applicator was used to dispense the treating agent at doses of 1500 and 3000 ppm onto a 1 mm thick slick of fresh Alberta Sweet Mixed Blend crude oil. Oil samples were taken hourly to determine the elasticity using the die swell procedure as outlined in Bobra et.al. (1987a). The Elastol used was the latest version formulated by GTA, "80/20 Elastol", and had a different composition than the Elastol used in the previous laboratory study.

Results

i. Brand M

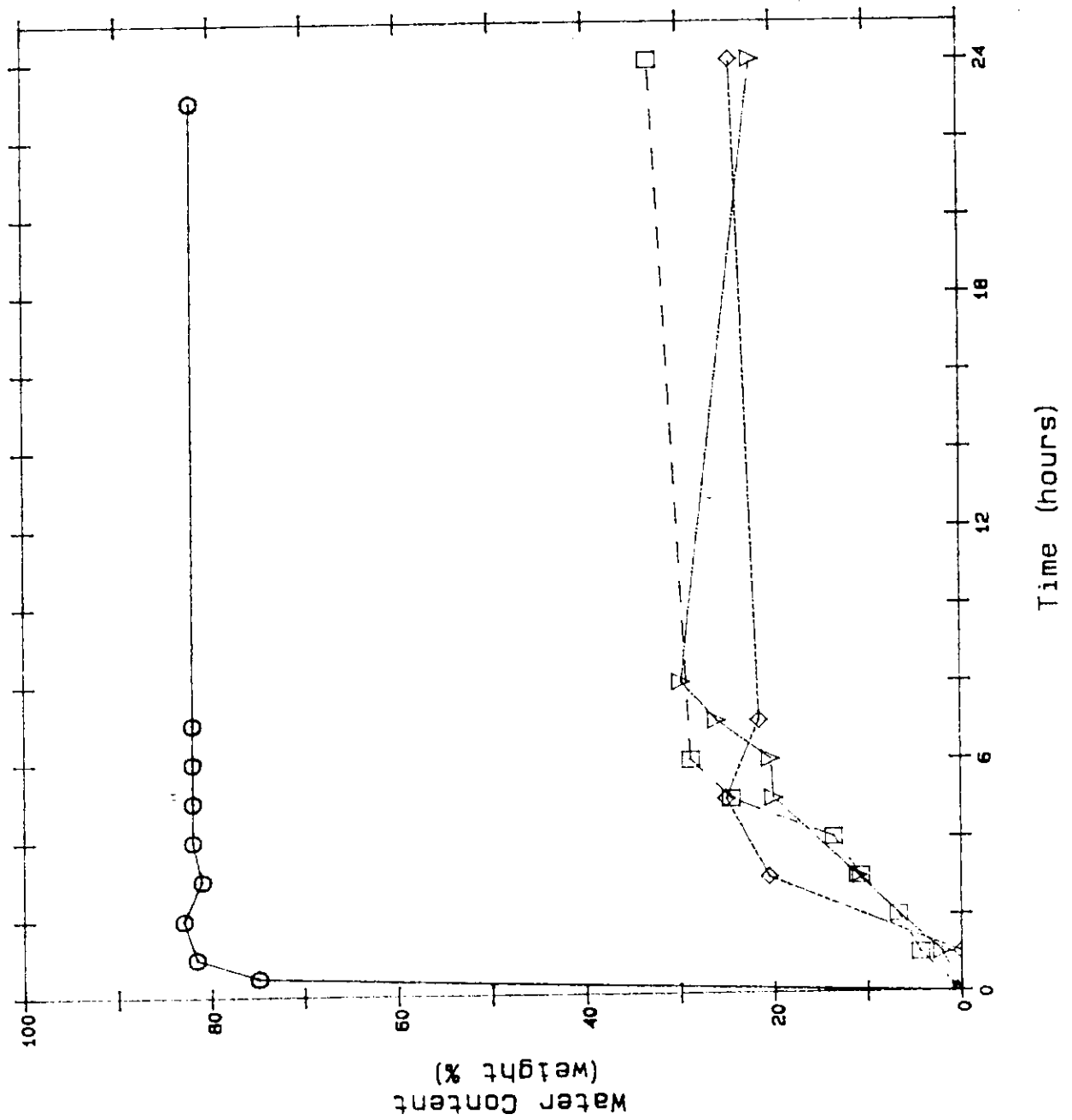
The results of the demulsifier application tests in the large oscillating hoop tank are presented as a plot of water content of surface oil versus time in Figure 6. It is clear that in the control slick to which no demulsifier was applied, the oil emulsified to a stable water content of 80% within the first hour. The other curves show that the addition of the demulsifier in the dose range from 1:4000 to 1:500 reduces the degree of emulsification and the rate of water uptake. Approximately 6 hours were required for treated slicks to attain a constant water content.

It is peculiar to note that considering the large difference in treatment doses, there was little difference in the water content values of the three treated slicks. These results are similar to those found in the wind/wave tank tests of Brand S emulsion inhibitor (S.L. Ross, 1987). In an attempt to further examine this behaviour, oil/seawater interfacial tension was measured as a function of Brand M concentration. These measurements are plotted in Figure 7. Pure oil and seawater has an interfacial tension of 26 dynes/cm. Figure 7 shows that the addition of Brand M (at Brand M-to-oil ratios of 1:10,000 to 1:500) significantly reduces the interfacial tension, but that there is only a slight drop in the interfacial tension from about 15 to 14 dynes/cm with a 20 factor increase in Brand M concentration. This may, in part, account for the results obtained in Figure 6. Nevertheless, these results seem to indicate that only a small dose of demulsifier may be required to effectively prevent extensive emulsion formation.

Figure 8 shows the results of the test in which the demulsifier was applied to emulsified oil. A 10% drop in the water content was observed after the first application and a further 15% decrease was obtained following the second addition. This indicates that the demulsifier is also effective in reducing the water content of oil that is already emulsified.

The test results show that the applicator was successful in effectively delivering the demulsifier to oil spilled on water.

FIGURE 6 . Water Content of Slick as a Function of Time



○ Control slick
□ 1:2000 dose applied
▽ 1:4000 dose applied
◇ 1:5000 dose applied

FIGURE 7 . Interfacial Tension of Oil/Seawater as a Function of Brand M Dose

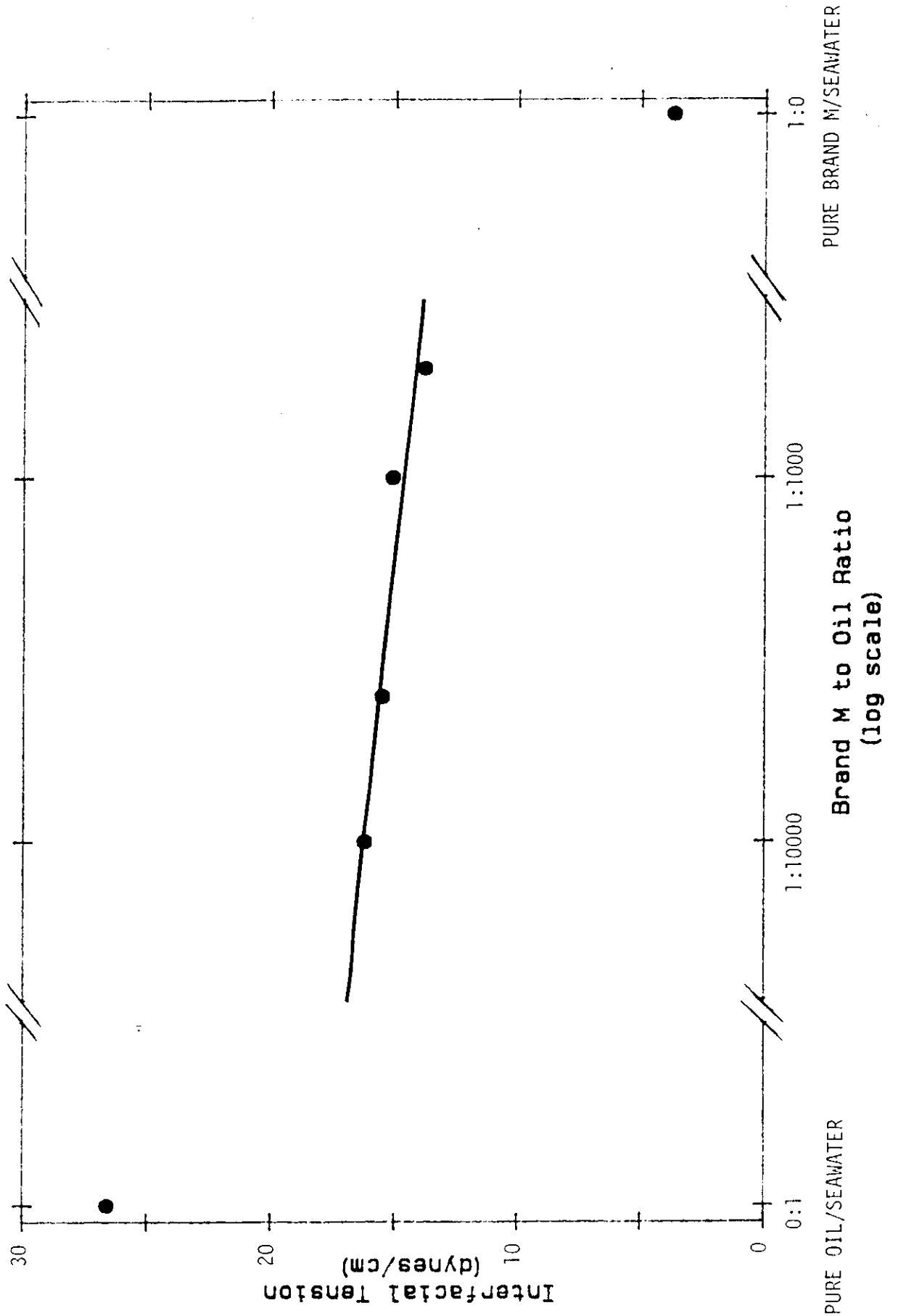
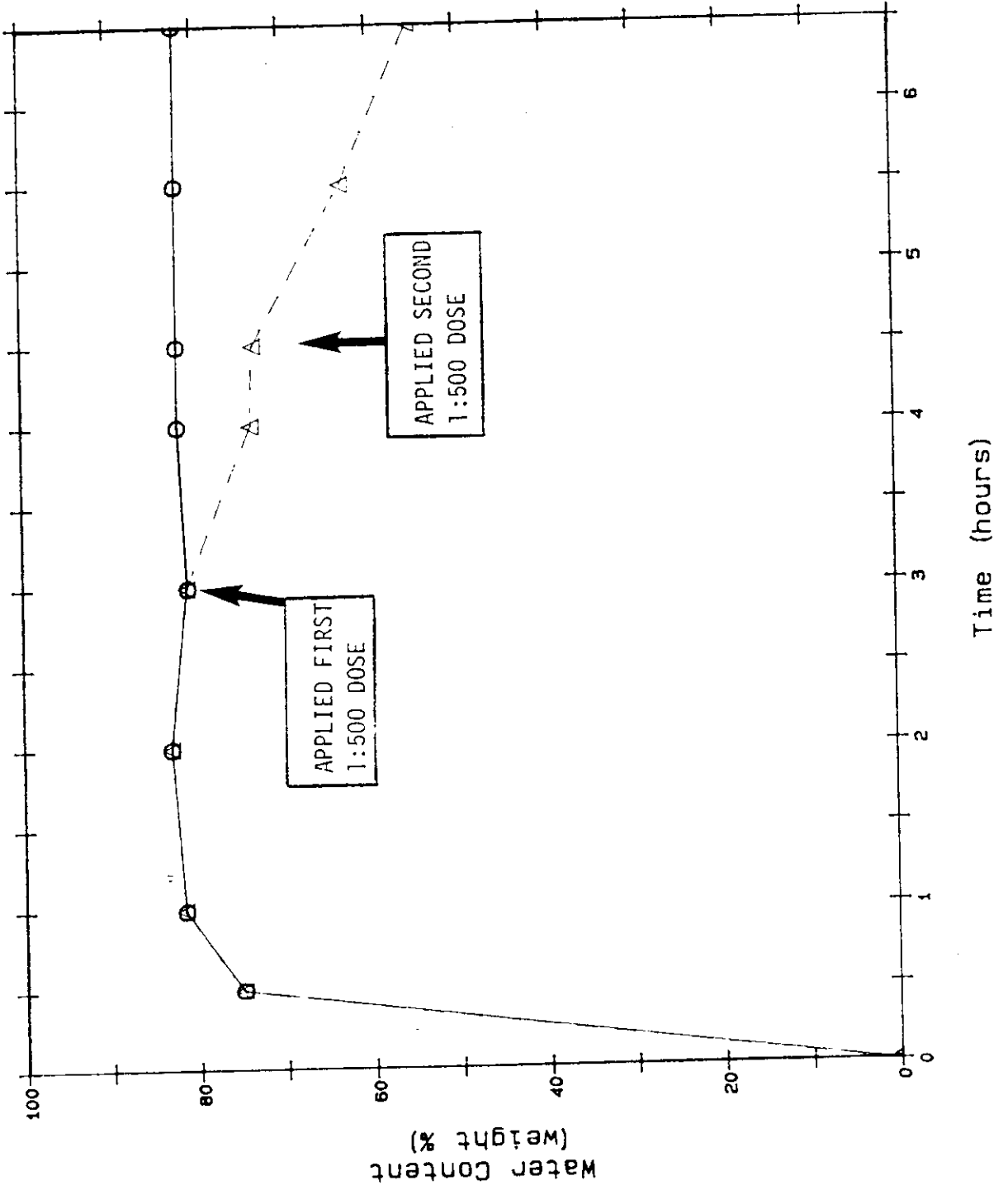


FIGURE 8 . Water Content of Slick as a Function of Time
When Treated with Brand "M" Demulsifier



ii. Elastol

The results of the Elastol application tests are presented in Figure 9 which plots the die swell ratios as a function of time. The results show that Elastol applied in this manner was effective in imparting elastic behaviour to the oil slicks within one-half hour after application as indicated by the greater-than-one die swell ratios, and that increasing the Elastol concentration resulted in greater elasticity. Furthermore, observation of the slicks showed a fairly even elasticity development throughout the oil, indicating a relatively even distribution of the treating agent during the application procedure.

PART 2 - REPORT ON MESOSCALE OF ELASTOL AND BRAND M

INTRODUCTION

Four days of testing were conducted by M. Fingas in the outdoor test basin at the Esso Research Facility in Calgary. The previously described applicators were used for applying the treating agents. The purpose of the testing was:

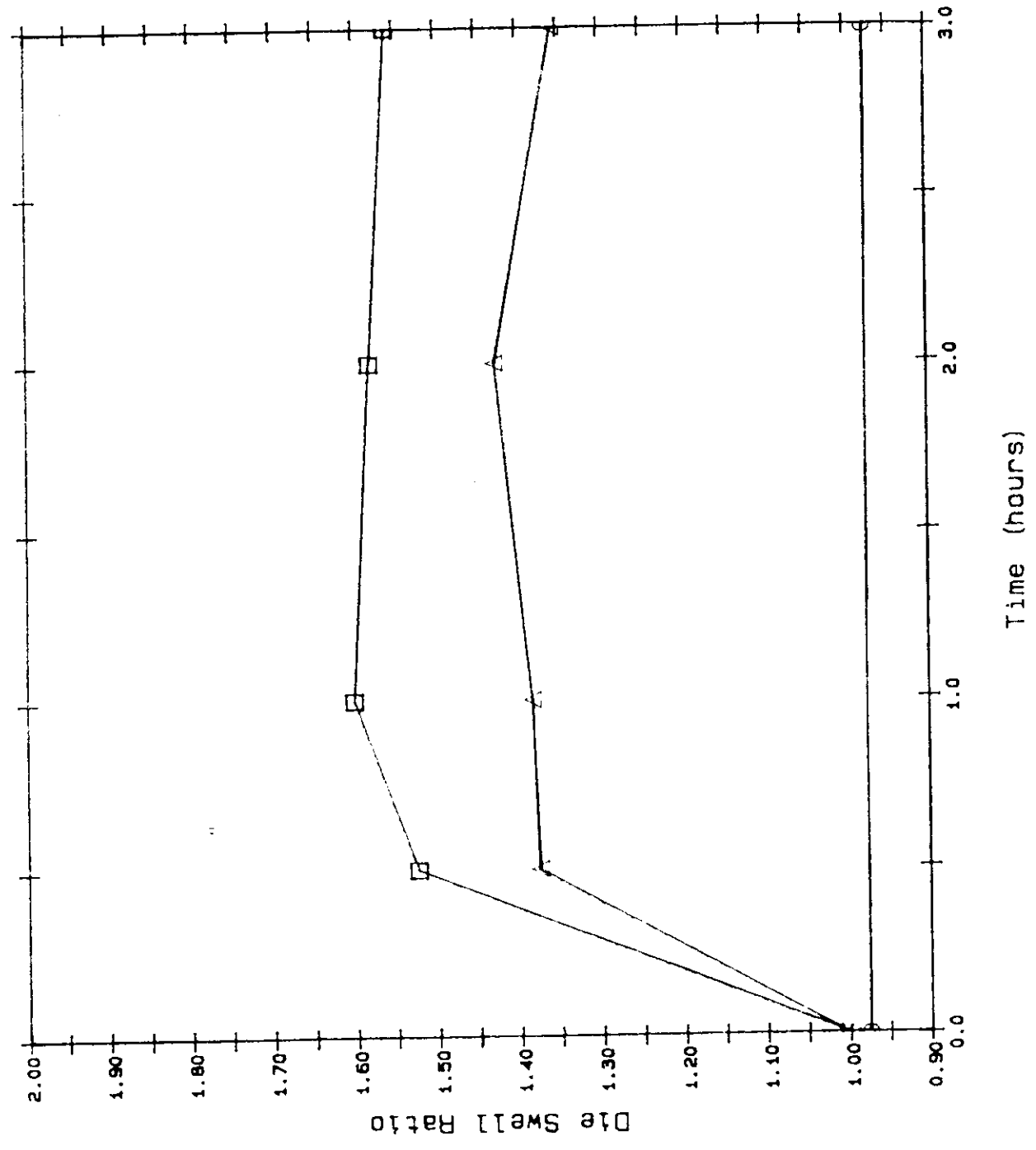
- i. to examine the performance of the applicators under conditions that loosely resemble those found at environmental spill situations;
- ii. to determine the effectiveness of the agents when applied in this manner and under these conditions;
- iii. to compare the behaviour of treated slicks to slicks left untreated.

EXPERIMENTAL

A schematic diagram of the basin is shown in Figure 10. The dimensions of the basin are 15 m x 19 m with a maximum depth of 2 m. For these tests, the basin was filled with fresh water. Two circular boom configurations of 5m in diameter were positioned side by side and parallel to the wave generating flap. With the booms placed in such a configuration, slicks can be placed in each of the boomed areas and then subjected to identical wave conditions. For each day of testing, one slick was treated with an agent and the other slick was left untreated to serve as a control.

After applying the treating agent, the wave generators were turned on to produce waves 10 cm in height. The wave generators were turned off during sample taking and during oil recovery with the skimmer. Samples were taken from both slicks at approximately logarithmic intervals and dynamic viscosities were measured using a Fann viscometer.

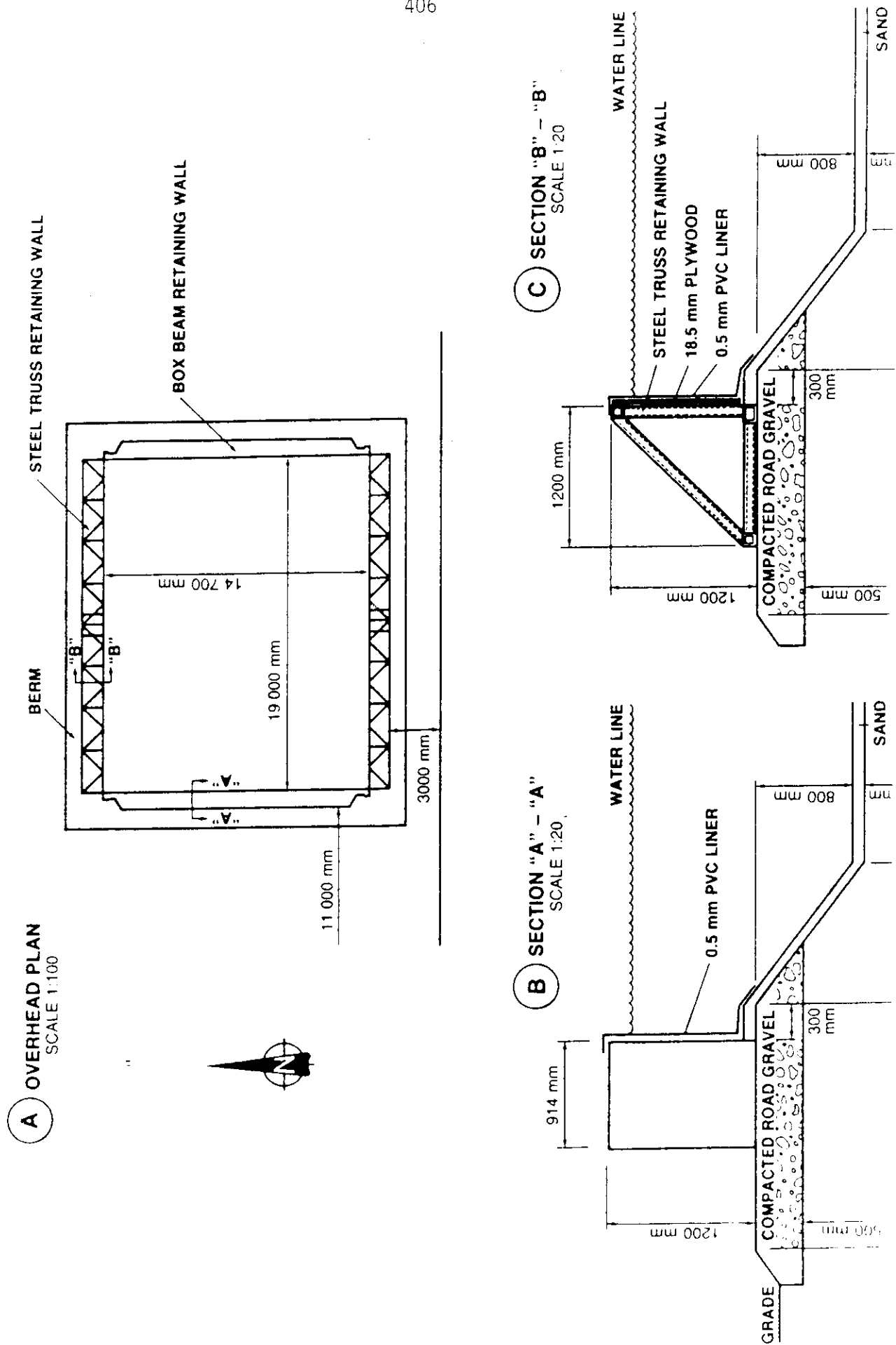
FIGURE 9 . Die Swell Ratio versus Time



405
3000 ppm Elastol
1500 ppm Elastol
0 ppm Elastol

Figure 10

Schematic Plans of Test Basin



A OVERHEAD PLAN
SCALE 1:100



B SECTION "A" - "A"
SCALE 1:20

C SECTION "B" - "B"
SCALE 1:20

At the end of each test day, the oil contained in the booms was recovered by a Morris MI-2C skimmer. The recovered oil was allowed to settle overnight in order to separate the oil and water. Recovery rates were calculated from the volume of oil recovered and the skimmer's operating time.

RESULTS

Day 1 - Application of 2000 ppm Brand M Demoussifier

The test oil used was a half-half mixture of Federated crude oil and tar. This mixture was used because preliminary tests showed it had a strong tendency to form stable emulsions. Some diesel fuel was inadvertently added to the test oil thus producing a mixture slightly different than that used on Day 2.

The measured viscosities are given in Table 1 and Figure 11. The higher viscosity values recorded for the control slick indicate that the untreated oil was forming an emulsion more readily than the treated oil. This was also supported by the physical appearance of the slicks. The control slick had reddish-brown streaks in it, indicating formation of "chocolate mousse". On the other hand, the treated slick remained black in colour and the slick surface was distinctly smooth and glossy.

The slicks also showed a marked difference in their recoverability by the skimmer. The untreated oil was recovered at more than twice the rate of the treated oil. It is suspected that this is due to the lower interfacial tension of the treated oil caused by the demoussifier.

Day 2 - Application of 2000 ppm Brand M Demoussifier

The test oil was a half-half mixture of Federated crude oil and tar. The viscosity results are presented in Table 2 and Figure 11, and as in Day 1, the viscosity of the control slick was higher than the treated slick. The difference in oil recoverability was less dramatic than in Day 1, but the untreated oil had a recovery rate of about 37% higher than the treated oil.

During the course of the day, another quick test of opportunity was performed. A small mat of oil which had escaped from the boom of the control slick on the previous day was floating at one end of the tank. This oil was highly emulsified and had the typical "chocolate mousse" appearance. A small amount of demoussifier was poured directly onto the oil mat and observations were taken. Over a period of minutes, the oil's colour turned to black and then the oil broke up into a thinner, shiny slick.

TABLE 1: NUMERICAL RESULTS FROM THE ESSO TANK TESTS

Day 1: 2000 PPM DEMOUSSIFIER TRIAL

Oil: 70L half Federated crude oil and half tar (approx.)
(contaminated with small amount of diesel fuel)

Time (min)	Viscosity (cP or mPa.s)	
	0	40
test slick	64(±2)	113(±7)
control	64(±2)	169(±1)
		85
		190(±42)
		324(±25)

Recovery by Skimmer

	Volume (L)	Rate (L/min.)
test slick	46	0.93
control	32	2.1

Overall Conditions:

Wave Height: 10 cm
Water temperature: 19 deg C
Air temperature: 20 to 28 deg C, depending on time of day
Wind speed: 0 to 5 km/hr, direction and speed variable

TABLE 2: NUMERICAL RESULTS FROM THE ESSO TANK TESTS

Day 2: 2000 PPM DEMOUSSIFIER TRIAL

Oil: 70L half Federated crude oil and half tar

Time (min)	Viscosity (cP or mPa.s)		
	0	20	90
test slick	176(±3)	176(±5)	203(±8)
control	176(±3)	383(±23)	668(±92)
			310
			350(±160)

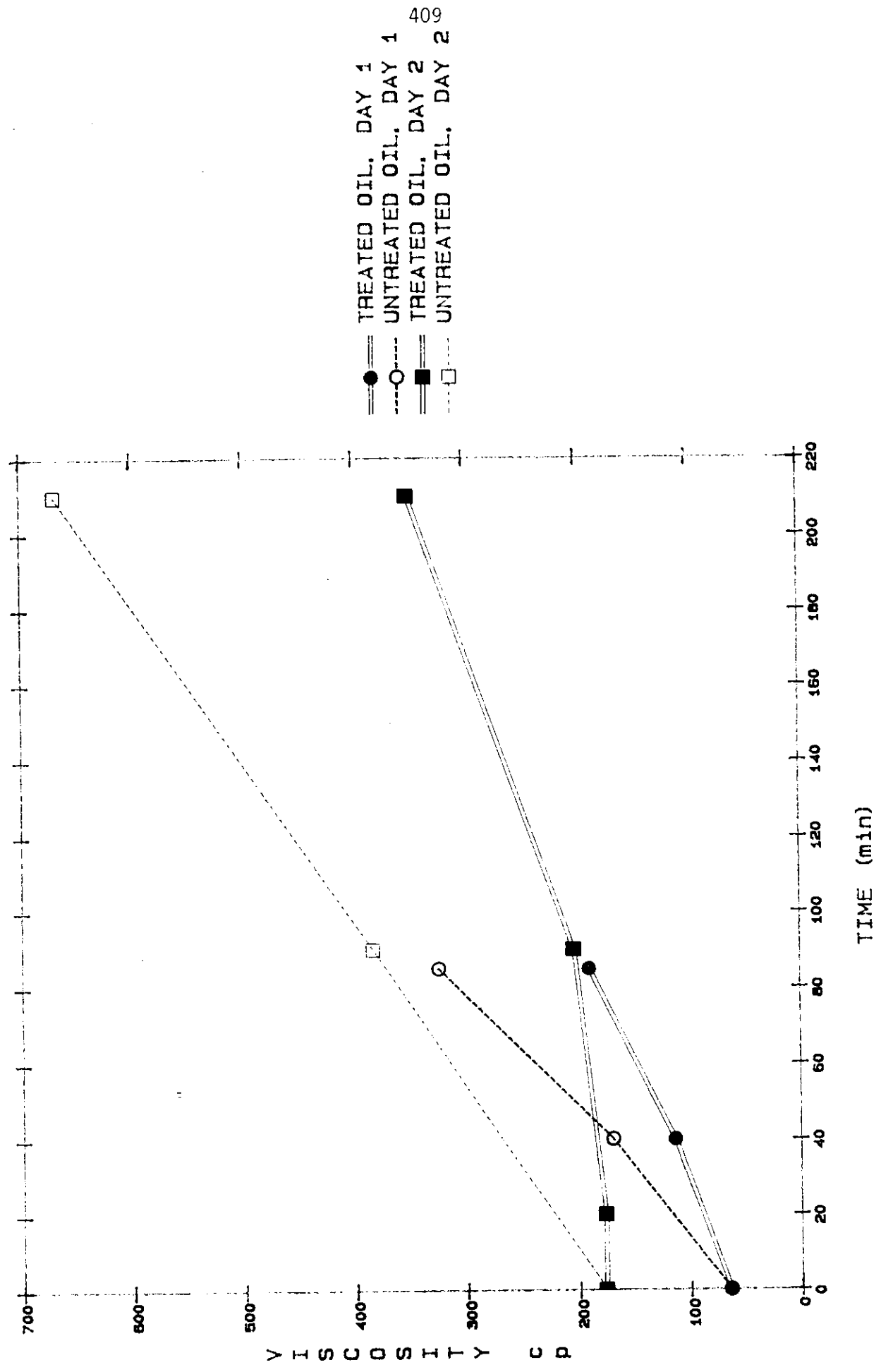
Recovery by Skimmer

	Volume (L)	Rate (L/min.)
test slick	57	0.95
control	60	1.3

Overall Conditions:

Wave Height: 10 cm
Water temperature: 19 deg C
Air temperature: 20 to 28 deg C, depending on time of day
Wind speed: 0 to 5 km/hr, direction and speed variable

Figure 11. RESULTS OF THE DEMOUSSIFIER TANK TESTS



Day 3 - Application of 4000 ppm Elastol

The test oil used was Federated crude oil. The numerical viscosity results, given in Table 3 and Figure 12, show the dramatic increase in viscosity caused by the addition of Elastol.

At the end of the day, it was decided that a quick burning experiment be conducted prior to recovering the oil. With the wave generator turned off, the treated slick (viscosity of 4825 cP) was released from the boom. A simple ignition device consisting of cubes of solidified barbecue lighter fuel on a piece of styrofoam was lit and then placed in the thickest portion of the slick. The flame did not propagate but oil in the immediate vicinity of the device burned with the characteristic popping sound of a burning slick. The flame was sustained for 35 minutes. Examination of the device showed that most of its components remained intact indicating that oil had sustained the burn. The oil slick was thin and by visual estimation was not of sufficient thickness to permit flame propagation. The oil remaining after the burn experiment was recovered by the skimmer. The recovery rate was not recorded but it was observed that the skimmer was collecting oil at maximum capacity.

Day 4 - Application of 2000 ppm Elastol

The test oil was Norman Wells crude oil. Figure 12 and Table 4 show that the Elastol treated slick had a higher viscosity than the control.

During the course of the test, the control slick was observed to be taking up water and the characteristic reddish-brown appearance of mousse was spreading throughout the slick. At 140 minutes, a 500 ppm dose of Brand M was added to the control slick to prevent further emulsification. The demoussifier was poured directly onto the slick and in a non-uniform manner. Despite this, the entire slick surface gradually turned black and took on the distinctive glossy shine. The same 500 ppm demoussifier treatment was applied to the Elastol-treated oil to ensure no experimental bias.

The recovery rates are shown in Table 4; the Elastol treated oil was recovered at more than twice the rate of the untreated oil. Indeed, the treated oil resulted in flooding of the skimmer indicating that the skimmer was operating at capacity. Therefore, the recoverability of the oil may be more than that indicated by the capacity of the Morris MI-2c skimmer. This also shows that the decrease in recoverability caused by the demoussifier can be remedied by the addition of Elastol, and it confirms previous laboratory tests that show Elastol and Brand M can be employed together.

TABLE 3: NUMERICAL RESULTS FROM THE ESSO TANK TESTS

Day 3: 4000 PPM ELASTOL TRIAL

Oil: 75L of Federated crude

Time (min)	n	25	110	270
test slick	5(±0.5)	22(±3)	128(±18)	4825(±75)
control	5(±0.5)	12(±0.5)	28(±5)	229(±25)

Recovery by Skimmer

	Volume (L)	Rate (L/min.)
test slick	None attempt -- did not propagate	
control	100 (much H ₂ O)	2.9

Overall Conditions:

Wave Height: 10 cm
 Water temperature: 19 deg C
 Air temperature: 20 to 23 deg C, depending on time of day
 Wind speed: 0 to 5 km/hr, direction and speed variable

TABLE 4: NUMERICAL RESULTS FROM THE ESSO TANK TESTS

Day 4: 2000 PPM ELASTOL TRIAL

Oil: 75L Norman Wells Crude

Time (min)	0	40	120	276
test slick	6.7(±0.2)	41(±5)	173(±28)	356(±22)
control	6.7(±0.2)	19(±1)	75(±28)	136(±14)

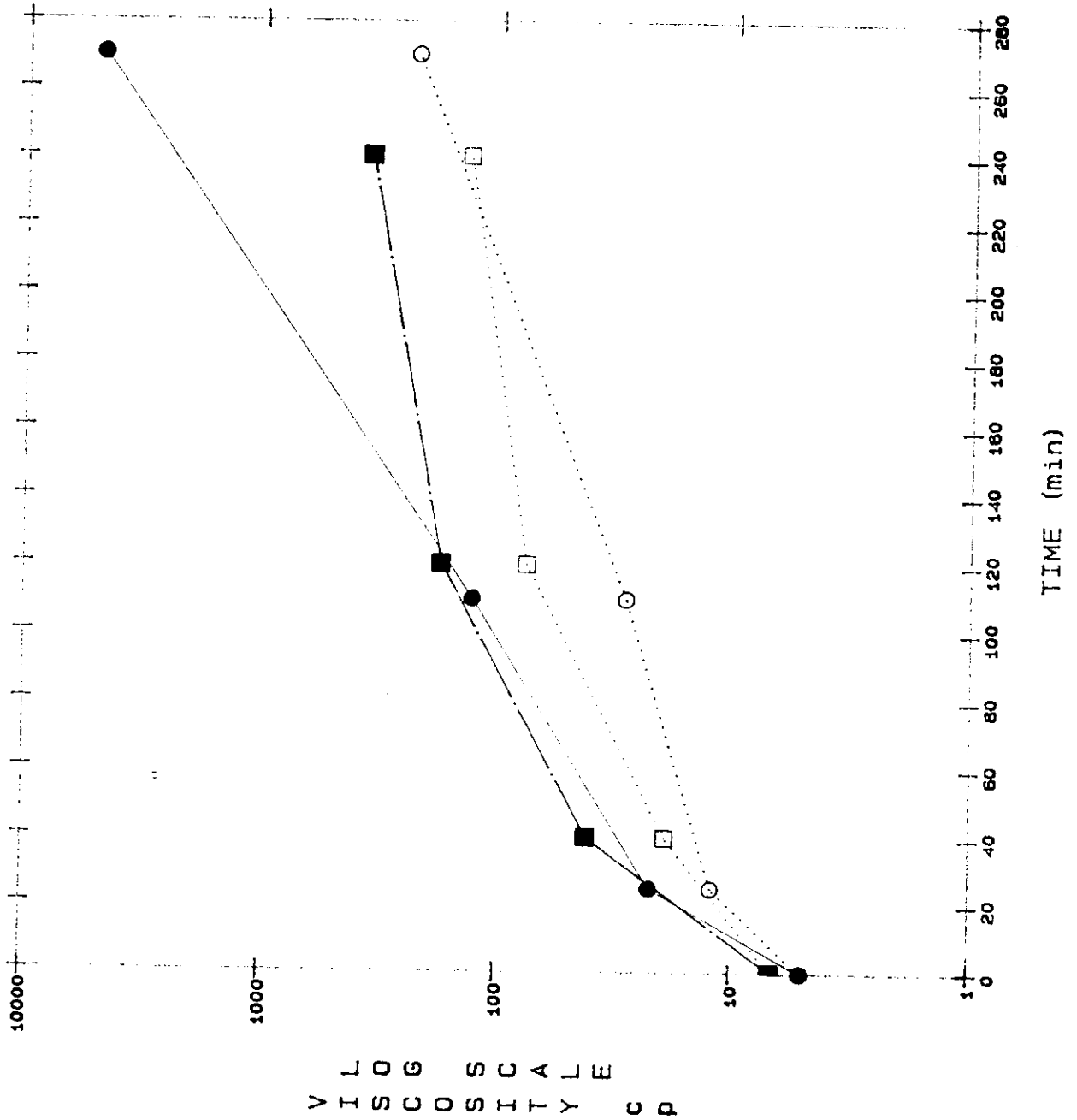
Recovery by Skimmer

	Volume (L)	Rate (L/min.)
test slick	90	5.0
control	46	2.3

Overall Conditions:

Wave Height: 10 cm
 Water temperature: 19 deg C
 Air temperature: 20 to 23 deg C, depending on time of day
 Wind speed: 0 to 5 km/hr, direction and speed variable

Figure 12. RESULTS OF THE ELASTOL TANK TESTS



CONCLUSIONS

Mesoscale application systems have been developed for the two new oil spill treating agents, Elastol and Brand M. The main components of both applicators are a commercially available sandblaster and portable air cylinders. Tests conducted during this study showed that from a fixed position, the Elastol applicator could distribute the treating agent up to a distance of 7 m and cover an area of 26 m². Similarly, the Brand M applicator could spray up to 4 m and cover an area of 5.5 m². A solvent, Isopar M, was chosen as a carrier/solvent for Brand M application in order to improve its spray characteristics and to promote better mixing with oil.

Tests were conducted in a large laboratory wave-generating tank to measure the effectiveness of the treating agents when applied from these systems. The results obtained from these tests were similar to those of previous laboratory studies; they showed that Brand M demoussifier can effectively reduce the degree to which oil emulsifies and that Elastol renders oil viscoelastic.

The applicators proved to work well during the four days of wave basin testing. Slicks treated with Brand M had lower water content than untreated control slicks subjected to the same conditions. As Figure 13 shows oil recoverability (as determined by a skimmer) was decreased by the demoussifier treatment but this could be remedied by adding Elastol.

Testing done with Elastol showed that its application resulted in a dramatic increase in viscosity and in recoverability. A slick treated with 2000 ppm was of sufficient viscoelasticity that its recoverability exceeded the capacity recovery rate of a Morris MI-2C skimmer. A slick of Norman Wells crude treated 4000 ppm of Elastol proved to be insufficiently thick to propagate burning.

ACKNOWLEDGEMENTS

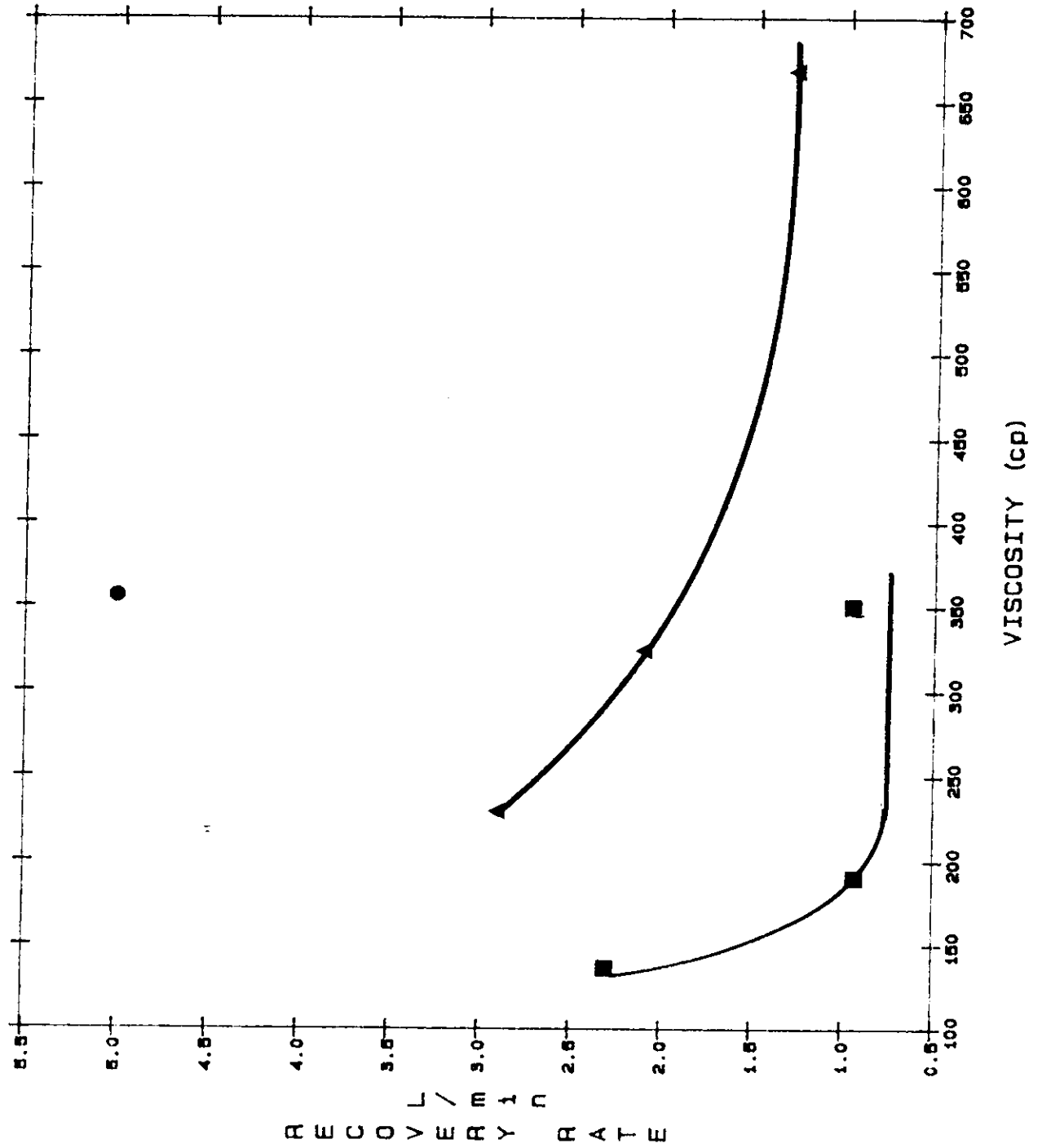
This project was funded by the United States Minerals Management Service and Environment Canada. Mr M. Fingas of the Environmental Emergencies Technology Division of Environment Canada was Scientific Authority for the study.

The authors would like to express their appreciation to the members of the Ad Hoc Committee on Elastol and Demoussifier Testing: Mr. E. Tennyson of the Minerals Management Service; Dr. R. Goodman of Esso Resources Canada; Mr. E. Tedeschi of General Technology Applications; Mr. R. Percy of Environment Canada; Mr. R. Stright of the Canadian Coast Guard; Mr. L. Hannon of the Minerals Management Service; Mr. R. Gershey of Seakem; Mr. L. Nash of the U.S. Coast Guard; and Mr. J. Nash of Mason & Mason Hanger Silas. Special thanks is extended to Mr. E. Tennyson who was instrumental in organizing this study.

ELASTOL TREATED
UNTREATED
DEMOUSSIFIER

● ▲ ■

Figure 13. EFFECT OF TREATMENT ON RECOVERY RATES



REFERENCES

Bobra, M., Kawamura, P., Fingas, M., and Velicogna, D., Laboratory and Tank Test Evaluation of Elastol. Environmental Emergencies Technology Division, Environmental Protection Service, Environment Canada. EE-94, 1987a.

Bobra, M., Kawamura, P., Fingas, M., and Velicogna, D., Mesoscale Application and Testing of An Oil Spill demulsifying Agent and Elastol. report submitted to Environmental Emergencies Technology Division, Environmental Protection Service, Environment Canada. 1987b.

Mackay, D., Zagorski, W. Studies of Water-in -Oil Emulsions. Environmental Emergencies Technology Division, Environmental Protection Service, Environment Canada. EE-34, 1982.

S.L.Ross Environmental Research Limited, An Experimental Study of Oil Spill Treating Agents that Inhibit Emulsification and Promote Dispersion. Environmental Emergencies Technology Division, Environmental Protection Service, Environment Canada. EE-87, 1986.