it is clear that optical properties of the examined materials should be considered when Born's method[6] is used to measure platelet aggregation.

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APPLIED SCIENCE

Wind Forces and the Proximity of Cooling Towers to Each Other

A REPLY[1] to a letter written by Malik and myself[2] on cooling towers and drag forces contains an error to which I wish to draw attention.

Our letter reported some measurements of drag forces on spheres supported in assemblages through which a fluid was constrained to flow. The measurements were represented as the variation of the drag coefficient for a single sphere in our assemblage with the particle Reynolds number, and the well known relationship for the isolated single sphere was included in the graphs as a comparison. Unfortunately, Bearman misread the results as the drag coefficient for unit projected area across the whole assemblage, and quoted a simple application of Torricelli's law to show that our results could be explained by consideration of momentum changes in an ideal fluid. As the assemblage was twenty layers deep, a twenty-fold error was generated, so that Bearman's table for the drag coefficient related to unit projected area for the assemblage should read

Table 1

a	S	$R/\varrho U^2$ (measured)	$\frac{S}{2(1-S)^2}$ (predicted)
0	0·785	146	8·5
0·5	0·349	5·0	0·41
1·0	0·197	2·8	0·15

It would have been surprising if such a theory were to describe the results of the complex fluid–solid interactions found in flow through assemblages of solids, although one could produce a better agreement than that shown in Table 1 by reformulating the assumptions in the light of the experimental results.

We have since published a full account of our experimental results[3].

In the latter part of his letter Bearman suggested that our inferences concerning the increase of drag forces on objects caused by proximity did not apply to objects in unconstrained airflow. This is a point which merits some discussion because the proper resolution may be useful in designing experiments to give reliable drag coefficients for groups of bodies.

It is a matter of common experience that in conditions of unconstrained airflow around groupings containing large numbers of bodies, the hydrodynamic resistance of the bodies can so resist penetration of air flow that drag forces on bodies in the centre of the grouping may be very small. For example, conditions inside a forest are still, even in strong winds. Shallow groupings, however, such as the Ferrybridge cooling towers, are much more susceptible to wind penetration, and it is certainly possible that the difference between drag coefficients measured in constrained and unconstrained conditions of airflow will be small at lateral spacings similar to the cooling towers, although one acknowledges that the difference will increase sharply for very small lateral separations. There is some experimental evidence of increase in drag coefficients of the order of 50 per cent for a sphere in proximity to one other in conditions of unconstrained flow[4].

Wind penetration into shallow groupings of bodies will also be affected by the scale of turbulence of the atmospheric flow field (or the distance over which the field is correlated). If the distance over which the flow field is correlated is comparable with, or smaller than, the dimensions of the grouping, one would expect a degree of wind penetration rather greater than found during steady flow.

A further effect of unsteady flow comes to mind from the extensive work of Lunnon[5], who investigated drag forces on spheres accelerating through fluid. He found that the force acting on an accelerating body was greater than that experienced by the same body in steady conditions at the same velocity, the difference increasing with acceleration.

The report of the committee of inquiry[6] attributed most of the blame for the failure of the Ferrybridge cooling towers to structural weakness arising from a misinterpretation of the results of wind tunnel tests on isolated towers. Wind tunnel tests on groupings of towers were commissioned, and one may calculate from the table on p. 10 of the report the ratio of drag forces experienced by tower 1*A* (in the centre of the grouping) to that experienced by an isolated tower as $(84\cdot3/74\cdot6)^2 = 1\cdot28$, an increased force that is obviously significant particularly when it is borne in mind that but for the diversionary effect of the station buildings on the wind flow the measured increase would probably have been larger.

The results of wind tunnel tests can presumably be relied on to be accurate indications of real conditions only if the conditions measured are related to atmospheric turbulence. In the absence of specific wind tunnel tests on groups, the remarks on wind penetration into groups of bodies suggest that it is not unreasonable to assess the effects of proximity of bodies, in such groups as the Ferrybridge cooling towers, as though the flow were constrained. The results of our experiments show that at interbody spacings similar to that of the Ferrybridge group one would expect an increase in drag forces because of proximity of about 90 per cent—probably something of an overestimation, yet perhaps not very different from the increase that would be experienced by a central tower in a Ferrybridge group without the station buildings.

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Intensive Beef Production from Molasses and Urea

AN important problem in many underdeveloped countries is the shortage of protein, particularly animal protein. This is rarely because the animal population is small, but rather because of the poor productivity which results from the dependence on forages and pastures characterized by low energy availability.