

## ENGINEERING IN THE UNIVERSITY OF NOTTINGHAM

## OPENING OF LABORATORY EXTENSIONS

THE original engineering laboratories of University College, Nottingham, as it then was, were completed in 1930, and until 1948, apart from a small extension of drawing-office accommodation, no further expansion was made. In 1930 the number of full-time students was 17, a number which by 1940 had increased to 44, and by 1946 (the date of the Barlow Report) to 128. In 1950 there were approximately two hundred students reading for degrees in engineering; this number was really far in excess of the facilities at the University's disposal, and adequate training was only given by running dual streams of undergraduates in each year. Such conditions could only be tolerated for a short time to meet a national emergency, and a further demand on accommodation was made when, on the University receiving its charter in 1948, it became possible to develop further the research schools in applied science.

The University was faced with the preparation of a long-term scheme for the development of technology, or of putting into operation a smaller scheme which would bring relief with the shortest possible delay. The first scheme would certainly have taken six years to plan and complete, and in this time the intake of applied science students would have had to be reduced. This seemed contrary to the national interest, and so it was decided to proceed with the smaller project which could be completed in a little more than two years, during which time the student numbers could be maintained and active research schools developed. The project has now been completed, the immediate extra accommodation provided by the extensions representing an increase of some 60 per cent; when rooms at present loaned to the Arts Faculty are available, the total increase of accommodation will be 80 per cent, making possible an intake of students at the rate of ninety a year.

The extensions to the laboratories were opened on April 14 by Lord Hives, chairman and joint managing director of Rolls Royce, Ltd. Lord Hives pointed out that, although society to-day is increasingly dependent on the achievements of applied science, too few of the present-day university students in Britain study this vital subject—only a sixth, in fact, of the 72.5 per cent at universities who are in some measure or other assisted financially by the State. That the percentage of technological students is so small is causing both educationists and industrialists much anxiety, and Lord Hives noted with satisfaction that Nottingham anticipated some time ago the increase in the facilities required for training.

In Lord Hives's opinion, the reason for the unsatisfactory state of recruitment is not to be found at the level of the university, but is something much deeper: it is to be found in the schools and in the attitude of mind of a great number of the parents in Britain. Since engineering, even in its fundamentals, is not taught in schools, too often when a boy comes to consider what he should study at the university, or what career to take up straight from school, he knows nothing at first hand of one of his country's greatest possible careers—engineering.

A distinguished careers master, Mr. Howard Ruby, of Dulwich College, put the position very neatly

when he wrote recently that even when careers masters are well aware of the good prospects in an industrial career, their problem is to convince parents and boys, for there still survives in the minds of some parents the view that a career in industry is not so respectable as one in the Armed or Civil Services or other professions. Such a point of view is not only out of date but also harmful, and so long as it persists Britain will never have the skilled men that it requires. A unique place in the estimation of the world has been earned for Britain by its craftsmanship, the skill of its engineers and technicians and the ingenuity of its scientists, and it is necessary that young men should come forward in increasing quality and numbers for past triumphs to be maintained and even exceeded. The main lesson to be learnt from the United States is the high position in society given to industry in that country. As one of the recent Anglo-American productivity teams said in its report: "It is because of this social and intellectual prestige attaching to the highest position in industry that many of the best students choose industry for a career". Lord Hives emphasized the fact that in the engineering industry many of the key positions at the very top of the tree are held by trained engineers. In fact, there is no better training for an executive in the industry to-day than to have worked in his time as a skilled engineer. Yet to many people engineering is still something 'messy', something that polite young men ought not to get mixed up in. Technical engineering, on the other hand, can be the most exciting and fascinating way of earning a living, and the chief reason for this is that it can never remain static.

Prof. J. A. Pope, head of the Department of Civil and Mechanical Engineering in Nottingham, thanked the University Grants Committee and members of industry who through their generous support had made the developments possible, and paid tribute to the University surveyor, Mr. J. W. Popplewell, and his staff on achieving a useful and economical design of building; the capital expenditure per student place had been kept very low without any sacrifice of student amenities or teaching efficiency.

BRITISH GELATINE AND GLUE  
RESEARCH ASSOCIATION

## RESIDENTIAL CONFERENCE

THE first residential conference of the British Gelatine and Glue Research Association was held at Hulme Hall, University of Manchester, during April 8-11, and the progress made in the first two and a half years of research work was reported. The meeting was well attended, those present including representatives of gelatine and glue manufacturing firms, of firms using these products, and of government laboratories, research associations and university departments.

The Conference Lecture, by Dr. G. R. Tristram (University of St. Andrews), reviewed recent progress

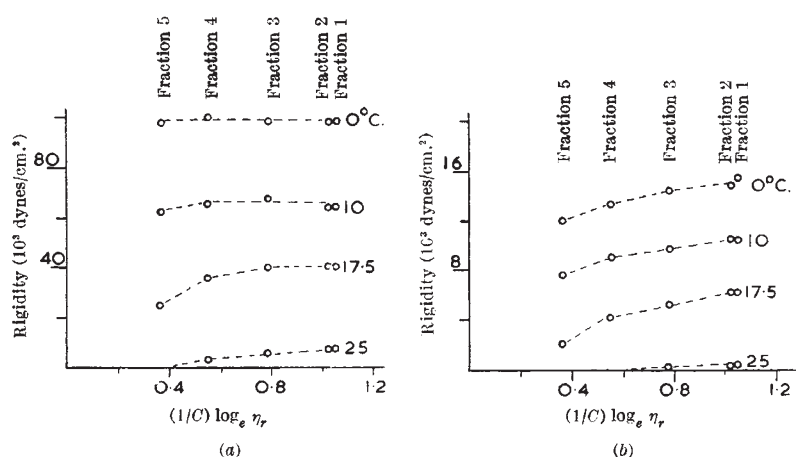


Fig. 1. Rigidity of gels from fractions of gelatin as a function of reduced viscosity ( $C = 0.2$  per cent) at temperatures from 0°–25° C. in 1 *M* sodium chloride at pH 7: (a) gel concentration 5.5 per cent; (b) gel concentration 2.2 per cent

in protein research. The techniques by which the amino-acid composition, N-terminal and C-terminal residues, and amino-acid sequence might be determined were given, and illustrated by F. Sanger's work on insulin. Although adequate to give the structure of insulin, which is a protein of comparatively low molecular weight, existing techniques appear inadequate for obtaining the sequence in proteins of higher molecular weight, and still more so for heterodisperse systems such as gelatin.

One of the principal raw materials of the industry was considered by Dr. J. E. Eastoe, in a paper on the composition of bone. The tissue selected for study was a powdered sample of compact bone from the central, tubular portion of the femur of the cow, since it could be obtained almost entirely free of other tissues. The organic components of the tissue were collagen (18.64 per cent), mucopolysaccharide (0.24 per cent), and a protein which resisted solution in boiling water (1.02 per cent). Free sugars were not detected, nor was fat present. Inorganic matter, with which citrate was included, made up 70.91 per cent, and with water (8.18 per cent) gave a total of 99.0 per cent. No significant chemical differences were observed between the bone collagen and hide or sinew collagens. The mucopolysaccharide contained some 70 per cent of a protein of amino-acid composition similar to blood albumin, while the carbohydrate portion did not correspond to published compositions<sup>1</sup> for chondroitin or mucoitin sulphate. Glucos-2-amine, galactos-2-amine, glucuronic acid, galactose and mannose were all detected in the carbohydrate, and they were estimated approximately. The resistant protein was shown to be neither collagen nor elastin.

Mr. D. Fysh gave a short paper describing the equipment being used for empirical studies of the extraction of bone glue. Preliminary results indicate the relative importance of the two stages—heating under steam pressure, and addition of hot water to give the glue liquor—in the extraction process.

The remaining papers were concerned with the properties of gelatin, which had been chosen as the main field of study. Dr. G. Stainsby described a new technique<sup>2</sup> for fractionating gelatin, using the solubility of the complex formed between gelatin and sodium dodecyl sulphate. The method makes

extensive use of the work of Smith and Pankhurst<sup>3,4</sup> concerning the behaviour of the complexes. Successive raising of the salt concentration in a solution of gelatin and sodium dodecyl sulphate at 35° C. and pH 7 causes portions of the complex to separate as a coacervate. Material of high molecular weight is separated off at the lower salt concentrations. By acetone precipitation, the gelatin present in the coacervate may be separated from the sodium dodecyl sulphate and its properties measured. A very simple procedure involving the preparation of five fractions has proved adequate to show differences in the distribution of molecular weight between closely related gelatins.

P. R. Saunders reported on the properties of the gelatin fractions. Contrary to results obtained by J. D. Ferry for unfractionated materials of differing molecular weight<sup>5</sup>, the molecular weight of a gelatin fraction has been shown to be of importance in determining the rigidity of a gelatin gel, only as the temperature approaches the melting point or the concentration is lowered to a point at which weak gels alone are formed. The method used for rigidity measurements<sup>6</sup>, involving the deformation of a cylinder of gel, set in a precision-bore tube, under air pressure, was sufficiently simple to enable measurements to be made at two concentrations and four temperatures (0–25° C.) for fractions of six gelatins of widely differing types. The results for one gelatin are shown in Fig. 1. It can be clearly seen that at 0° C. and 10° C. the rigidity (5.5 per cent concentration) was independent of the reduced viscosity ( $1/C \log_e \eta_{rel.}$ , in 1 *M* sodium chloride, pH 7) and hence of molecular weight. Confirming results by Pouradier<sup>7</sup>, it has been shown that the melting point of gelatin does not depend solely on molecular weight. The viscosity of fairly concentrated solutions has been shown to be uniquely related, within the rather large experimental error, to the dilute solution viscosity.

Dr. A. Courts showed how the fluoro-dinitrobenzene technique of F. Sanger<sup>8</sup> can be used to determine the N-terminal amino-acid residues of gelatin and its degradation products. Typical figures for gelatin prepared from an alkali-treated calf-skin precursor and an acid-process pigskin gelatin are given in Table 1.

TABLE 1

	N-terminal residues of gelatin (gm./100 kgm. gelatin)	
	Calfskin	Pigskin acid process
Glycine	0.83	0.74
Serine	0.19	0.10
Threonine	0.11	0.08
Alanine	0.11	0.24
Aspartic acid	0.11	0.13
Glutamic acid	0.10	0.07
Others	0.12	0.19
Total	1.57	1.55
Isoelectric point (pH)	5.1	9.4

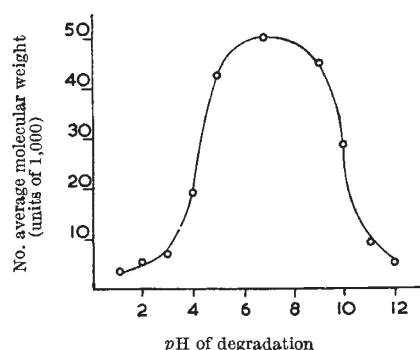


Fig. 2.  $M_n$  of gelatin ( $M_n$  initial = 58,000) after heating in solution for 24 hr. at 75° C.

The examples quoted in Table 1 were selected to give almost the same total of end-groups, to assist in comparison.

The number of N-terminal residues may be used to give the number-average molecular weight ( $M_n$ ) for the gelatin sample, if it is assumed that the gelatin molecule is a single polypeptide chain with one N-terminal residue per molecule. The values of  $M_n$  obtained for alkali-processed gelatins were 50,000–70,000, which is in fair agreement with osmotic determinations by Pouradier<sup>7</sup> for similar gelatins.

A number of samples of a gelatin, which gave  $M_n = 58,000$  by fluoro-dinitro benzene technique, were degraded at 75° C. for 24 hr. at 5 per cent concentration at different pH's. The effect on the values of  $M_n$  is shown in Fig. 2. The curve is nearly symmetrical about pH 7. Further experiments at different temperatures suggest a figure of 19,000 cal. for the mean activation energy for breaking peptide bonds, as measured by the release of N-terminal residues. This figure is in quite good agreement with values deduced<sup>9</sup> from the viscosity and other properties.

A. W. Kenchington presented a paper on the methylation of gelatin, and on the means by which the degree of substitution can be estimated when gelatin is modified by organic reactions. The most important method, giving values for several groups, makes use of the titration curve. Provided the isoelectric point is also known, the titration curve can be used for giving values for carboxyl, imidazole,  $\epsilon$ -amino and guanidino groups. The proportion of the dicarboxylic acids in the amide form can also be deduced. By analysis of the curves obtained for gelatin samples, the limits of titration suggested by Cannan<sup>10</sup> have been modified, so that at 40° C. they are:

TABLE 2

	New values	Cannan's values
Carboxyl groups	pH 1.5–6.5	pH 1.5–6.0
$\alpha$ -Amino and imidazole	pH 6.5–8	pH 6.0–8.5
$\epsilon$ -Amino	pH 8–12	pH 8.5–12.5
Guanidino	not titrated	pK presumed > 12

The use of these limits secures agreement between figures for the grouping by analytical and titration-curve methods. The need for the changes results from the following: (i) the presence of a substantial proportion of hydroxylysine; (ii) the higher temperature of measurement reduces the pK of the  $\epsilon$ -amino group; (iii) some proportion of the carboxyl

groups have pK's in the region of pH 5, and their contribution will only become small above pH 6.5.

Methylation has been carried out by a slow reaction with methanol under acid conditions. Although almost complete methylation of carboxyl groups was achieved, a proportion of the esterified groups is very unstable, and readily loses methanol. Up to 33 per cent substitution, the derivative appears stable to most conditions, but not to alkalis. The degree of substitution was measured using a modified Zeisel method, and the values agreed well with the number of carboxyl groups no longer titratable in the titration-curve method. This suggests that no methylation of hydroxyl groups has taken place. There was also no evidence of methylation of the  $\epsilon$ -amino groups. The methylated gelatin was not very different in general behaviour from its parent gelatin and gels were easily obtained. Some degradation had occurred, probably due to the low reaction pH.

E. Courtman outlined a method for determining total bacterial counts for gelatine. Wide variations of total count are known to occur for samples withdrawn from a single gelatine batch<sup>11,12</sup>, which result, it would appear, from high local concentrations of bacteria in individual grains. The expression of results as a mean with limits of error will assist in preventing needless disputes over disagreeing values.

M. E. Adams reviewed the manifold uses of gelatine and glue. By classification according to relevant properties, she was able to show that problems of the interface represent the largest gap in knowledge of gelatine and glue.

A. G. Ward, director of research of the Association, in the concluding paper of the conference, outlined the present knowledge of gelatin and its preparation from collagen. The structural features of gelatin which determine the properties of its solutions and gels appear to be, in the main, charge distribution arising from the ionizable groups, molecular weight and molecular weight distribution, and some third factor which affects the rigidity of gels, particularly at low temperatures. This third factor also appears to influence the melting point and the point at which alcohol gives turbidity to a gelatin solution<sup>7</sup>. Little is known of the changes involved in converting collagen to gelatin, but the techniques now available will assist in studying this problem. In addition to these subjects, the Association will in the next five years use empirical methods both for problems of manufacture and for user problems, and also examine in a more fundamental way the behaviour of gelatin at the liquid-gas, liquid-liquid and liquid-solid interfaces. This behaviour is of importance in many uses of gelatine and glue.

A. G. WARD

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<sup>4</sup> Pankhurst, K. G. A., "Surface Chemistry" (*Research Supp.*), 109 (London: Butterworth, 1949).

<sup>5</sup> Ferry, J. D., *J. Amer. Chem. Soc.*, **70**, 2244 (1948).

<sup>6</sup> Saunders, P. R., and Ward, A. G., Proc. 2nd Int. Conf. Rheology (London: Butterworth) (in the press).

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<sup>8</sup> Sanger, F., *Biochem. J.*, **39**, 507 (1945).

<sup>9</sup> Sheppard, S. E., and Houck, R. C., *J. Phys. Chem.*, **36**, 2319 (1932).

<sup>10</sup> Cannan, R. K., *Chem. Rev.*, **30**, 395 (1942).

<sup>11</sup> Tech. Comm. Edible Gelatin Manuf. Res. Soc. Amer., *Food Research*, **8**, 429 (1943).

<sup>12</sup> Johns, C. K., *Food Research*, **16**, 281 (1951).