THE EFFECT OF SPRAY THICKENING ANTI-DRIFT ADJUVANTS ON FLOW RATES THROUGH NOZZLES

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SUMMARY

All seven spray-thickening anti-drift adjuvants tested, increased flow rates, compared with water alone, through a D2-13 hollow cone nozzle. Addition of Nalco-Trol II to water increased flow rates through most disc and swirl plate combinations but not through flat fan nozzles. The increase in flow was greatest for small nozzles. It is recommended that sprayer calibration should be undertaken with the adjuvant rather than with water alone. Changes in flow rates can be minimised by using flat fan nozzles or disc and swirl plate hollow cone nozzles with high outputs.

Keywords:

INTRODUCTION

Spray droplet drift from the operational site into environmentally-sensitive areas is a major hazard of aerial and ground spraying. Many ways of reducing droplet drift have been investigated, amongst them the addition of chemicals which modify the physical characteristics of the spray liquid (Butler *et al* 1969; Richardson 1974; Yates *et al* 1976), primarily by increasing the viscosity. Although these materials increase the volume median droplet diameter (VMD) of the spray (Yates *et al* 1985), there is some doubt as to whether the very small droplets (<150 µm) are eliminated (Howitt *et al* 1980; Grumbles *et al* 1980). However, in wind tunnel simulations to measure droplet spectra produced by 8006 and D8-46 nozzles, using a Particle Measuring System laser probe, the volume of spray in droplets less than 150 µm was substantially reduced on addition of Nalco-Trol (Yates *et al* 1985).

In addition to altering the spectrum of droplet sizes, changing the physical properties of the spray liquid has other effects. Bouse *et al* (1981) reported that flow rates through a D6-45 nozzle at 207 kPa were increased by 37% when an anti-drift adjuvant was added to water. Since sprayers are usually calibrated at the beginning of each operation with water alone, changes in flow rate would seriously affect precision of the application. The object of this study was to further investigate the effect of the adjuvants on the rate of flow through various nozzle types and sizes.

MATERIALS AND METHODS

The flow rates of water alone and water plus adjuvant mixtures were compared. In all cases, flow rates were measured by spraying into a measuring cylinder for a given time, through a single nozzle fitted to a hand-held sprayer pressurised with compressed air. Tests were carried out in duplicate unless stated otherwise. The flow rates of the adjuvant mixtures compared to water alone are reported as a relative flow rate where:

$$\text{Relative flow rate (\%)} = \frac{\text{Flow rate with adjuvant} \times 100}{\text{Flow rate with water}} - 100$$

A range of adjuvants were tested for their effect on flow rate through a D2-13 hollow cone nozzle (Spraying Systems Co.) at 276 kPa. Adjuvants were added at rates specified by the manufacturers (Table 1). Each test was replicated four times, and Fishers protected least significant difference was used to test for differences among means.

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Flow rates were measured for water and water plus 0.15% (v/v) Nalco-Trol II at 276 kPa using the following nozzle (Spraying Systems Co.) combinations:

- (a) hollow cone nozzles with disc orifice sizes D2, D3, D4, D6, D7 and D8, each with swirl plates 13, 23, 25, 45 and 46.
- (b) flat fan nozzles 730039, 730077, 730462, 8005.

RESULTS

The addition of each of the adjuvants tested led to increased flow rates through a D2-13 nozzle compared to water alone (Table 1). The relative increase in flow rates was between 70 and 85% with the exception of Windfall, which was 31%.

TABLE 1: Effect of adjuvants on the flow rate of water through a D2-13 nozzle at 276 kPa.

Adjuvant	Manufacturer	Concn ¹ (%)	Flow rate ² (litres/min)	% increase in flow over water
Water alone	—	—	0.356 a	—
Windfall	Aviation Chemical Inc.	1.00	0.466 b	31
Nalco-Trol II	Nalco Chemical Co.	0.15	0.605 c	70
Get Down	Exacto Chemical Co.	0.09	0.610 d	71
Lo-drift	Amchem Co.	0.06	0.620 e	74
Drifgon	Sanitek Products Inc.	0.03	0.626 f	76
Nalcotrol	Nalco Chemical Co.	0.06	0.640 g	80
Orthotrol	Chevron Chemical Co.	0.09	0.660 h	85

¹All concentrations are within the manufacturer's recommended range.

²Numbers in a column followed by the same letter are not significantly different ($P < 0.05$).

With the majority of disc and swirl plate combinations, adding Nalco-Trol II to water caused an increase in relative flow rates (Figure 1). For each disc size, the greatest relative flow rate was generally with the smallest swirl plate sizes (lowest liquid output). For a given disc size, as output was increased (larger swirl plate size) there was an approximately linear reduction in the relative flow rate on addition of Nalco-Trol II. The slope of these lines tended to decrease as disc size increased. That is, with larger disc orifices, increasing the swirl plate size had a smaller effect on relative flow rates than with small disc orifices. Similar trends were observed at 400 kPa pressure, and with Nalcotrol (B. Richardson and J. Ray, unpublished data).

With fan nozzles, addition of Nalco-Trol II resulted in no significant difference (paired t-test) in relative flow rates (Table 2).

TABLE 2: Effect of 0.15% (v/v) Nalco-Trol II on the flow rate of water through flat fan nozzles at 276 kPa.

Nozzle	Mean flow rate (litres/min)	
	Water	+ 0.15% Nalco-Trol II
730039	0.178a ¹	0.177a
730077	0.320b	0.310b
730462	1.790c	1.745c
8005	1.830d	1.983d

¹Numbers in a row followed by the same letter are not significantly different.

Fig. 1: The relative change in flow rate of 0.15% (v/v) Nalco-Trol II for various disc and swirl plate combinations, plotted against the output from the nozzle using water alone. Each line represents a single disc orifice; points along each line represent the swirl plates 13, 23, 25, 45 and 46. As the water flow rate for each disc size is increased, the swirl plate size is increased.

DISCUSSION

All of the adjuvants tested caused an increase in relative flow rates through a D2-13 nozzle. Furthermore, for most disc and swirl plate combinations, addition of Nalco-Trol II generally caused an increase in flow rate. This result is surprising because these additives are assumed to function by increasing the viscosity of the spray (Bode *et al* 1976; Butler *et al* 1969) which would be expected to decrease flow rates. However, it may be explained if addition of these adjuvants to water produces a non-Newtonian fluid (Yates and Akesson 1973). For a non-Newtonian fluid, the apparent viscosity is a function of shear rate; the apparent viscosity will be reduced and thus flow rates increased with nozzles which produce a high shear rate. The effects observed may therefore have been due to the nature of the liquid and the shear rates produced by the disc and swirl plate combinations, smaller combinations producing higher shear rates.

With the flat fan nozzles used, addition of Nalco-Trol II resulted in no change in relative flow rates. This may be because such nozzles have constant discharge coefficients over a wide range of viscosities (Yates and Akesson 1973). Thus, flat fan nozzles may be advantageous if use of an anti-drift agent is contemplated.

Because anti-drift agents can cause considerable increase in relative flow rates, sprayer calibration must be performed using the adjuvant together with water rather than with water alone. Care must also be taken to ensure the correct adjuvant rate is used during calibration, and that spraying pressure remains constant for the operation, as both of these factors have been shown to have significant effects on relative flow rates for some disc and swirl plate combinations (B. Richardson and J. Ray, unpublished data). Changes in relative flow rates can be minimised by using flat fan nozzles, or disc and swirl plate hollow cone nozzles with high outputs.

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