

Bacon and Descartes, though themselves creative thinkers, apparently misunderstood the true nature of creative work. Both seem to have missed the point that scientific discovery is primarily a matter of intuition, that is to say, it is an art. The most essential feature of a creative scientific thinker, Prof. Beadle insists, is his power of imagination and intuition; and knowledge and experience, such as can be got from formal education, are the background from which spring those imaginative flights which are the essence of scientific discovery. He suggests that the greatest single need for the scientific development of Uganda is that the young children should be encouraged, more than they are, to play and experiment. It is the task of the schools to preserve the experimental and imaginative outlook and to protect it against the pernicious influence of examination syllabuses; and it is the task of the universities, the demands of which determine so much the teaching syllabuses in schools, to frame their demands so as to encourage the schools to teach real science, and also to send them teachers who really understand what science is.

### EFFECT AT GROUND-LEVEL OF GAS FROM A CHIMNEY-STACK

THE determination of the maximum concentration at ground-level of gas emitted from an industrial chimney-stack is an important problem in the application of meteorology to health. Sutton<sup>1</sup> showed that the concentration at ground-level downwind from the chimney of gas at the same temperature as the surrounding air drifting out of the top rises to a maximum with distance from the chimney and then falls off. He gave a formula for the maximum concentration in terms of wind speed, height of chimney, the atmospheric turbulence coefficients and the atmospheric stability. Usually, the gas is hotter than the surrounding air, and has an appreciable vertical speed at the top of the chimney. Both factors cause the gas plume to have a vertical component of speed for some distance from the chimney. The centre line of the plume gradually bends over to become horizontal along the wind at a great distance from the stack.

Recently, Dr. A. C. Best<sup>2</sup> has examined, with the view of helping the stack designer, the relative merits of the following three formulæ for finding the maximum concentration at ground-level of gas from a heated elevated source: (a) an extension of Sutton's 'cold' gas formula; (b) a theoretical one due to Bosanquet, Carey and Halton<sup>3</sup>; and (c) an empirical one suggested in the United States at the Atomic Energy Station, Oak Ridge<sup>4</sup>. Sutton's 'cold' gas formula is applied to the 'hot' gas problem by replacing the chimney by one at a height greater by a length proportional to  $u^{-3}$ , where  $u$  is the wind speed. Dr. Best shows that the other two formulæ are equivalent to treating the problem in the same way but with additional heights, for (b) proportional to  $u^{-2}$  (approximately) and for (c) to  $u^{-1}$ . He calculates the maximum values of concentration of gas at ground-level for various realistic values of wind speed, height and diameter of chimney, and rate of heat output by the chimney relative to the surrounding air, for example, speed of efflux 5 and

15 m./sec., diameter 5 and 10 m., heights 50, 100 and 200 m., and heat output  $10^5$ – $10^8$  cal./sec.

Formulæ (a) and (b) give values with ratios mostly nearly unity and with a maximum of 1.66, and formulæ (b) and (c) give ratios twenty-five of which were less than 2, thirty-eight less than 3, and with the greatest ratios 4.3, 5.6 and 6.4 occurring only for the somewhat abnormally great stack height of 200 m. The results apply only to occasions of a small fall of temperature with height. An inversion above the chimney would make the concentration at ground-level markedly greater. Formula (c), which is

$$\text{maximum concentration (mgm./m.}^3\text{)} = \frac{9 \times 10^6 Q}{h(14 vd + H)}$$

where  $Q$  is strength of source in lb./sec.,  $h$  height of stack (ft.),  $v$  speed of efflux (ft./sec.),  $d$  diameter of stack (ft.), and  $H$  rate of heat output relative to the surrounding air (B.Th.U.), gave the greatest values for the worst conditions of low height, small speed of efflux and low heat output. For this reason, and also because it is the simplest to use, Dr. Best suggests the Oak Ridge formula is the most suitable one for the stack designer.

<sup>1</sup> Sutton, O. G., "Micrometeorology", p. 292 (London, New York and Toronto: McGraw-Hill, 1953).

<sup>2</sup> Best, A. C., *Mel. Mag.*, **84**, 297 (1955).

<sup>3</sup> Bosanquet, C. H., Carey, W. F., and Halton, E. M., *Proc. Inst. Mech. Eng.*, **162**, 355 (1950).

<sup>4</sup> Rep. U.S. Atomic Energy Comm., Oak Ridge, Tenn., No. ORO-99 (1963); formula also quoted in Rep. Comm. on Air Pollution (Cmd. 9322), (London: H.M.S.O., 1954).

### NEW NATURE RESERVES IN ENGLAND

THE Nature Conservancy has recently established two new nature reserves—Fyfield Down, Wiltshire, and Westleton Heath, Suffolk—and in addition has acquired further land for the existing nature reserve of Yarner Wood, Devon.

Fyfield Down is one of the finest remaining tracts of unreclaimed high chalk downland in England and is probably the richest in sarsen stones, locally known as 'grey wethers', from their resemblance when seen in the distance to a flock of sheep. It is probable that the great 20-ft. sarsen stones in the circle at Avebury (weighing about 60–70 tons) were brought there from Fyfield Down nearly four thousand years ago to form the oldest important structure in Britain and one unique in Europe. Being close to Avebury, the new reserve is within one of the principal areas inhabited by prehistoric man, and the Celtic field system is one of the largest in England. There is a tumulus to the south of the fields and two others along the western boundary formed by the Ridge Way, which at this point crosses another ancient track known as the Herewith. There are also remains of an ancient village along the 700 ft. contour, the highest point on the reserve being about 830 ft. The sarsens are large blocks of sandstone apparently derived from a bed of sand which covered the site in Eocene times. Their distribution is considered to be natural, none having been erected as standing stones. They produce an effect of great botanical interest, being accompanied by pockets of acid soils, on which grow acid-loving plants such as sheep's sorrel. This is in contrast to the ordinary lime-loving plants of downland; meadow saxifrage (*Saxifraga granulata*)