

# Solubility of paraffin wax in kerosene

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The solubility of fully refined paraffin wax (51–54°C m.p.) in a commercial kerosene has been determined and compared with theoretical and empirical prediction equations. Over the limited range of these experiments the experimental results and the theoretical and empirical curves show similar trends; at concentrations up to about 10 wt % wax the empirical equation seems to predict the experimental results reasonably well, but between 10 and 50 wt % wax the theoretical equation seems more accurate.

The wax content of paraffinic hydrocarbons is important in some processes but there is often a problem of making an assessment of the actual composition of mixtures or solutions.

Berne-Allen and Work<sup>1</sup> concluded that the solubility of any paraffin wax in any predominantly non-aromatic saturated petroleum solvent could be determined from the empirical equation:

$$c = \{1120 - 2.97 T_{bp}\} 1.1357^{(T - T_{mp})} \quad (1)$$

where  $c$  is the concentration expressed in g/100 ml solvent;  $T_{bp}$  is the solvent boiling point (°C);  $T_{mp}$  is the wax melting point (°C); and  $T$  is the solubility temperature (°C). Nathan<sup>2</sup> assuming ideal solution conditions used the thermodynamic relation:

$$\ln x = \frac{\Delta H_f}{R_c} \left( \frac{1}{T_{mp}} - \frac{1}{T} \right) \quad (2)$$

where  $x$  is the mole fraction of paraffin wax dissolved in the kerosene solvent;  $\Delta H_f$  is the latent heat of fusion of the wax;  $R_c$  is the universal gas constant;  $T_{mp}$  is the wax melting point (K); and  $T$  is the solution temperature (K).

## COMPARISON OF EQUATIONS

Using a fully refined paraffin wax (51–54°C m.p.) in a commercial-grade kerosene a comparison has been made of the solubility of the wax in the kerosene using equations (1) and (2) and experimental data.

In order to make use of equation (1) as recommended by Berne-Allen and Work<sup>1</sup> the temperatures at which 10, 30, 50, 70 and 90 per cent of the kerosene had evaporated were averaged to give a solvent boiling point of 194°C for the particular kerosene used in the experiments. The solubility was calculated at the temperatures at the extremes of the melting point, i.e. at 51 and 54°C, and averaged to give the curve shown in Figure 1.

To obtain the latent heat of fusion and the molecular weight of the paraffin wax, so that equation (2) could be used to determine solubility, it was assumed that the wax contained a single species of normal paraffin, and the corresponding data were obtained<sup>2</sup>. For a normal paraffin with the melting point of 52.5°C the chain length was estimated to be 25, corresponding to a molecular weight of 352 and a latent heat of fusion of 78.9 kJ/mol. The aver-

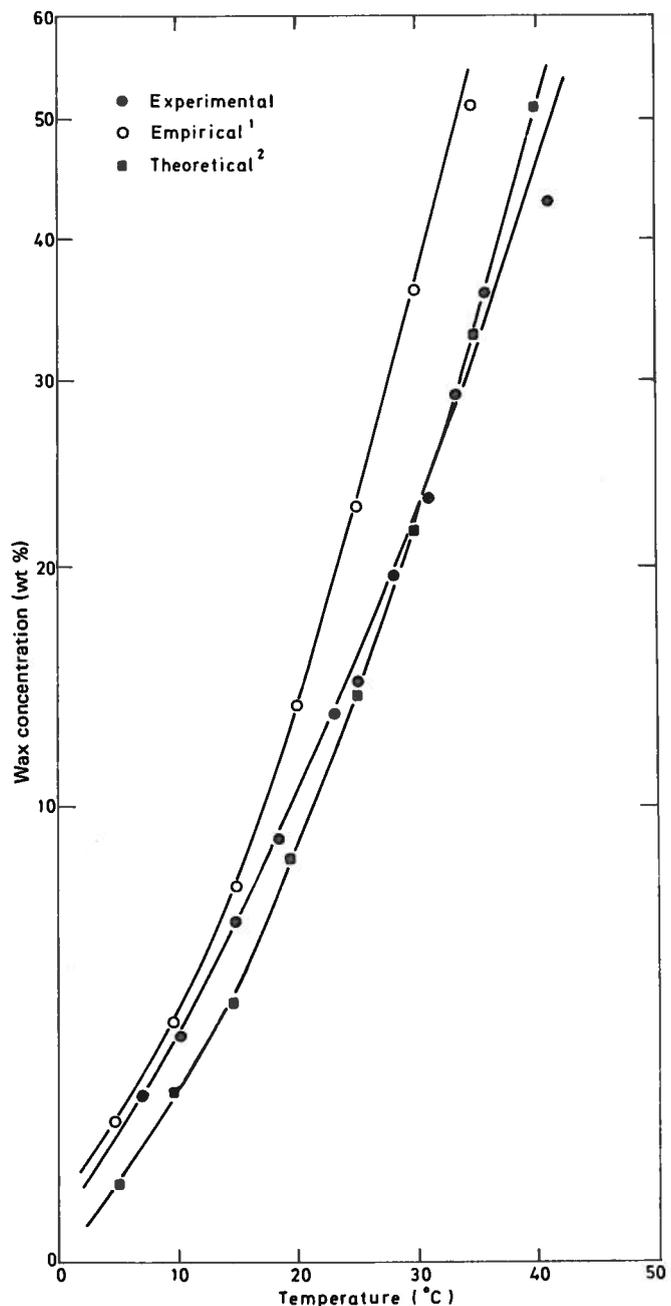


Figure 1 Solubility of 51/54°C fully refined paraffin wax in kerosene

age molecular weight of the kerosene of 153 was estimated from the data presented by Berne-Allen and Work<sup>1</sup> for a kerosene boiling point of 194°C. The theoretical solubility expressed as per cent wax in solution is shown in *Figure 1*.

The experimental solubility of the paraffin wax in the kerosene was measured using the standard cloud-point method<sup>3</sup>; the results are also plotted in *Figure 1*.

## DISCUSSION

The empirical and theoretical solubility curves are similar in shape but the empirical relation predicts a consistently higher saturation concentration for a given temperature. As the solution temperature rises, the difference between the empirical and theoretical curves becomes greater.

The experimental curve is fairly close to the empirical curve at low concentrations but at higher concentrations the curves deviate and the experimental curve follows more closely the theoretical prediction. It would be expected however that, as concentration increases, the departure

from ideality would increase and, in consequence, the theoretical curve would deviate further from the experimental results. The experimental results are affected by the cooling rate during the cloud-point determination<sup>4</sup>, and therefore at realistic experimental cooling rates the equilibrium concentrations at given temperatures are likely to be slightly higher than those recorded.

## ACKNOWLEDGEMENT

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## REFERENCES

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