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Hazardous Waste Engineering
Research Laboratory
Cincinnati OH 45268

Research and Development

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Project Summary

Calibration and Evaluation of a Dispersant Application System

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Summarized herein is a final report which presents recommended methods for calibrating and operating boat-mounted chemical dispersant application systems. Calibration of one commercially available system and several unusual problems encountered in calibration are described. Charts and procedures for selecting pump rates and other operating parameters needed to achieve a desired dosage are provided. The calibration was performed at the EPA's Oil and Hazardous Materials Simulated Environmental Test Tank (OHMSETT) facility in Leonardo, NJ.

This Project Summary was developed by EPA's Hazardous Waste Engineering Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

A chemical dispersant may be used in an oil spill when mechanical methods to contain and recover the spilled oil are not feasible because of weather conditions or the size or location of the spill. Successful use of a chemical dispersant in an oil spill cleanup depends on the effectiveness of both the chemical itself and the application techniques. An effective application requires properly designed equipment and a good regulation of dose rate.

The final report describes an evaluation and calibration of a SEASPRAY 2* dispersant application system. The SEASPRAY 2 was selected because of its commercial availability and certain design features. It is light-weight, portable, self-contained, and versatile, with good dosage control. It appeared to be representative of 1984 state-of-the-art design. The selected system was calibrated to demonstrate:

- The need for the calibration.
- How the calibration may be performed.
- The use of the calibration data for monitoring and control of the dispersant application rate.

The SEASPRAY 2 was calibrated for installation and use on board the EPA's Region 2 vessel CLEAN WATERS. The calibration was conducted at the EPA's Oil and Hazardous Materials Simulated Environmental Test Tank (OHMSETT) facility in Leonardo, NJ.

Equipment

The SEASPRAY 2 consists of a pump unit and two spray arms. The accessory items include hoses, suction pipe, mounting hardware, and securing stays.

The pump unit consists of an electric-start diesel engine and interconnecting piping. The entire unit is mounted in a

*SEASPRAY 2 is the tradename of Delavan Ltd., Widnes, England, and is supplied by Frank Ayles & Associates Ltd., London, England. Mention of tradenames does not constitute endorsement of the product by the U.S. Environmental Protection Agency.

stainless-steel tubular frame. Figure 1 shows a schematic of the piping arrangements. The inlet and discharge connections have cam-lock couplings for quick connections to the sea water intake, the dispersant supply, and the discharges to the spray headers. A separate priming port is provided for startup. A pressure gauge and a pressure-relief valve at the pump discharge manifold provide indication and adjustment of the discharge pressure to the spray headers.

The spray arms consist of two 6-meter (20-ft) long assemblies. Each assembly has a spray header and a fiberglass reinforced plastic structure for support. There are seven spray-nozzle connections on each spray header. Two types of nozzles are available for use. For diluted spraying mode, seven Model QLD-30 nozzles are fitted on each spray arm. For undiluted spraying mode, four Model QLD-10 nozzles are fitted on each header, and the remaining connections are blanked off. The nozzles produce flat spray patterns.

Method

The calibration was conducted with the equipment set up outdoors on the wash pad at the north end of the OHMSETT test tank. The calibration program consisted of calibrating the measurement instruments and the SEASPRAY 2 dispersant application system. The system's dispersant application rates under diluted spraying and undiluted spraying were determined. The indicating devices (i.e., the flow meter and the pressure gauge) on the SEASPRAY 2 were also calibrated.

Many operating variables affect the performance of a dispersant application system. The author attempted to calibrate the SEASPRAY 2 operating at or near the design specifications. Following are the variables considered in the calibration setup:

- Pump discharge pressure to the spray headers.
- Fluid viscosity and/or specific gravity.
- Pump suction lift.
- Static head at pump discharge to the spray holders.

The suction lift and discharge head were kept fixed during the calibration. The relative elevations of the equipment components during the calibration were set up to provide a suction lift and static head similar to that expected at the proposed installation. The pump elevation was approximately 2273 mm (89.5 in.) above the water level. The two spray arms were 152 mm (6 in.) above the pump base.

The suction lift for dispersant chemical under normal operation varies with the liquid level in the dispersant drum. The suction lift, being minimum with a full drum, increases as the dispersant is pumped out. The calibration was performed with a constant liquid head that is representative of an average suction lift for a full-to-empty drum.

Different fluids of various viscosities were used to calibrate the flow meter. The different fluids were also used to determine the system's dispersant application rate as a function of viscosity in undiluted spraying mode. These fluids were salt water from OHMSETT's test tank and different oils obtained by blending Circo 4X light and Circo medium oils in various proportions.

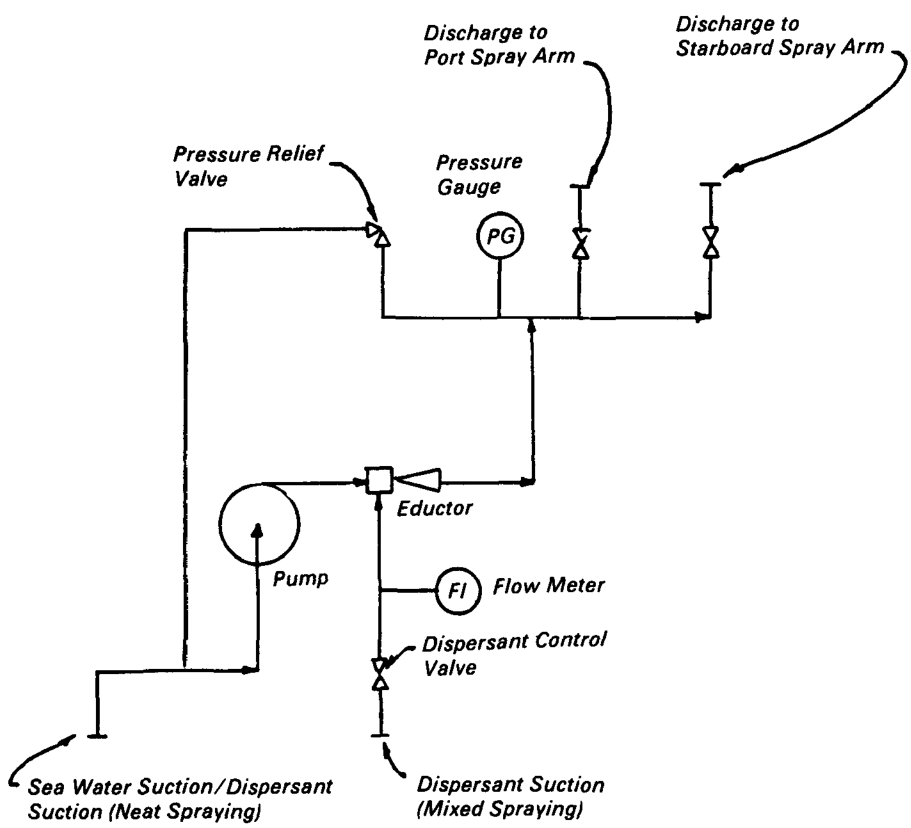

Figure 1. *Piping schematic of the pump unit. The spray headers and the nozzles are not shown in this figure.*

Results and Discussion

The calibration was conducted on two separate occasions. The results from the initial calibration show that the nozzle flow rates varied significantly along the length of the two spray headers. Inspection of the nozzle internals after the calibration showed several nozzles had defective orifices. In general, the orifices were not completely drilled through the plates. Foreign materials were also found in some of the nozzles.

The SEASPRAY 2 was recalibrated after modifications were made to correct the observed problems. All the defective orifice plates in the nozzles were replaced. Also, a filter strainer was installed at each of the pump discharge ports.

Calibration of the SEASPRAY 2 shows that the manufacturer-supplied flow meter has a positive bias indication. The 50-cS scale is biased an average 0.23 m^3/h (1 USGPM), or 11% of full scale. The meter performed better with the lower-viscosity fluid, resulting in an average bias of 0.005 m^3/h (0.2 USGPM) or 2% of full scale. The 100-cS scale average bias is 0.09 m^3/h (0.4 USGPM) or 4% of full scale.

In diluted spraying mode, the measured nozzle flow rates agreed well with the manufacturer's published data. The maximum dispersant eduction rate appeared to be limited by the upper range of the flow meter scale which is 1.95 m^3/h (8.58 USGPM). Figures 2 and 3 (from the flow meter calibration data) show the dispersant flow rate versus flow meter reading.

In undiluted spraying mode, the nozzle flow rate varied linearly with the fluid viscosity. The flow meter is not used with undiluted spraying. The maximum dispersant application rate is limited by the fluid viscosity. At high fluid viscosity (above 200 cS), the pump operation was accompanied by severe vibration. Also, the spray angle decreased from approximately 90° for salt water to approximately 30°-40°. Figure 4 shows the undiluted dispersant application rate versus dispersant viscosity.

Figure 5 shows the relationship between dispersant application rate and the vessel speed for various unit area dosage. This figure was developed for the proposed equipment installation. The operating procedures to maintain a correct dispersant application dosage (in liters per hectare or gallons per acre) are:

- For Diluted Dispersant Spraying—The operator selects a vessel speed and determines the required dispersant application rate from Figure 5. The operator then adjusts the flow meter to obtain the application rate using the flow meter calibration curves (Figures 2 and 3).
- For Undiluted Dispersant Spraying—The flow meter is not used. The operator must vary the speed of the vessel to control the application dosage. Figure 4 is used to determine the dispersant flow rate. The operator then determines and maintains the vessel speed as shown in Figure 5.

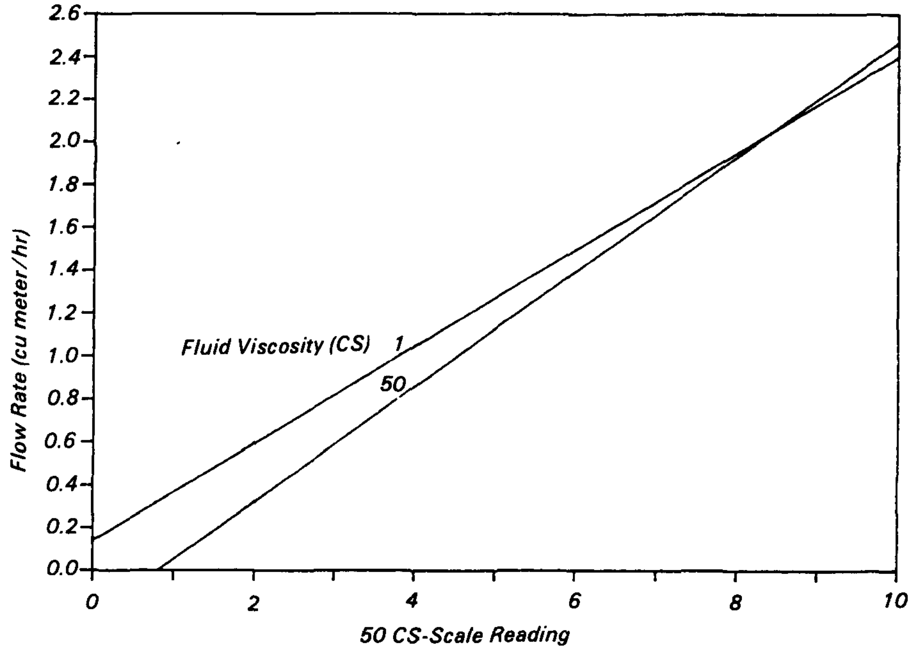

Figure 2. *Dispersant flow rate versus flow meter reading on the 50-cS scale.*

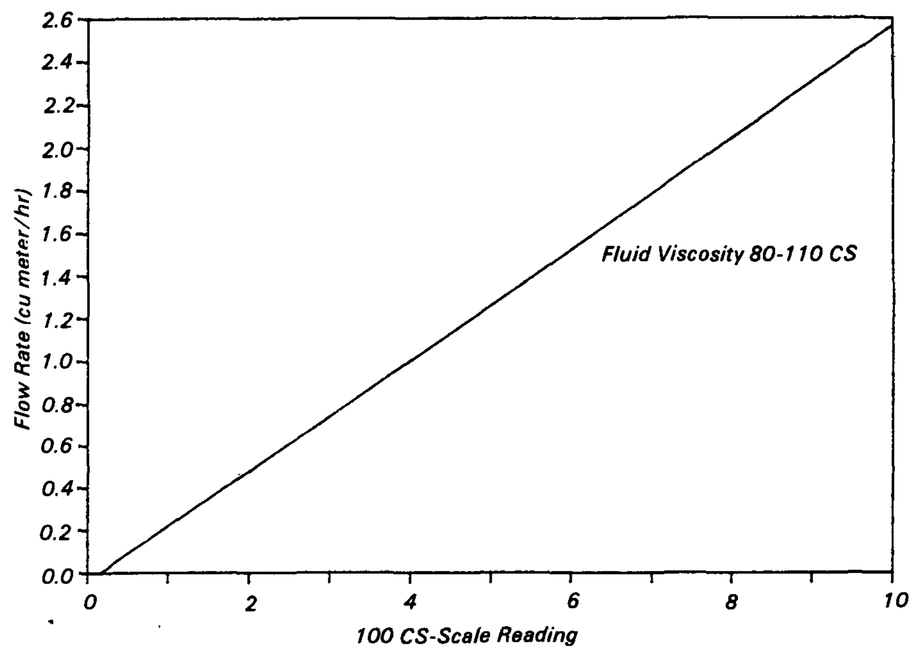

Figure 3. *Dispersant flow rate versus flow meter reading on the 100-cS scale.*

Conclusions

The study demonstrates that any new dispersant application system should be calibrated before one can be sure that the equipment will perform as expected. Dispersant application rate estimates based on the spray nozzle manufacturer's published data may be erroneous due to production variance or defective product parts. Fluid viscosity under actual application conditions may also affect the equipment's spraying performance. Manufacturer's installed instruments, such as flow meters and pressure gauges, should also be checked and calibrated. The nozzles should have provisions to access the internal parts for inspection and cleaning. To minimize potential nozzle plugging, liquid strainer(s) should be provided at the pump discharge.

Once the calibrating data are obtained, operating charts relating various operating parameters and the application dosage can be developed. For equipment with flow meters, the correct dosage is applied by determining the required flow rate from the operating charts and

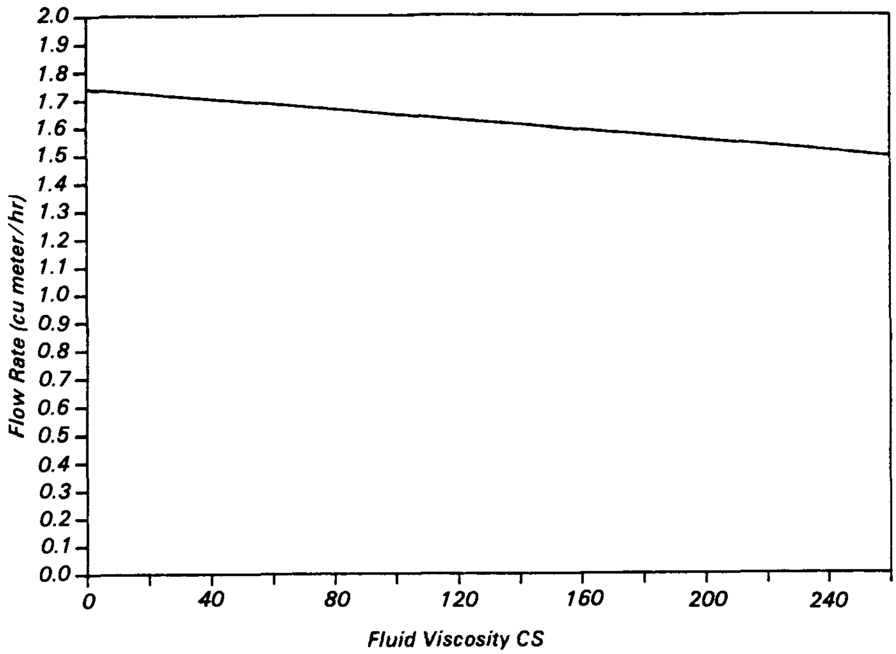

Figure 4. *Undiluted dispersant application rate versus dispersant viscosity at a pump discharge pressure of 276 kPa (40 psi) gauge.*

adjusting the flow meters accordingly. When there is no flow meter, application of the correct dosage requires control of the vessel speed.

Calibration of the SEASPRAY 2 shows that:

- The manufacturer-supplied flow meter has a positive bias indication. Use of the meter without calibration will overestimate the application rate.
- For low viscosity fluids, the measured nozzle performance agrees well with the manufacturer's published data. For higher viscosity dispersants used in undiluted spraying, calibration is required to establish the system's performance.
- The pump unit is not suitable for applying high viscosity dispersants. With viscosities above 200 cS, severe pump vibration will occur. Also, the spray angle will be significantly smaller than that specified by the manufacturer.
- In diluted spraying mode, the dispersant application rate can be adjusted with the flow meter over a range of 0 to approximately 2 m^3/h (8.8 USGPM). This represents a unit area dosage of approximately 0-104 liters/hectare (0-11 USGPA) for the proposed installation at a vessel speed of 5 knots.
- In undiluted spraying mode, the flow meter is not used. The dispersant application rate is not readily adjustable. Maintenance of correct vessel speed is necessary to obtain the desired area dose rate. The operating range of the application equipment in undiluted mode for a low viscosity dispersant is approximately 91 liters/hectare (9.7 USGPA) at a vessel speed of 5 knots.

This study was conducted at the EPA's Oil & Hazardous Materials Simulated Environmental Test Tank (OHMSETT) facility in Leonardo, NJ. The full report was submitted in fulfillment of Contract 68-03-3203, Work Assignments No. 121 and 137 by Mason & Hanger-Silas Mason Co., Inc., under the partial sponsorship of the U.S. Environmental Protection Agency. The American Petroleum Institute was the co-sponsor.

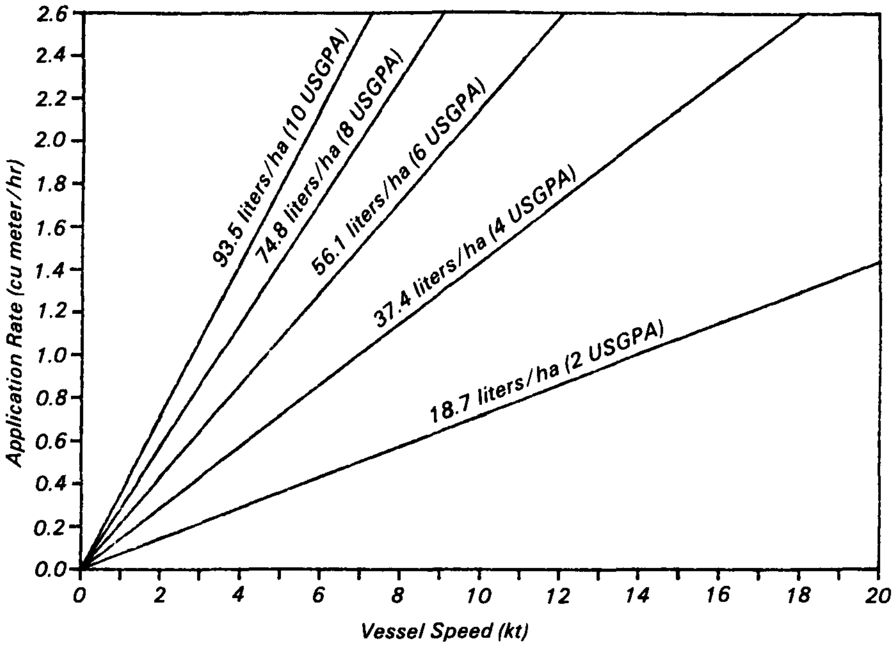

Figure 5. *Vessel speed and dispersant application rate for various unit area dosage. For the proposed installation configuration with a swath width of 20.7 m (68 ft) and 90° spray angle.*

For intermediate values, use:

$$\text{Dispersant Rate } (m^3/h) = \frac{\text{Vessel Speed (kt)} \times \text{Swath (m)} \times \text{Area Dosage (liters/ha)}}{5397}$$

or

$$\text{Dispersant Rate (GPM)} = \frac{\text{Vessel Speed (kt)} \times \text{Swath (ft)} \times \text{Area Dosage (GPA)}}{430}$$

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***Richard A. Griffiths** is the EPA Project Officer (see below).*
The complete report entitled "Calibration and Evaluation of a Dispersant Application System," (Order No. PB 87-194 213/AS; Cost: $13.95, subject to change)
will be available only from:
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