The present experiments are being extended to higher and lower saturation stresses, and correlated with observations of slip. The effects of orientation and temperature have also been measured.

D. F. WATT
R. K. HAM*

Department of Metallurgy and Metallurgical Engineering,
McMaster University,
Hamilton, Ontario.

* Present address: Materials Division, Central Electricity Research Laboratories, Leatherhead, Surrey.

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ENGINEERING

Wind Forces and the Proximity of Cooling Towers to Each Other

Gunn and Malik have recently suggested[1] that their results showing the effect of spacing on the drag of an array of spheres in a closed duct provide an explanation for the collapse of the Ferrybridge cooling towers. It is well known that the drag of a grid of bars or a screen in a wind tunnel increases rapidly as the solidity (that is, the blocked area over the total area) increases. The air passes through the grid as a series of jets and, crudely, it can be argued that the velocity in these jets varies as the solidity. Because aerodynamic forces increase as the square of velocity the drag of the grid will go up as the square of the solidity. For an array of spheres the solidity is $\frac{\pi}{4}(1+a)^{-2}$, where a is the gap in diameters between adjacent spheres; Gunn and Malik present results for a = 1·0, 0·5 and 0. Using this crude theory, over this range one might expect an increase in drag coefficient based on upstream velocity of some sixteen times.

However, Baines and Peterson[2] devised a more exact theory for the drag of grids. They equated $\frac{R}{\rho U^2}$, where R is the force on unit projected area, to $\frac{S}{2(1-S)^2}$, where S is the solidity. The shape of the bars and any Reynolds number effects are ignored. At high Reynolds numbers these effects are likely to be small in comparison with the effect of the wind tunnel blockage. The array of spheres tested by Gunn and Malik was twenty layers deep but because the spacing was small it will be considered as a single grid. Table 1 gives a comparison of the measurements of Gunn and Malik, at their highest Reynolds number of 2×10^3, with those predicted by the method of Baines and Peterson.

Table 1

a	S	$\frac{R}{\rho U^2}$ measured	$\frac{S}{2(1-S)^2}$ predicted
0	0·785	7·3	8·5
0·5	0·349	0·25	0·41
1·0	0·197	0·14	0·15

Thus, although Gunn and Malik's results are very interesting, they were to be expected. However, they bear little relation to the forces experienced on an array of cooling towers in an unconstrained airflow: indeed, if their results were relevant to groups of cooling towers, they would also be applicable to building complexes generally, and would imply wind loadings large enough to have caused failure of a great many of our major buildings and structures.

P. W. BEARMAN

Aerodynamics Division,
National Physical Laboratory,
Teddington, Middlesex.

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CHEMISTRY

Food from Coal-derived Materials by Microbial Synthesis

THE explosive increase in the world's population has been accompanied by an overall food shortage. New and increased supplies of food, especially high quality protein, are urgently needed. Earlier investigations have described the growth of micro-organisms on paraffins, synthetic liquid fuel ('Kogasin'), and petroleum fractions[1-3]. Recently, it has been found that micro-organisms convert petroleum or petroleum fractions to protein, vitamins, or amino-acids[4-14]. Because coal is a cheap fossil fuel and by far the most abundant source of readily available, fixed carbon, investigations were initiated to determine whether coal could serve as a source of high protein food.

This communication reports some results of an evaluation of a variety of coal-derived materials as growth substrates for micro-organisms. Emphasis was placed on liquid coal-derived fractions because of the possibility of extending the utility of fuels and chemicals from coal conversion processes. In general, we found that yields of growth on several coal-derived materials compared favourably with yields on pure hydrocarbons and on a petroleum-derived fraction.

The yeasts *Candida lipolytica* (strains 409, 409*A*, 409*B*), *C. tropicalis* 410, and six unidentified species of bacteria isolated from soil by enrichment culture were used as test organisms. The basal growth medium (*p*H 7·0) contained 5·0 g ammonium nitrate, 2·5 g potassium monohydrogen phosphate, 1·0 g $MgSO_4 \cdot 7H_2O$, 0·1 g yeast extract per litre of tap water and to this was added, as the major source of carbon and energy, a weighed quantity of one of the substrates described here. Triplicate cultures (50 ml. of medium in 300 ml. Erlenmeyer flasks) were incubated at 30° C for 4–6 days (bacteria) or 6 days (yeasts) on a rotary shaker. The resultant growth was collected on tared solvent resistant membrane filters, washed free of residual substrate with acetone followed by *n*-hexane, and then dried and weighed. Yields were corrected for growth in triplicate controls without added substrate.

The following substrates were tested as major sources of carbon and energy:

Fischer-Tropsch synthetic liquid fuel fractions: FTL (boiling 0°–204° C), FTD (204°–316° C), and FTW (> 316° C) were Bureau of Mines products (iron catalyst); fraction SASOL (C_{11}–C_{20}, mainly C_{12}–C_{18}: 64 per cent paraffins, 33 per cent olefines; both mostly normal) was a product of the South African Coal, Oil, and Gas Corporation.

Low temperature tar fractions: HSF (a "hexane solubles" forerun with about 7 per cent phenols) and HSD (a "hexane solubles" distillate with about 12 per cent phenols) were obtained from the Texas Power and Light Company. These fractions constituted 7 and 46 per cent, respectively, of the primary tar from Rockdale lignite. Passage of fractions HSF and HSD through alumina provided hydroxyl-free fractions HSFφ and HSDφ (infra-red analysis). Paraffin-rich fraction CTP (88 per cent *n*-paraffins-C_8–C_{15}; 12 per cent normal α-olefines, C_{10}–C_{14}) and paraffin,