ABSTRACT

Drag reduction phenomenon has been studied and applied to extend the discharge distance of kerosene, gas oil and tap water falling freely from horizontal tube. The effect of liquid head, type of solvent, polymer characteristics and concentration, pipe diameter and roughness and addition of surfactant were investigated.

Experimental tests were performed using apparatus consisting of a reservoir connected to a horizontal tube from which the flux was allowed to fall freely under different heads. The distance traveled horizontally was measured and used to estimate the friction factor (f) and the percentage drag reduction (%DR). The tests were carried out under liquid heads of 140, 165, 190, 215, 240 cm to ensure turbulent flow circumstances, i.e. Re > 3000.

Three types of polymers were tested, viz., polyisobutylene (PIB), xanthan gum (XG) and guar gum (GGM). The activities of these polymers for drag reduction were evaluated at concentrations of 10-200 ppm for PIB and 50-400 ppm for XG and GGM using three solvents, viz., kerosene, gas oil and tap water. Glass tubes of 3,7,10 and 11mm diameters in addition to carbon steel and stainless steel pipes of 10mm diameter were used to investigate the effect of pipe diameter and roughness.

The interactions between polymer and surfactant were investigated using sodium luaryl sulfate (SLS) so that experimental tests were performed with PIB in the absence and presence of (SLS) at different concentrations.

The discharge distance and %DR is generally increased with increasing liquid head and additive concentration. However %DR is

sometimes reached to a maximum value at a specific concentration termed " critical concentration" beyond which %DR is fallen, the %DR observed with 100ppm of PIB is 44.3% at head equal 140 cm and 56% at head equal 240 cm from stainless steel tube. Moreover, %DR is progressively increased with increasing Reynolds number (Re) at any specific concentration, %DR achieved due to the addition 50ppm of PIB is 20.8% at Re equal 17236 and 45.9% at Re equal 26056 from stainless steel tube.

Polyisobutylene has effectively reduced drag with kerosene and gas oil. Its activity seems to be higher with gas oil compared to that with kerosene. The maximum %DR achieved due to the addition 100 ppm of PIB in gas oil and kerosene are 63% & 56% respectively from Stainless steel tube. The activity of SLS for drag reduction with kerosene is evidently lower than that of PIB, and the difference between %DR observed is reduced with increasing concentration. Efficiency of PIB is considerably decreased by adding SLS so that the maximum %DR achieved with their mixture is 40.1%.

The polymers XG and GGM are effectively reduced drag when added to tap water. Their activities at any specific operating conditions are decreased according to the sequence of XG > GGM. The maximum %DR observed with them at 300 ppm are 77% and 48.8% respectively. The values of (%DR) measured with all tested liquids seem consistent with Blasius equation and they are progressively shifted to the direction of Virk asymptote with increasing of polymer concentration. The percent drag reduction is well correlated with Reynolds numbers, (L/D) and polymer concentration according to the relation of the form: $\%DR = a\ (Re)^{b}\ (C)^{d}\ (L/D)^{k}$, where a, b, d and k are constants, so that a specific empirical correlation is observed for each polymer.