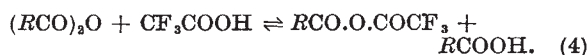


very marked rise in conductivity, which, although it still remained quite small, was much too large to be due to the trifluoroacetic acid formed according to equations 1 and 2, and was slightly greater than could be accounted for by the two molecules of acid formed as in equation 3.



It should be noted that, for the acylation of hydroxy-compounds<sup>8</sup> and of anisole<sup>9</sup>, the carboxylic acid-trifluoroacetic anhydride mixture may be replaced by one consisting of a carboxylic anhydride and trifluoroacetic acid. For use in a general method of acylation the latter mixture is less convenient, for it entails the preparation of each individual carboxylic anhydride; however, it does possess the advantage that a stoichiometric amount of trifluoroacetic acid is not required. As will be seen from equations 4 and 5, the trifluoroacetic acid which is utilized in the formation of the unsymmetric anhydride is regenerated when this anhydride reacts, for example, with an alcohol ( $R'\text{OH}$ ). In support of the theory that the unsymmetric anhydride is an intermediate in this reaction, we have shown that aniline reacts with a mixture of acetic anhydride and trifluoroacetic acid to form both acetanilide and trifluoroacetanilide<sup>5</sup>.



From the above evidence, it will be seen that there is strong factual support for our hypothesis concerning the mode of reaction between weak oxy-acids and trifluoroacetic anhydride. Since this support has been drawn from experiments in which the oxy-acid is of either the carboxylic or sulphonic type, it should not be assumed that other oxy-acids do not react in a similar fashion. Indeed, it has already been shown in these laboratories that trifluoroacetic anhydride promotes the formation of phosphate esters from phosphoric acid derivatives, of nitrate esters and nitro-compounds from nitric acid<sup>6</sup>, and of nitro-compounds, nitroso-compounds and diazonium salts from sodium or amyl nitrites<sup>8</sup>. All these reactions, details of which will be published later, can be explained satisfactorily on the basis of equations 1 and 2.

We are greatly indebted to Prof. M. Stacey for his interest in this work, to Imperial Chemical Industries, Ltd. (General Chemicals Division), for part of the trifluoroacetic acid used, and to the Department of Scientific and Industrial Research for a grant towards the expenses. [June 26.]

<sup>1</sup> Stacey, M., Bourne, E. J., Tatlow, J. C., and Tedder, J. M., *Nature*, **164**, 705 (1949).

<sup>2</sup> Bourne, E. J., Stacey, M., Tatlow, J. C., and Tedder, J. M., *J. Chem. Soc.*, 2976 (1949).

<sup>3</sup> Bourne, E. J., Stacey, M., Tatlow, J. C., and Tedder, J. M., *J. Chem. Soc.*, 718 (1951).

<sup>4</sup> Bourne, E. J., Pettit, M. R., Stacey, M., Tatlow, J. C., and Tedder, J. M. (unpublished results).

<sup>5</sup> Bourne, E. J., Henry, Mrs. S. H., Tatlow, Mrs. C. E. M., and Tatlow, J. C. (forthcoming publication).

<sup>6</sup> Emery, A. R., and Gold, V., *J. Chem. Soc.*, 1443, 1447, 1455 (1950).

<sup>7</sup> Morgan, P. W., *J. Amer. Chem. Soc.*, **73**, 860 (1951).

<sup>8</sup> Bourne, E. J., Stacey, M., Tatlow, J. C., and Tedder, J. M. (forthcoming publication).

<sup>9</sup> Newman, M. S., *J. Amer. Chem. Soc.*, **67**, 345 (1945).

## THE ELECTRICAL RESEARCH ASSOCIATION

**D**URING October 10-12 the laboratories at Perivale of the Electrical Research Association were open for general inspection by some seven hundred members of the Association and others interested in its work, this being the first time they had been on view since the official opening by the late Duke of Kent in 1935. Some of the researches of the intervening years were exhibited, though the emphasis was naturally on current work. In view of the limited size of the Laboratories themselves and of the Association's income the range of exhibits was noteworthy, and the exhibition may be expected to expedite the provision of improved facilities in the Association's accommodation at Leatherhead.

Of necessity, the presentation conformed with the organization of the Association's researches into switch and control gear, surges and transformers, insulating materials, transmission and utilization, rural electrification and wind power, space and water heating, ignition and the welding arc. In addition, the important work carried out extra-murally on magnetic materials, power plant materials, meter bearings, and electrical discharges in gases was also displayed, though necessarily in a less complete manner.

A series of introductory displays were shown which aimed at summarizing aspects of the Association's work that cut across the organizational divisions. These dealt with the important parts played by the Association in the fields of national and international co-operation, standardization, and in the study and developments of materials (including a separate exhibit on electrical discharges in gases). Other displays outlined the contributions made in education, instrumentation, earthing and the application of mathematical methods, while another indicated the valuable facilities which the library and information bureau offers to members.

*Switch and Control Gear.* A striking exhibit in this field was a display illustrating the genesis, development and industrial applications of two basic principles of arc extinction, namely, the axial air-blast circuit-breaker with a short, fully scoured arc-gap and the oil-filled, side-blast baffle pot, which have formed the basis of nearly all modern switchgear development in Great Britain.

Most of the present work is of a fundamental character and was well illustrated by the demonstration of the oscilloscopic, stroboscopic and spectroscopic study of low-power arcs in hydrogen, which has clarified the phenomena observed at much higher powers, and by the photographic study of arc form and movement in an axial air-blast circuit-breaker. A semi-commercial axial gas-blast breaker is being used for studying the aerodynamics of arcs in high-speed gas flow, and *Schlieren* pictures of the shock waves in cold gas flow in a nozzle were demonstrated.

Since the electrical characteristics of the circuit of which the breaker forms a part influence its operation, another display illustrated the results of a survey of the restriking voltage characteristics of British high-voltage networks.

A bridge-connected fuse of novel design giving improved performance, and a miniature electro-magnetic pressure-recorder were features of the fuses laboratory. Work on contactors, air-break switch-gear and flameproof electrical gear was also displayed.

*Surge Phenomena.* The study of surge phenomena has, as its main objective, the increased reliability of overhead transmission systems during thunderstorms. The work includes the collection of data on the occurrence of thunderstorms, the correlation of these with data on lightning faults supplied by the area electricity boards, measurement of lightning currents, the effects of lightning on insulators and substation plant, and the study of all problems associated with methods of protecting against lightning.

Demonstrations included the calibration of magnetic links (surge current indicators), the distribution of various types of surge in transformer windings, detection of transformer faults due to surges, protection of a transformer by a surge filter, and the protection of a wooden stay insulator by an air gap. Most of the recording apparatus was designed and constructed by the Association, a notable example being an automatic, three-element oscillograph for continuous recording on lines operating at voltages up to 132 kV.

*Transformers.* The investigation in the Association of transformer problems, other than those associated with surge phenomena, is of comparatively recent growth, but already it includes transformer noise, the experimental investigation of mechanical forces, the general study of temperature distribution, the application of the capacitor transformer to the measurement of very high transmission voltages, and various problems associated with parasitic losses. Demonstrations included investigations of mechanical forces and of temperature distribution in experimental transformers.

*Transmission and Utilization.* The great use made nowadays of model and analogue techniques was illustrated by a pilot network analyser suitable for steady-state and transient solutions and incorporating novel features leading to low cost and versatility, and by a model high-voltage D.C. transmission system. This has yielded important information on starting, operation and protection, which will undoubtedly facilitate progress with a pilot full-scale project, when the necessary resources are marshalled.

A diagram entitled "Control of Radio Interference" summarized the work in a field in which the Association is widely recognized as an authority, and interference measuring sets and examples of suppression components were exhibited.

The detection of incipient failure in insulation provided an interesting example of the logical development of a method of assessment of a property not itself measurable, through the following stages: study of the material for the selection of an associated measurable property, construction of precise equipment for measurement in the laboratory, and, finally, reduction to a portable and simple instrument for field use.

The sensitive recording magnetometer, now used for measuring small changes in the earth's magnetic field to permit ionospheric predictions, is a modified form of the magnetic bomb and mine locator developed during the Second World War.

*Dielectric Materials.* The majority of the exhibits in the section on materials illustrated various mechanisms of electrical breakdown, a subject to which the Association has made very great contributions. Ionic discharge within voids in insulation were shown by an artificial transparent cable, with a series of oscillograms, electrophotographs and photomicrographs demonstrating the behaviour of the discharges and the nature of the microscopic breakdown paths which they erode in insulation.

Electrochemical reactions due to leakage currents through materials have only recently been recognized as an important factor in breakdown. Tests were in progress on insulation 'stabilized' against such reactions by the addition of hydrogen-accepting compounds. Other electrochemical work included a study of ionic exchange reactions in paper as a means of reducing its electrical conductivity, and an investigation of reactions in electrolytic capacitors. Several compounds were exhibited, including long-chain paraffins, alcohols and ketones, which had been synthesized in the laboratory in connexion with the foregoing, or for investigations on the relation between crystal structure and dielectric behaviour.

Notable in this section was the wide range of physical methods which can be adapted to the study of electric properties. These included the development of photographic emulsions by electrolysis for detecting minute faults in insulation; the polarizing microscope applied to the study of molecular orientation in polystyrene; a vacuum torsion balance accurate to  $10^{-7}$  gm. in 0.1 gm. for the measurement of moisture sorption; X-ray diffraction as a means of identifying compounds or for following changes in their structure; apparatus giving hydrostatic pressures up to 1,000 atmospheres for the study of structural changes; and a high-temperature furnace adapted for single-crystal growth in connexion with the study of ferro-electric compounds.

Reports and published papers indicated the major contributions to the theory of the solid state (including a new theory of superconductivity) made by leading scientific workers in this sphere under the aegis of the Electrical Research Association.

*Magnetic Materials.* A selection from the large number of reports available illustrated the work done on sheet steel and permanent magnet materials. Important results were obtained from the work on sheet steel at Cambridge, now concluded, and its continuance on a larger scale is being considered. On permanent magnets, X-ray studies are being made at Cambridge with the fine-beam technique on precipitation states in iron-copper-nickel alloys and alloy phase structures. At Sheffield precipitation-hardening alloys of nickel, chromium, iron, etc., and the mechanism of hysteresis are being investigated. At Nottingham the Bitter powder technique is being applied to domain structure and formation, and was demonstrated on a magnetized crystal of cobalt. Co-operative research with member organizations of the Association on the commercial production of permanent-magnet materials, including crystals, has led to the development of magnetic bodies with remarkable properties.

*Power-Plant Materials.* To improve generating efficiency in steam power stations, higher temperatures and pressures are being used, and the Electrical Research Association, jointly with the British Iron and Steel Research Association, supports an extensive investigation at the National Physical Laboratory on the creep and corrosion resistance of steels under these conditions. Corresponding extensions of the steam tables are naturally essential, and the Electrical Research Association, having sponsored the development of the Callendar tables from the start, has put in hand a further extension. The general nature and results of this work were illustrated by diagrams and specimens. It has been estimated that, as a result of twenty years of research and development, the increased efficiency of generation results in an annual saving of 18.5 million tons of coal.

*Rural Electrification.* Practical, rather than fundamental, problems are met with in the applications of electricity to agriculture, stress being placed always on the attainment of low electric loading and high load factor. The exhibits demonstrated how these essentially economic aims have been achieved in various aspects of soil- and space-heating and crop-drying by electrical methods.

*Electric Power from the Wind.* Photographs illustrated the type of hill usually found suitable for wind-power sites, on which studies of wind regime and wind structure have been made. The model wind-generators exhibited included one of the 100-kW. pilot plant now erected on Costa Hill, on the Orkney mainland.

*Space- and Water-Heating.* The work deals with the fundamental side of problems arising from the use of electricity for space- and water-heating, mainly from the domestic aspect. The major current research is an all-round study of the heat pump. One small installation using static water as a heat source is in operation at Perivale, and other work on heat sources such as the earth is in progress. A model house was on show which could be operated to show the possible saving effected during transient warming periods by the use of reflecting wall papers.

*Ignition Research.* Investigations on the electrical equipment of vehicles, including novel types of sparking plugs and the suppression of radio interference, constituted an important contribution to the national effort during the Second World War, and this work has continued with the support of the Ministry of Supply. A major aspect is the study of ignition by electric sparks, and this is also of considerable interest to the Safety in Mines Research Establishment of the Ministry of Fuel and Power, which maintains close liaison with the Association.

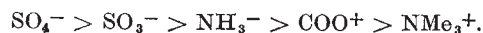
A high-speed single-transient oscillograph, giving a temporal resolution of  $10^{-9}$  sec., has been developed by the Association for these researches and is being extensively used.

*The Welding Arc.* The detailed investigation of ferrous welding arcs was recently interrupted so that a study might be made of a.c. argonarc welding of non-ferrous metals. The result has been the development of a surge injector which maintains the arc with an a.c. r.m.s. voltage of less than 50, and is free from radio interference.

## RHEOLOGY OF FILMS AND SURFACES

THE annual conference of the British Society of Rheology was held jointly with the local section of the Chemical Society at the Washington Singer Laboratories of the University College of the South-West of England, Exeter, during September 27-29. The conference was opened by Prof. H. T. S. Britton and by Dr. G. W. Scott Blair, president of the Society. On the afternoon of September 28 a visit was arranged to St. Mary's Abbey, Buckfast, when Brother Adam demonstrated the thixotropic breakdown and other rheological properties of honey in production processes. Papers were read by B. A. Pethica and by J. H. Schulman and M. Z. Dogan (Department of Colloid Science, Cambridge) dealing with the properties of insoluble monolayers at an air/water interface in the presence of some soluble long-chain electrolytes of strong activity. Com-

parison of the Langmuir isotherms for penetration of liquid-condensed chloesterol with a series of straight-chain  $C_{12}$  compounds has shown that the polar head group specificity falls off in the order:



In the case of the interaction of saponin with condensed chloesterol, where a stoichiometric complex is formed, the penetration isotherm shows a transition corresponding to the formation of a two-dimensional solid film. The areas of the saponin show a corresponding change in the transition zone.

Studies have also been made of the penetration of myristic acid by dodecylamine hydrochloride and of the properties of protein films in the presence of electrolytes in relation to the tanning industry. Prof. F. H. Garner and Dr. C. W. Nutt (Department of Chemical Engineering, Birmingham) read a paper on cybotactic phenomena at interfaces, describing experiments on the movement of droplets in viscous media. Evidence on the molecular orientation into a quasi-crystalline structure was discussed in its relation to chemical engineering phenomena, for example, mass transfer across interfaces.

E. Eisma (Netherlands) described experiments on the rheological properties of interfacial films on water. For films of high yield-stress and small viscosity the rotating disk method is suitable, while in the case of purely viscous interfaces the torsion oscillation method has an advantage.

Under the chairmanship of Prof. M. Reiner (Haifa), K. V. Shooter (Research Laboratory for the Physics and Chemistry of Surfaces, Cambridge) described the mechanism of boundary lubrication at light loads taking into account the pressure-dependence of viscosity of oil films. H. J. Bezer and Dr. R. Schnurman (Manchester Oil Refinery) discussed experiments with extreme-pressure lubricants using a four-ball apparatus of the Boerlage type. There was no evidence for a defined 'breakdown load' of a lubricant. An energy balance would appear to allow for an appreciable proportion, up to 10 per cent, of the mechanical energy to be available for the separation of electrostatic charges.

At another session, with Dr. R. N. Saal (Netherlands) in the chair, C. C. Mill (Printing and Allied Trades Research Association) spoke on the rheology of printing, mainly of letterpress and lithographic processes, the photogravure process being fundamentally different and generally simpler rheologically. There was a discussion on the significance of the phenomenon of parallel ridge formation in the ink film on rotating rollers in contact. M. R. Hopkins (British Iron and Steel Research Association) spoke on the mechanics of the coating of steel sheet with molten tin between rollers. A mathematical investigation based on arguments similar to those used in the theory of lubrication gives a relation between the coating thickness and the relevant variables for a single pair of rollers. This relation was found to be in accord with experimental results obtained with a sheet of nickel foil emerging from a bath of oil through a pair of polished stainless-steel rollers under precise conditions of test. A. de Wael and G. L. Lewis (Gestetner) read a paper on the electrical behaviour of oil-pigment dispersions. They have found that a dispersion with electrically conducting particles behaves differently according to the state of flocculation, whereas with non-conducting particles there is little difference. Conductive systems do not seem to obey Ohm's law. It is possible to correlate the