Pergamon

PII: S1353-2561(97)00010-8

Spill Science & Technology Bulletin, Vol. 3, No. 4, pp. 193–194, 1996

1353-2561/96 $15.00 + 0.00

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RESEARCH

The Effect of Energy, Settling Time and Shaking Time on the Swirling Flask Dispersant Apparatus

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The effects of varying the rotational speed (energy), settling time and shaking time were measured on the laboratory dispersant test; the swirling flask test. Dispersant effectiveness onset between 100 and 150 rpm, indicating a threshold process for dispersion. The dispersant effectiveness increased slowly after the onset with increasing rotational speed. The settling time changes effectiveness very much between 5 and 80 min. Change was especially rapid at 5 min. The amount of shaking time did not change the effectiveness significantly. This is also indicative of a threshold dispersion process. © 1997 Published by Elsevier Science Ltd

Keywords: **Dispersant, effectiveness testing, swirling flask.**

Methodology and Results

The standard swirling flask test was employed with the parameters noted being changed one at a time (Fingas *et al.*, 1995a,b). Three oils: Prudhoe Bay crude; Alberta Sweet Mixed Blend; and Thevenard Island were used with the dispersant, Corexit 9500. Four or more replicate samples for each type of experiment were taken. These were taken from at least two separate experimental runs. Effectiveness was measured as the percent of oil in the water column versus a control sample.

Figure 1 shows the results of varying the rotational speed or energy applied to the system. This shows that dispersion onsets rapidly between 100 and 150 rpm, indicating that dispersion is an onset process and that the minimum energy is transmitted to the system at a value somewhere between 100 and 150 rpm. The change in effectiveness after 150 rpm is constant and significant.

The effect of changing settling time is shown in Fig. 2. The effectiveness drop is very rapid with settling time. Large droplets can be seen resurfacing in the first few minutes after energy is no longer applied. After

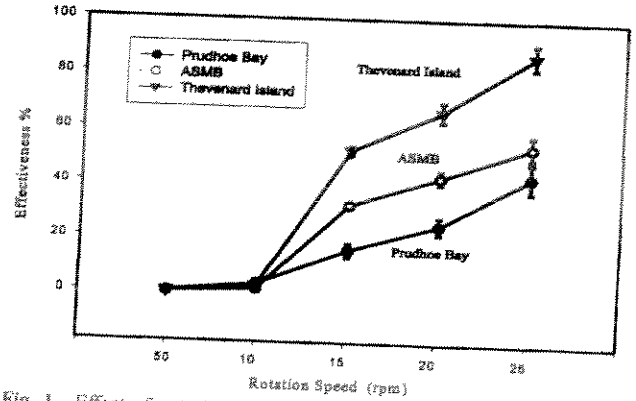

Fig. 1 Effect of rotational speed.

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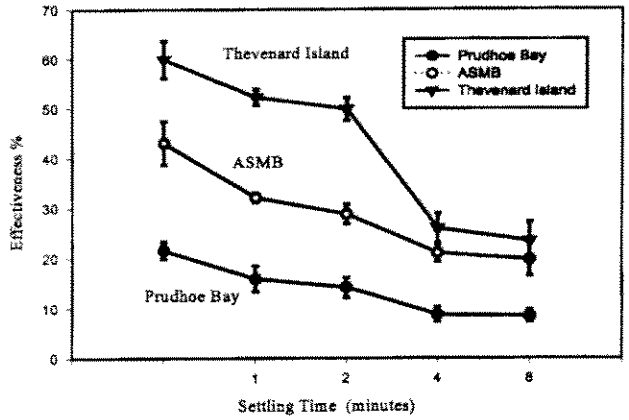

Fig. 2 Effect of settling time.

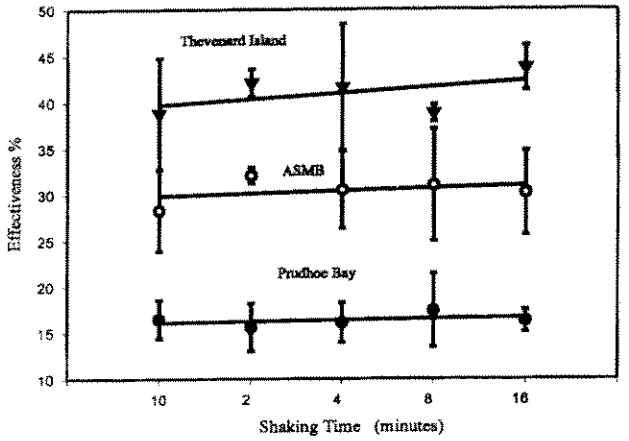

Fig. 3 Effect of agitation time.

about 40 min, there is little change of effectiveness with time. The rapid change at the 5-min mark is significant in that this time is chosen in some tests. Discrete amounts of time are required for sampling and, thus, the choice of a small settling time (e.g. < 10 min) results in errors as large as 30%. The 10 min sampling time for the swirling flask could be extended to 20 min to reduce error.

The effect of shaking time is shown in Fig. 3. The lines were fitted using linear regression. It can be seen that in all cases the effectiveness rises slowly, but not significantly with increasing shaking time. This is again indicative of a threshold process.

Conclusions

The studies on rotational speed for the swirling flask apparatus show that the onset of dispersion occurs between 100 and 150 rpm. The rapid onset is indicative of a threshold process for dispersion. This threshold process has been observed in previous studies. The dispersion amount increases with increasing rotational energy, as would be expected and as shown by earlier studies directed toward energy-dispersion studies. The 150 rpm now specified for the swirling flask test is at a region of relatively little change.

Dispersion amount was found to decrease rapidly (perhaps exponentially) with settling time. The change at the 5 min time was large and at the 80-min point of time was small. The 10 min time specified for the swirling flask test might be changed to 20 min, although this would only marginally improve the SD. The concern over settling time involves three factors: first, the large, unstable droplets cream to the surface very rapidly after the absence of turbulent energy, as they would at sea; secondly, the point at time at which the dispersion is sampled should not be critical, so that a small error in timing does not change the dispersion amount significantly; and finally, with multiple samples run at the same time, not all samples are taken at precisely the specified time. The resulting error decreases as settling time increases.

The rotational time or time that energy is applied does not change the amount of dispersion significantly. A small upward trend is observed, as might be expected. The little amount of change with increasing rotational time is consistent with a threshold process that has been proposed for oil spill dispersion.

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