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PHASE SEPARATION OF ETHANOL/GASOLINE BLEND. PART. I

M. Anwar-ul-Haq

Fertilizer Research and Development Institute, P.O. Box 1012, Jaranwala Road, Faisalabad

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Improvement in water tolerance of 25/75 v/v ethanol/gasoline blend, by the addition of 5 %v of aromatic and aliphatic inhibitors has been investigated. Aromatic hydrocarbons proved to be very poor water stablizing agents, whereas aliphatic compounds registered 22 % mass improvement in the water tolerance of the blend.

Key words: Alcohol gasoline blends.

INTRODUCTION

Considerable interest has developed in the use of ethanol as an extender for gasoline. The most serious problem associated with ethanol/gasoline blend is that of phase separation, caused by the presence of small amount of water. A study of the factors controlling phase stability of the blend has therefore become significant. Research on the subject has identified the relationships controlling the stability of various concentrations of gasoline/ethanol.

The phase stability of the blend is known to be affected by (a) water content of the blend, (b) temperature of the mixture, and (c) presence of the additives [1].

Few papers have dealt with the phase stability problem of ethanol/gasoline blends. Scheller [2] has reported that an addition of 10 % v of ethanol to unleaded gasoline increased water tolerance to 0.25 % mass and reduced the fuel consumption by 5 %. Sladek [3] has discussed ethanol as a blending component in gasoline and its associated problems. Scheller and Mohr [4,5] have tested the performance of 10 % v ethanol blend with gasoline and reported no significant difference in fuel consumption, vapour lock and corrosion problems. Hobson and Pohl [6] have reported that 20 % v ethanol/gasoline blends have been used successfully as automobile fuel.

EXPERIMENTAL

In order to measure the phase separation temperature of the blends in the presence of water and additivies, 25 ml of the mixture was transferred into a 50 ml capacity flask fitted with a cork and a thermometer, so arranged that the bulb of the thermometer remained fully immersed in the solution. Due to the hygroscopic nature of the ethanol, exposure of the mixture to the atmosphere was minimised. The flask containing the sample was cooled in a deep freezer capable of cooling down to -50^{0}. The temperature at which the mixture turned cloudy on cooling and clear on heating was recorded as the correct phase-separation temperature of the blend. The difference between the two temperatures was not more than ± 0.5

The solutions were made on a percentage volume basis and were weighed to ± 0.01 mg before a predetermined amount of water was added. The percentage of water was taken on a mass basis in order to eliminate any error caused due to change in temperature.

RESULTS

Fig. 1 shows the effect of various concentrations of ethanol in gasoline on the phase separation temperature of the blends. The blends studied were of 9/91 v/v, 20/80 v/v, 25/75 v/v and 40/60 v/v ethanol/gasoline ratios. As expected from the solution theory, the points lie on a curve for each blend investigated. The water tolerance of the ethanol/gasoline blend increased with increasing ethanol concentration and temperature. The plot of the percentage of ethanol (ve.) versus critical water content (wc) at given temperature. Fig. 2 shows a liner relationship where the slope increases with increasing temperature.

The effect of the inhibitor compound was examined by comparing the results from tests on aromatic and aliphatic inhibitors. Water tolerance of 25 % ethanol in gasoline was determined by using ethylbenzene, toluene, *o*-xylene, benzyl alcohol, ethyl methyl ketone, *iso*-butylmethyl ketone, ethyl acetate, *iso*-butylester, 1-butanol and methanol.

The aromatic hydrocarbons additives failed to improve the water tolerance of ethanol in gasoline blends, based on tests using 5 % v aromatics with 95 % v blends of 25/75 v/v ethanol in gasoline (Fig. 3). This will not serve any useful purpose if used as a water stabilizing agent.

Different aliphatic hydrocarbons were studied for mixtures containing 5 % v aliphatics compounds and 95 % v

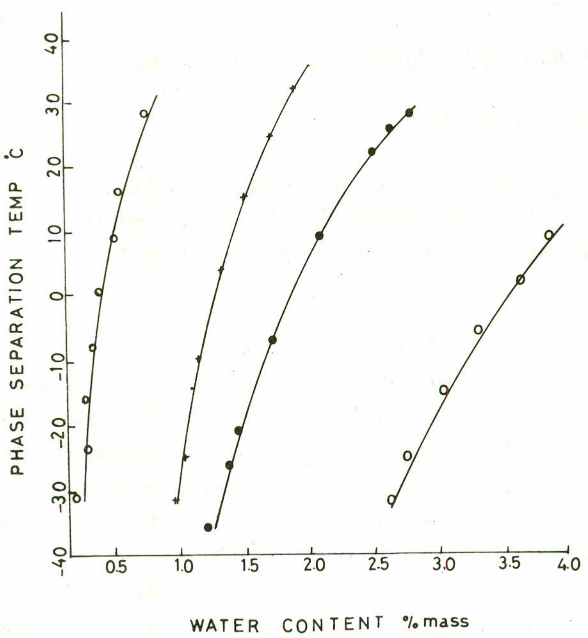

Fig. 1. Improvement in water tolerance with increasing concentration of ethanol in ethanol/gasoline blend. ○ – 9/91 v/v; 3 –– 20/80 v/v; ● –– 25/75 v/v; O –– 40/60 v/v.

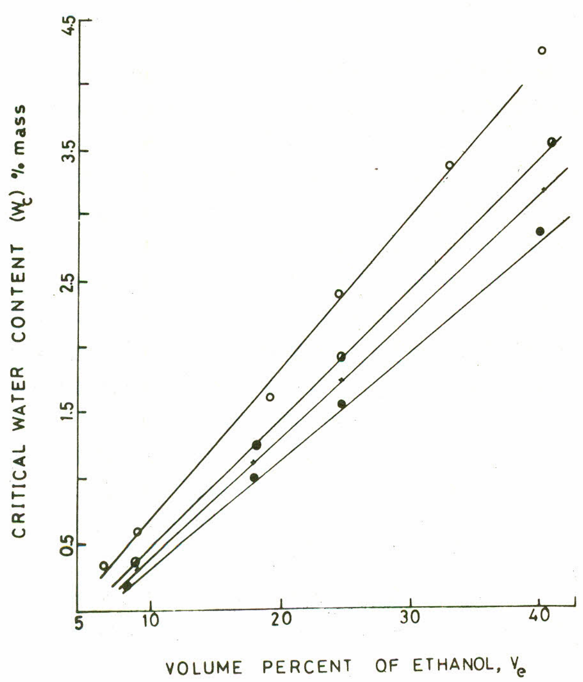

Fig. 2. Critical water content(W_c) at phase separation with the volume percentage of ethanol(V_e) in the blend at constant temperature. ○ –– +20°C; O –– 0°C; + –– -20°C.

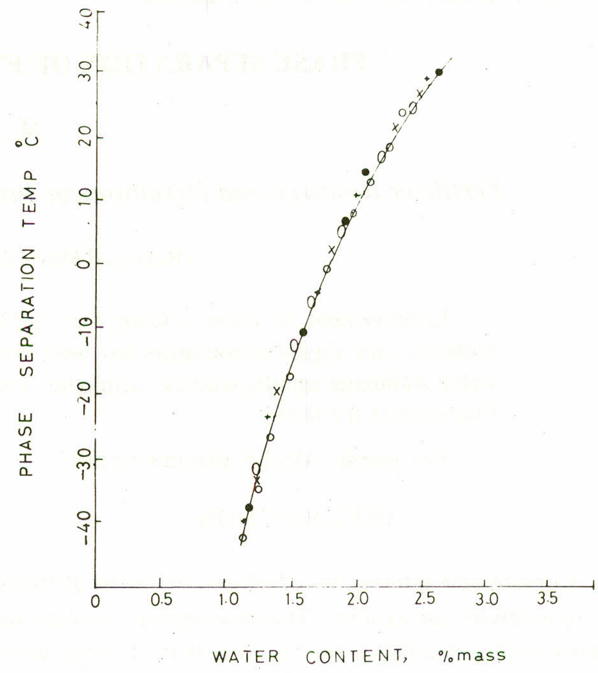

Fig. 3. Effect of 5 % v aromatic additives on the water tolerance of 25/75 v/v ethanol/gasoline blends. + –– 5 % v benzene; X –– 5 % v loluene; O –– 5 % v; O-xylene; ● –– 5 % v ethyl benzone; ○ –– without any additives.

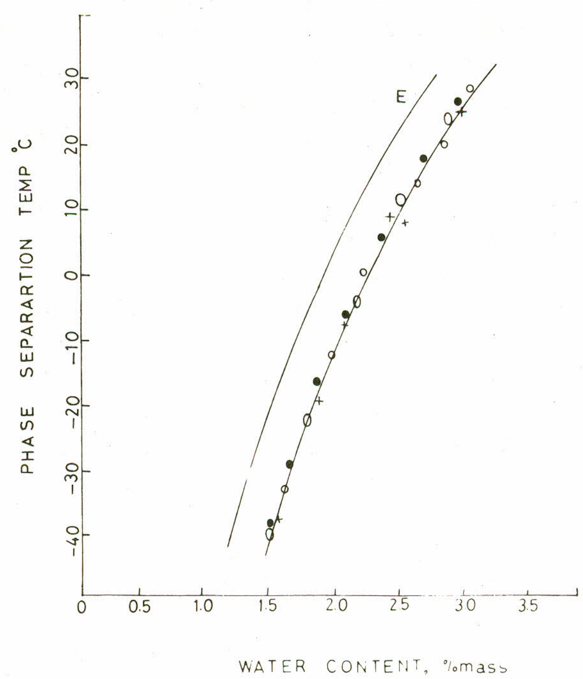

Fig. 4. Effect of 5 % v aliphatic ketone and ester additives on the water tolerance of 25/75 v/v ethanol/gasoline blends. ○ – 5 % v ethyl methyl ketone; O –– 5 % v *iso*-butyl methyl ketone; + –– 5 % v Ethyl acetate; ● –– 5 % v *iso*-butyl ester.

Curve E is taken from Fig. 1 for 25/75 v/v ethanol/ gasoline blend without any additive.

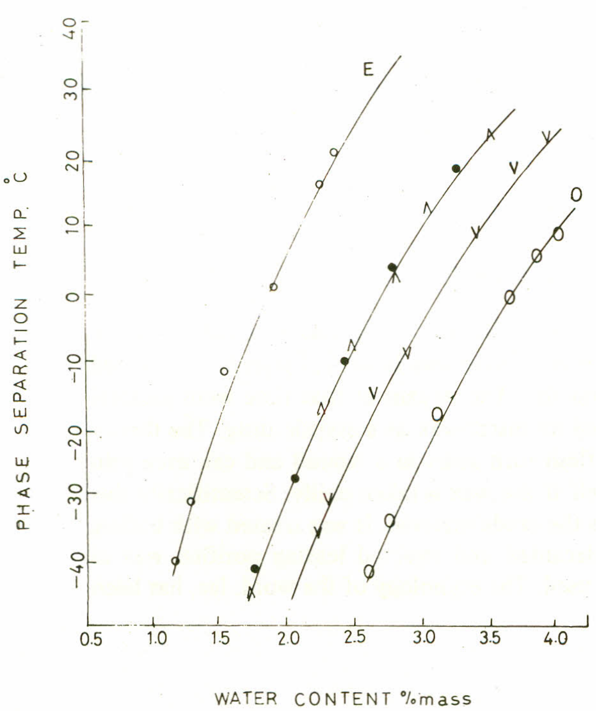

Fig. 5. Effect of alcoholic additives on the water tolerance of 25/75 v/v ethanol/gasoline blends. ○ –– 5 % v methanol; ● –– 5 % v benzyl alcohol; Λ –– 5 % v (1-) Butanol; V –– 7% v(1-) Butanol; O –– 10 % v(1-) Butanol.

Curve E is taken from Fig. 1 for 25/75 v/v ethanol/gasoline blend without any additives.

blend (Fig. 4). The water tolerance of the blend increased with the addition of aliphatic ketones and esters. These compounds produced virtually identical improvement in the water tolerance of the blend over the temperature range investigated. These results could not be compared due to the paucity of the data. Obviously further investigations are needed before these results could be used with any confidence.

The effect of various concentrations of 1-butanol on the phase separation of ethanol/gasoline blend using water content as a variable parameter was investigated for volume concentration of 5, 7 and 10 % v (Fig. 5). The water tolerance of the blend improved with increasing concentration of 1-butanol. 5 % v of 1-butanol and benzyl alcohol produced identical effects on the phase stability of the said blend, whereas no improvement was observed due to methanol addition. 1-butanol is considered the most effective water stabilizing agent. This is in agreement with the reports of earlier workers [7,8].

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