instinct in the past for being right in his engineering judgments. He may very well be right again on this issue of the pace of development of nuclear plant towards higher working temperatures. That part of his paper which deals with the further development of the Calder Hall type of station is of the greatest interest. The British commercial designs of graphite-moderated gas-cooled reactor have already gained a commanding lead over rival American designs for liquid-cooled reactors. It now seems probable that the gas-cooled reactor may also prove superior in its capacity for future development. Certainly no responsible engineer or scientist could quarrel with Sir Christopher's statement that "the technology of design is advancing so quickly that manufacturing provision must be laid down on the basis of forecasts; its provision cannot follow in the wake of technical development". J. M. KAY

OXIDATION OF PLANT PHENOLICS

INAUGURAL MEETING OF THE PLANT PHENOLICS GROUP

THE Plant Phenolics Group was inaugurated at a meeting held in the Department of Botany, University of Cambridge, on April 9. Dr. E. C. Bate-Smith, presiding, said that the idea of forming the Group originated from a succession of inter-laboratory symposia on tannins, hydroxyaromatic acids (see *Chemistry and Industry*, 478; 1956), etc., in plants, under the auspices of the Food Investigation Organization of the Department of Scientific and Industrial Research. These symposia attracted a diversity of interest not catered for by any single existing Society. The response received to the invitation to enrol in the Group is a clear indication of the need which is felt for an association to provide for these diverse interests. The enrolled membership numbers one hundred and twenty, and represents university laboratories, agricultural and forestry research institutions, food research laboratories, and various other industrial laboratories, in approximately equal numbers.

The objects of the Group were defined as "the advancement of the knowledge of the phenolic constituents of plants in respect of their function, biosynthesis, the effect on plant and animal physiology and pathology, and the application of such knowledge in industry and agriculture".

A provisional committee was elected as follows: Dr. E. C. Bate-Smith (Low Temperature Research Station, Cambridge); Dr. H. G. Harvey (British Food Manufacturing Industries Research Association, Leatherhead, Surrey); Dr. D. E. Hathway (British Leather Manufacturers' Research Association, Egham, Surrey); Dr. A. C. Hulme (Ditton Laboratory, Larkfield, Maidstone, Kent); Mr. W. W. Reid (Carreras Limited, Stanhope Road, London, N.W.1); Dr. E. A. H. Roberts (Indian Tea Association, Lafone Street, London, S.E.1); Dr. T. Swain (Low Temperature Research Station, Cambridge); Mr. A. H. Williams (Agricultural and Horticultural Research Station, Long Ashton, Bristol). Dr. J. Friend (Low Temperature Research Station) was appointed honorary secretary of the committee, *pro tem.* (*vice* Dr. T. Swain, absent abroad).

The inaugural meeting was followed by a symposium on "The Oxidation of Plant Phenolics", with Dr. J. Barker (Cambridge) presiding.

In a paper on "The Oxidation of Phenols" Prof. R. D. Haworth (Sheffield) enumerated the several chemical mechanisms by which phenols may be oxidized. With persulphate or Fenton's reagent, hydroxyl groups may be added either in *ortho*- or *para*- positions; these changes are often accompanied by shifts of *p*-methyl groups and elimination of *p*-aldehydic groups. Thus the oxidation of *p*-cresol to form homogentisic acid. Elimination of hydrogen takes several forms: the production of *o*- or *p*-quinones; the formation of diphenyl derivatives or diphenyl ethers; or the formation of peroxides. The oxidation of gallate esters to ellagic acid is an instance of the first type. Slightly more complicated bimolecular oxidations lead to such compounds as Pummerer's ketone from *p*-cresol. The fusion of rings and the formation of C—C bridges can also lead to the morphine and apomorphine skeletons from phenyl*iso*quinoline.

The very common phenolic compounds derived from phenylpropylene can be oxidized in the side-chain to form bimolecular structures such as those found in the lignans. It seems highly probable that the group of substances known as lignins are built up on this plan. Oxidations involving rupture of an aromatic nucleus lead to the formation of tropolones such as purpurogallin, and compounds such as brevifolin carboxylic acid and chebulic acid may be formed as products of ellagic acid oxidation.

The paper on "The *in vitro* Oxidation of Plant Phenolics" by Dr. D. E. Hathway (British Leather Manufacturers Research Association) was concerned with the way in which such chemical mechanisms as those described by Prof. Haworth might be involved in the formation of the larger molecules found in plant tissues, and especially those found in tanning extracts. These are of two classes, the one based on gallic acid and its oxidation products, and the other based on catechin-like substances and their condensation products. Aerobic autoxidation of gallate esters leads to ellagic acid and humic acids, but oxidation catalysed by mushroom polyphenolase proceeds preferentially to ellagic acid. The coincidence in the recorded systematic distribution of gallic acid with that of ellagic acid suggests that in some cases at least the latter may arise by enzymic oxidation of the former.

Studies of the autoxidation of *d*-catechin and a number of methyl-substituted catechins by manometric and spectrophotometric methods confirm that the oxidation proceeds by way of a quinone stage, followed by intermolecular C—C linkage. The evidence suggests that the most likely linkage is between either the 6 or 8 carbon of one molecule and the 2′ carbon of the second. Such 'head-to-tail' linkages might take place progressively leading to large molecules of a phlobatannin nature. Autoxidation and polyphenolase (tobacco and potato) oxidation of catechin gave polymers which had the same elementary analysis and physical properties, and were closely similar in these respects to phlobatannins from *Uncaria gambir* (gambier) and *Acacia catechu* (cutch). Since both species contain catechin epimers, there is a strong supposition that the phlobatannins present in the tanning extracts are formed from catechins by oxidative condensation.

In dealing with "Polyphenolases as Respiratory Enzymes", Dr. W. O. James (Oxford) summarized the evidence in favour of the function of polyphenol-

ases as terminal oxidases in the respiration of plants under four heads.

First, polyphenolases are widely distributed throughout plants and are capable of catalysing the oxidation of most naturally occurring phenols; secondly, enzymes exist in plant tissues which catalyse the reduction of quinones by reduced co-enzyme diphosphopyridine nucleotide, and an electron transfer can be visualized as occurring between their substrates and molecular oxygen; thirdly, the respiration of many plant tissues can be stimulated by the addition of small amounts of polyphenol; and fourthly, many substances which act as competitive inhibitors on polyphenolases or inhibit by complexing with the copper of the enzyme also inhibit the respiration of plant tissues.

Although such evidence at first sight seems impressive, if it is examined critically the conclusion cannot be avoided that proof of the participation of polyphenolases in a respiratory chain has still to be produced. Polyphenolases are not found in all plant tissues, and the fact that model respiratory systems can be constructed *in vitro* is not evidence that they so function *in vivo*. Many plant tissues, the respiration of which is stimulated by the addition of polyphenols, contain no polyphenolases and, in those tissues which do, stimulation of respiration may be achieved by the addition of substances such as 2-6-dichloroindophenol and by other dyes. Similarly the inhibition of respiration by substances such as *p*-nitrophenol can be seen with other tissues, for example, yeasts, in which no one would suggest that polyphenolases play any part in respiration. The inhibition of respiration by substances such as Dieca may well be due to the inhibition of other enzyme systems, such as those systems involving ascorbic acid oxidase. The case *against* a polyphenolase system is largely the case *for* a cytochrome system. It is possible, as H. S. Mason suggests, that the polyphenolases are concerned in the further oxidation, by dehydrogenation or introduction of hydroxyl groups, of simpler phenolic constituents to such complex products as lignin.

Dr. C. Weurman (Central Institute for Nutrition Research, Utrecht) read the fourth and last paper on "The Oxidation of Phenols in Injured Plant Tissues". The situation is one in which the tissue is dead or in a state of rapidly approaching death. Studies of isolated enzymes *in vitro* are of no help when the complete chaos of the dying cell is the object of study. As one example of the way enzyme systems interact in such a system, phenoloxidases are frequently inactive towards glycosides, and it will therefore be of importance whether or not active glycosidases are present along with phenoloxidases in the complex system. After discussing results which had been obtained with purified enzymes, Dr. Weurman described his own work with enzyme mixtures from potatoes and mushrooms acting on a large number of naturally occurring phenolic glycosides and aglycones. Only very few of the glycosides were not attacked by these enzyme preparations. Dr. Weurman briefly outlined the part played by oxidation of phenols in the development of desirable commercial quality in tea, cocoa, and cider, and invited discussion in greater detail from the experts in those commodities present at the meeting. A written contribution on polyphenols in fruits to the discussion of Dr. Weurman's paper was submitted by Dr. A. C. Hulme (Ditton Laboratory, Kent).

E. C. Bate-Smith

FITTING THE JOB TO THE WORKER

An international seminar under the title "Fitting the Job to the Worker", organized by the European Productivity Agency, was held at Leyden during March 28–April 3. It was attended by about seventy people, from thirteen European and North American countries, comprising physiologists, psychologists, engineers and industrial physicians in about equal numbers; the aim was to bring out what each has to contribute to the scientific study of the industrial worker as he uses his tools and equipment and as he is affected by his immediate environment, and how such knowledge can be applied to the design of machine and work-place either to increase the effectiveness with which the job is done, or to improve the worker's well-being. Welcoming the participants, Dr. Alexander King (deputy director of the European Productivity Agency) said that the Agency is giving increasing attention to the application of the human sciences to industrial problems linked with productivity. This gathering was to provide opportunity for a full and frank exchange of views between scientists from different countries; and it should help the European Productivity Agency to see further action it could take, bringing together as it does employers, trade unionists and scientists.

The nucleus of the seminar was a small team from different countries which had spent two months in the United States to study activity there in the field of industrial physiology and engineering psychology —the field for which the name 'ergonomics' has developed in Britain. Mr. K. F. H. Murrell, of the Department of Psychology at the University of Bristol, speaking of the visit, commented that nearly all the research in the 'human engineering' field appears to have been done in a military context, and to have concerned itself largely with high-stress situations which do not arise in industry; the effects of long-continued work at normal stresses still await study, and pending this, there may be danger in premature translation of military results to the industrial field. Prof. H. S. Belding (Department of Occupational Health, University of Pittsburgh), who was United States adviser to the team, commented on its impact in stimulating contact in the United States between the different types of scientists. Also they had not previously experienced the three-sided approach by scientists, employers and unions. The problems needing study are very similar in the United States and in Europe; physical stress has been reduced ("the hardest physical effort of the worker is now that of the housewife"), and the lighting of factories has improved tremendously over the past twenty years; but in new factories some jobs are hotter than ever, and noise-exposure is probably increasing.

The seminar divided into two groups for discussion of particular fields, with short notes in advance by participants on relevant work in progress in their own country. One group discussed the physiological assessment of heavy muscular work and heat-stress, and next day turned to the effects of noise, and noise-abatement. A joint contribution from Dr. F. H. Bonjer, of the Department of Occupational Medicine at the Netherlands Institute for Preventive Medicine, and Dr. D. van Zuilen, of the T.N.O. Research Institute for Public Health Engineering, showed impressive collaboration between the physiologist