

The friction rose very markedly at the transition and the surfaces scored, so rendering observations on the reversibility of the process difficult. When the entire test was completed rapidly the effect seemed reversible for fatty acids. A plot of temperature against chain length shows a peak (Fig. 3).

Also it was suggested² that the critical temperature of 150°–200° C observed in many experiments on lubricated systems such as gears^{6,7} was caused by a desorption of the surface active material isolated by Groszek and Palmer⁸ which is normally present in oils. We dissolved the same material as that used in ref. 2 in hexadecane, dekaline and white oil, three solvents which matched the material progressively closer. The log concentration $1/T_c$ curves are shown in Fig. 4. This lends support to the supposition put forward in ref. 2 identifying this critical temperature with desorption and gives a rational basis for the critical temperature scuffing mechanism for gears and disks.

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Heat Transfer Enhancement by Addition of a Liquid Phase

EL'PERIN¹ has shown that the addition of small quantities of liquid in atomized form to gases flowing across tube clusters can substantially increase the rate of transfer of heat from a surface. Recognizing the potential of the system investigated by El'perin, Acrivos *et al.*² measured the rates of transfer of heat under more controlled conditions on an isolated cylinder. An air-atomized water mixture was used but only two flow conditions were explored in detail.

As the first part of an investigation of heat transfer rates and pressure losses during two-component mist flow across tubes, transfer rates of surface heat have been measured under conditions of constant heat flux during the flow of an air-water mist across an isolated cylinder.

A wind tunnel was used to provide a steady and controllable flow of air to a test section. Atomized water was injected into the air flow, upstream of the test section, to generate a two-phase mixture of the required quality.

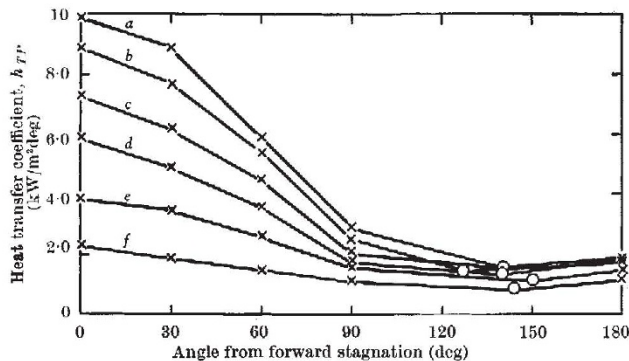


Fig. 1. Variation of heat transfer coefficient around cylinder. O, Minimum recorded value of heat transfer coefficient; x, local values of heat transfer coefficient. Mixture quality (q): a, 6.1 per cent; b, 5.5 per cent; c, 3.8 per cent; d, 2.8 per cent; e, 1.6 per cent; f, 0.42 per cent. For all tests $Re_g = 75,000$.

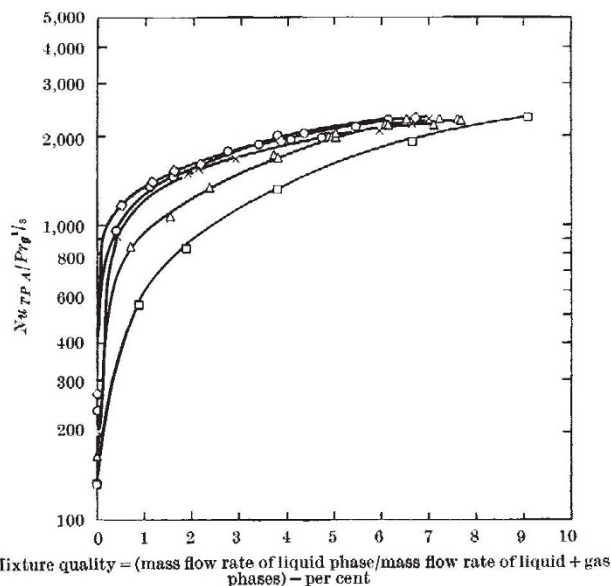


Fig. 2. Variation $Nu_{TPA}/Pr_g^{1/3}$ based on the physical properties of the gas phase with the mixture quality and Re_g . Re_g : □, 29,000; △, 42,000; ×, 58,000; ○, 75,000; ◇, 95,000; $Re_g = \frac{\rho u \infty d_0}{\mu_g}$; $Nu_{TPA} = \frac{h_{TPA} d_0}{k_g}$.

The test section was about 20 cm square. It housed centrally, and in the horizontal plane, a constant heat flux probe on which the measurements of heat transfer rates were made. Details of this probe are given in ref. 3. In order to measure the variation in circumferential temperature the probe was located in such a fashion that it could be rotated.

Mixture qualities (q) were measured by means of an isokinetic probe similar in design to the device described in part (1) of ref. 4. For all tests reported, the variation in quality over the projected area of the constant heat flux probe was less than 5 per cent.

Fig. 1 shows the variation of the local heat-transfer coefficient, h_{TF} , with position around the cylinder and with mixture quality, q . Under all test conditions a liquid film was observed to form over the region of the tube between forward stagnation and separation. It is within this region, that is $\approx \pm 90^\circ$, from stagnation that the bulk of the heat transfer occurs. h_{TF} was determined from the difference in temperature between the locally heated tube surface and the unheated tube surface.

Fig. 2 shows the variation of average Nusselt number, Nu_{TPA} , with mixture quality and the Reynolds number, Re_g , of the gas phase. The Nusselt number as used here is calculated from h_{TPA} , the heat transfer coefficient based on the mean difference in temperature between the heated and unheated tube surfaces, the outer diameter d_0 of the cylinder and the thermal conductivity of the gas phase (k_g).

Clearly the addition of small amounts of atomized liquid brings about a substantial increase in the surface heat-transfer coefficient, the mixture quality being a more dominant parameter than the gas Reynolds number, Re_g . The maximum intensification measured, with respect to the dry gas value, was about seventeen times. This occurred at the lowest Reynolds number explored.

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