DUST IN INDUSTRY

CONFERENCE AT LEEDS

ABOUT two hundred delegates attended the Conference on "Dust in Industry" which was organised by the Society of Chemical Industry and held at the University of Leeds during September 28–30. The papers presented during the five sessions of the Conference covered a wide range of subjects and showed how dust problems enter into almost every major industrial process.

After a civic welcome by the Lord Mayor of Leeds, the delegates proceeded to the business of the first session under the chairmanship of Prof. H. V. A. Briscoe. Under the general title of "The Physical Characteristics and Estimation of Dust" the following four papers were presented: "Problems on the Design of Plant Handling or Producing Dust", by G. Nonhebel: "A Rapid Method of Dust Estimation in Iron and Steel Foundries", by B. W. Lawrie; "Dust Hazards in the Explosives Industry", by Prof. W. M. Cumming, Dr. F. Rumford and Dr. W. G. D. Wright; and, finally, "Particulate Clouds in the Gas Industry", by E. H. M. Badger.

Mr. Nonhebel made a broad survey of the processes in the production or control of fine particles. From his review of the factors concerned in such operations as grinding and classification, the separation of dusts from gases and liquids, mixing, aggregation and the size analysis of dust samples he pointed out the lack of knowledge in this field and the vast amount of fundamental work which is needed before the design of plant for such purposes can be established on a sound scientific basis.

Mr. Lawrie described a quick method of dust estimation suitable for survey work in iron or steel foundries or other industries where the dust concentrations encountered are so great that counting of samples taken by the thermal precipitator is frequently impossible. In brief, samples collected by the thermal precipitator or by the Owens jet counter are photographed on a projection microscope and compared visually with a standard scale of dust concentrations. While admittedly this method gives only an estimate of the dust concentration, it is claimed that it is entirely adequate for comparing the efficiency of dust control systems and that it gives as good an indication as may be obtained of the health risk in an industry. This work has shown, incidentally, that more accurate estimates of thermal precipitator slides can probably be made by counting a photographic record rather than by the usual direct visual count.

Prof. Cumming discussed the three main dangers of excessive dust concentrations in explosives factories —ignition, health hazards from contact or by inhalation of the dust, and dermatitis. Trinitrotoluene and tetryl show all these three dangers to a greater or lesser extent. He described a simple photo-electric method used for measuring the relative 'dustiness' of explosives, and also gave an account of colorimetric methods devised for estimating the concentration of airborne dinitrotoluene, trinitrotoluene and tetryl sampled by the standard D.S.I.R. pump. Trinitrotoluene and tetryl are absorbed in a mixed solvent of methyl ethyl ketone and *cyclo*hexanone containing a little potassium hydroxide, and estimated by comparison with standard colour disks.

Mr. Badger described how, in the separation of dust from producer-gas, trouble was experienced with the formation of stalactitic growths across the electrostatic precipitator plates. The difficulty has been overcome by the evaporation of a small amount of tar oil into the gas. This condenses and forms a liquid film around the dust particles, rendering the deposit fluid enough to run off the plates. Removal of much tar fog from gas takes place in the exhausters; but particles of above a certain critical size only are removed. The tendency for spontaneous condensation, producing small droplets, can be minimized by mixing pre-cooled gas with the main gas stream, thus introducing nuclei for condensation. A portable electrostatic precipitator used during this work was described.

The discussion centred around Mr. Lawrie's paper. The chief criticism of his method was that it does not differentiate chemically between the particles present in foundry dusts. The health hazard is primarily dependent on the silica content and not on the total dust count. The suggestion that it is a quick method suitable for use in dust surveys was endorsed by several speakers.

The second and third sessions, under the chairmanship of Dr. Julian M. Leonard and Mr. A. V. Hussey, were both devoted to "Practical Aspects of the Dust Problem". The four papers given during the second session were "Some Methods of Reducing Contact with Dusts in Chemical Manufacture", by L. Marsden, G. W Robertson and Dr. R. A. Storey; "The Problem of Dust in the Chemical Industry", by G. Lowrie Fairs and E. Godfrey; "The Problem of Dust in the Cotton Industry", by Dr. D. W. Hill; and "Some Practical Methods of Industrial and Atmospheric Dust Elimination", by J. H. Hellyer and J. Cleeve.

Dr. Storey considered means of preventing the formation of, and removing, air-borne dust at its origin in a variety of unit operations involving the charging, processing and discharging of dry materials. He suggested that dealing with the problem in this way is preferable to applying individual protection for each operator.

Mr. Lowrie Fairs divided dust problems into three types and suggested means of dealing with each of them: (*a*) where dust produced at one stage may interfere with later stages in a process; (*b*) where escape of dust causes atmospheric nuisance; and (*c*) where atmospheric dust entering a plant may cause contamination of a product. The possibility of obtaining large flows of sterile air by filtration through 'Stillite' blocks was mentioned.

Dr. Hill reviewed the causes of dust production in the cotton industry and the problems arising therefrom. Operatives are liable to suffer from a respiratory disease known as byssinosis after long exposure to the dust liberated during the opening and carding operations. Little is known about the active agent in the dust, but it is evidently to be found in the finer fractions and may be histamine, lipoids, fungi or proteins which are potential allergens. The problem is one of removing the harmful dust without contravening strictly defined conditions of temperature, humidity, freedom from strong draughts and adequate access to machines.

Mr. Hellyer reviewed modern apparatus for the collection of dust from industrial gaseous effluents and for the cleaning of atmospheric air during conditioning. He dealt most fully with the design, operation and characteristics of electrostatic precipitators. A recent type, the 'Precipitron', was designed for air-conditioning plant. Ionization takes place in this precipitator at a potential of 14 kV. and

collection at 7 kV. Ionizing wires and charged plates are both positively charged, rendering ozone formation very small. A blackness test, using filter-paper disks, was described for measuring efficiencies. Numerous photomicrographs of industrial dusts were shown.

Points raised during the discussion on this session included the possibility of using oil treatment of the cotton during carding, recent experiments having shown very promising results. The high installation costs and the apparent drop in efficiency with time of electrostatic precipitators were mentioned by several speakers.

The three papers presented during the third session were "Practical Aspects of the Dust Problem, with Particular Reference to Flour Milling", by Leslie Smith; "The Dust Problem in the Photographic Industry", by R. G. R. Carnall; and "Surface Area in Dust Control", by P. J. Rigden.

Mr. Smith outlined present-day practice in dust control in flour-milling processes. High-speed exhaust systems with metal trunking and suction-type fabric filters are favoured. Current trends towards pneumatic conveyance of mill stock may necessitate installing complete air-conditioning plant.

Mr. Carnall presented the unique problem of preventing dust particles from reaching surfaces which could not be better designed to hold them. The solution lies in segregating dirty and clean work, providing special clothing for personnel and paying special attention to their health, forbidding the use of cosmetics and ointments, and using machinery as fully automatic and instrumented as possible. Bag filters, or the new 'Airmat' cellulose-wool filters, are used for air filtration because of their great reliability over long periods. Means of identifying dust particles embedded in photographic emulsions were described and illustrated by many photomicrographs.

Mr. Rigden described a method of measuring the surface area of dust samples, based on the well-known air-permeability method, but requiring samples of only 50 mgm. The pressure drop across beds of powder of sufficient length for accurate measurement is very high and necessitates special methods of measuring the flow of air. Direct weighing of air flowing through the bed into an evacuated bulb and the rise in pressure in such a bulb are the two methods used. Good reproducibility and agreement between the normal method using 10-gm. samples and the new method are attained.

Discussion during the third session showed particular interest in the methods used for dust suppression in the photographic industry. Many questions of detail were asked regarding the effect of sneezing and use of handkerchiefs and the precautions necessary during maintenance and overhauls.

The fourth session, which dealt with "Fire and Explosive Hazards", was held on the afternoon of September 29 under the chairmanship of Lieut.-Col. Sir Reginald Thomas. Six papers, which divided themselves naturally into three groups by their subject-matter, were presented, and discussion took place after each group.

The first two papers were "The Lower Inflammable Limit of Explosive Dusts and the Influence of Diluents Thereon", by Dr. J. E. Garside; and "Gas Explosions and Dust Explosions, a Comparison", by Elwyn Jones and A. Grenville White.

Dr. Garside described a method of determining the lower limit of inflammability of dust–air mixtures. The dust is dispersed by violently displacing into the explosion vessel a felt pad supporting the dust from a lead tube down which a detonation wave is injected from an exploding air–gas mixture. The method is used to show how the lower limit varies from material to material, is dependent on the grain size of the dust, and can be raised to a safe value by mixing inert powders, such as limestone, with the dust.

Mr. Jones maintained that flame propagation in dust explosions as well as in gas explosions is a thermal process capable of interpretation in terms of calorific value of the mixture. Impossibility of obtaining a perfect mixture of solids and gases complicates combustion in dust explosions. It seems that, at lower limits, solid particulate fuels are capable of forming local centres of ignition and propagation. An important factor in this process may be the volatility of the fuel. An appendix described an apparatus for determining limits of inflammability, which largely removes the influence of settling-rate of the dust.

In the discussion doubts were expressed about the validity of the results obtained in a laboratory-scale experiment when applied to large-scale explosions, and on the possibility of obtaining an accurate figure for the concentration of dust at the time of explosion.

The second group of papers comprised "The Ignition of Dust Clouds by Electrostatic Discharges", by Prof. E. G. Cox and A. G. Peace; and "Coal Dust Explosions. Recent British Experiments", by Dr. F. V. Tideswell.

Prof. Cox, describing work done during the Second World War, showed that many dust clouds might be ignited by electrostatic discharge. The incendivity of a spark depends upon its characteristics, and such a spark has an optimum incendivity when in series with a resistance of value depending on the capacity being discharged. Thus a discharge from a movable bin or from operatives which are badly earthed or from a charged body to an imperfectly earthed conductor is very liable to cause dust explosions.

Dr. Tideswell stressed the real danger of explosions due to coal dust not only in mines but also in pulverized fuel plants. Some amelioration of the danger in mines is to be expected from the increase in wet-cutting and the spraying of coal in tubs and at loading points. Powdered hydrates such as gypsum are more effective in suppressing dust explosions than shale dusts, and their use would increase the margin of safety given by the statutory stone-dusting requirements. Work is proceeding on specially free-flowing stone dusts which will be easier to apply continuously.

The final two papers of this session were "Explosion Reliefs on Dust Plant", by Dr. D. Matheson; and "Precautions Against Fire and Explosion" by G. V. Thom and G. A. V. West.

Dr. Matheson said that in the present state of knowledge the safest thing to do is to build a dust plant strong enough to withstand full explosion pressure, or place it where it can blow up without causing other damage. Work now proceeding should enable explosion reliefs to be designed which will safeguard existing types of plant from bursting through internal dust explosions.

Mr. G. V. Thom presented a very full survey of the explosion and fire hazards met with in chemical industry. He stressed the importance of properly maintaining fire-fighting appliances and of instructing personnel in their use.

A report of the proceedings of Section V of this Conference has already appeared in *Nature* (January 15, p. 111).