average death rate is 12 per thousand, in a city of 100,000 population there will be about 23 deaths in a week. If black and white balls in indefinitely large numbers are distributed in the ratio of 23 black to 99,977 white and 100,000 are drawn, the most probable number of black balls is 23, but one time in four there will be more than 27. Thus the recorded death rate for a week for a city of 100,000 will normally fluctuate. If it is on the average 12, it will in half the weeks be approximately either as large as 15 or as small as 9.

If the death rate exceeds 15 in two consecutive weeks then the chances are fifteen out of sixteen that it is due to some cause such as an epidemic. The conditions are obviously of practical importance for physicians and health officers. The situation for death rates is nicely illustrated by the illustration that has been used of the distribution of black and white balls in an urn. If the population of the country were 100,000,000 and the death rate were 12 (as it should be, but is not), then 1,200,000 people would die during a year. Among 100,000,000 black and white balls there are 1,200,000 black. But if we draw 100,000 (*i. e.*, take a town of that population) there will be a chance fluctuation as described above. It is also the case that the balls are not completely mixed, there being more black balls in some part of the urn than others. In some places we shall draw a larger proportion of black balls. When there is a negro population or a tenement house population or a large population of very young or very old people, there are relatively more black balls. There are temporarily more black balls in one place when there is an epidemic or the like. In that case we have the analogy of the black balls attracting one another.

This paper has been written to explain the methods used to select the thousand leading American men of science by votes. The psychologists have been taken as an example; if space and time permitted tables and curves might be given for the other sciences and a study of the data might yield results of interest. Such treatment must, however, be postponed or left to others. The object of the present paper will be accomplished if it makes clear that the scientific men have been selected and placed in the order of merit for their work by valid objective methods and that the methods used have wide application. In a subsequent paper the distribution of the scientific men will be considered with special reference to the changes that have occurred in the course of ten years.

J. MCKEEN CATTELL

THE PSYCHOLOGICAL CORPORATION,
AUGUST 1, 1922

THE AMERICAN CHEMICAL SOCIETY

(Continued)

DIVISION OF LEATHER CHEMISTRY

John Arthur Wilson, *chairman*
Arthur W. Thomas, *secretary*

The mechanism of unhairing: JOHN ARTHUR WILSON and GUIDO DAUB. A series of detailed studies was made of the mechanism of the unhairing of skins by means of the sweating process, lime liquors and caustic sulfide liquors. Sections of skin were examined under the microscope at different stages. In liming and in sweating, the first action on the skin itself is the hydrolysis of the epithelial cells of the Malpighian layer of the epidermis, once the cells are destroyed, the remainder of the epidermis, the hair and the sebaceous and sudoriferous glands are completely separated from the derma and can then be removed mechanically. In the sulfide method, the alkali destroys the corneous layer of the epidermis and the skin appears to be freed from epidermal matters on its surface long before the alkali has penetrated to the depth of the hair bulbs. Where this method has been employed, the hair bulbs are usually found intact in the finished leather. The paper is illustrated with photomicrographs.

Pancreatin as an unhairing agent: JOHN ARTHUR WILSON and ALBERT F. GALLUN, JR. When calf skin is swollen in dilute caustic soda, neutralized with sodium bicarbonate, and then put into a suitable solution of pancreatin at 25° C. exposed to air, the hair is completely loosened in 24 hours, but the action is not due to the enzyme, since it is checked by covering the solutions with a layer of toluene. At 40° a solution of pancreatin fails to cause a loosening of the hair of fresh skin because the corneous layer of the epidermis is impermeable to the enzyme and thus prevents it from attacking the soft Malpighian layer below. When a skin has previously been swollen by acid or alkali, and the corneous layer rendered softer and more permeable, a solution of pancreatin at 40°, even under toluene, will not only destroy the Malpighian layer of the epidermis and loosen the hair, but it will also dissolve the elastin fibers of the skin, thus effecting both unhairing and bating in a single bath.

A study of the strength of proteolytic enzymes in the process of bating: CHARLES S. HOLLANDER. During comparative tests of bating with dung bates and with pure enzymes, tests were made at intervals of the strength of enzyme in the liquors, by the casein method. The concentration varied considerably with time in the case of the dung but remained practically constant when pure enzyme preparations were used.

The hydrolysis of collagen by trypsin: ARTHUR W. THOMAS and FRANK L. SEYMOUR-JONES. It is shown that collagen is readily digested by trypsin under proper conditions, and that it is unnecessary to subject collagen to chemical or pepsin pretreatment in order to render it vulnerable to tryptic action. This refutes the generally accepted belief based on the statement of Kuehne (1887) that trypsin can not hydrolyze collagen.

The points of minimum plumping of calf skin: JOHN ARTHUR WILSON and ALBERT F. GALLUN, JR. A study was made of the change in degree of plumping of calf skin at different acidities and alkalinities. There are two points of minimum plumping, one occurring at a value of 5.1 and the other at 7.6 on the p_H scale. Available data seem to indicate that these two points of minimum represent two different forms of skin protein, one stable only in acid solution and the other in alkaline solution.

Direct determination of plumping power of tan liquors: JOHN ARTHUR WILSON and ALBERT F. GALLUN, JR. The degree of plumping of skin in a given tan liquor is measured by the ratio of its resistance to compression when taken from the tan liquor to its resistance to compression under standard conditions. The method can be conducted with extreme sensitivity and is capable of making the measurement in actual tannery practice.

Effect of hydrogen-ion concentration upon the analysis of vegetable tanning materials: JOHN ARTHUR WILSON and ERWIN J. KERN. The per cent. of tannin found by the A. L. C. A. official method increases with p_H value to a maximum at 8 and then decreases rapidly towards zero. On the other hand, p_H value appears to have no effect upon the determination by the Wilson-Kern method over the range 3.6 to 7.3, but the rate of tanning of hide powder decreases rapidly with increasing p_H value above 7. The rate of filtration of tan liquors is markedly affected by change of p_H value, which may be attributed to changing degrees of dispersion of some of the solid matter. The addition of lime to tan liquors causes a precipitation of tannin, but only at p_H values above 7.2.

Stability of the hide-tannin compound at different p_H values: JOHN ARTHUR WILSON and ERWIN J. KERN. Leather is resistant to washing in neutral or acid solutions, but is broken up into protein and tannin by alkaline solutions. The decomposition begins at $p_H = 7.7$ and proceeds at an increasing rate as the p_H value is raised above this value.

The concentration factor in the fixation of tannins by hide substance: MARGARET W. KELLY. The relationship between degree of fixation of tannin by hide substance and the concentration of the vegetable tanning liquors has been worked out for a number of important extracts. All show a steady increase in tannin fixed, as concentration increases, up to a maximum tannage followed by a sharp drop in more concentrated liquors.

The hydrogen-ion and time factors in the fixation of tannins by hide substance: MARGARET W. KELLY. The combination of vegetable tannins with hide substance is shown to depend upon the hydrogen-ion concentration of the liquor to a most pronounced degree. Over a broad range of hydrogen-ion concentration, an M-shaped tannage curve is obtained. In acid solutions the greatest fixation is obtained at $p_{H^+} = 2$ to 3, falling off at greater acidities. On the less acid side of $p_{H^+} = 2$ to 3, the fixation decreases to a minimum at $p_{H^+} = 5$, the isoelectric point of collagen, then increases to a second maximum at $p_{H^+} = 8$, and at greater alkalinities falls off approaching zero. The second maximum at $p_{H^+} = 8$ is much lower than the principal maximum fixation at $p_{H^+} = 2$ to 3. Explanation for this behavior is submitted in the original paper.

The influence of neutral salts upon the fixation of tannins by hide substance: ARTHUR W. THOMAS and MARGARET W. KELLY. Both sodium chloride and sodium sulfate decrease the fixation of vegetable tannins by hide substance at $p_{H^+} = 3$; sodium sulfate to a greater extent than sodium chloride. At $p_{H^+} = 5$, sodium chloride in low concentrations promotes the fixation; at higher concentrations it inhibits fixation, as sodium sulfate does at all concentrations. At $p_H+ = 8$, both salts decrease the fixation, but not to the same extent. Explanations for the differences in behavior are given based on the Donnan effect on the collagen and the action of the salts in altering the degree of dispersion and diffusibility of the tannin particles.

The difference in kind or degree of tannin fixation as a function of the hydrogen-ion concentration: ARTHUR W. THOMAS and MARGARET W. KELLY. It has been shown that after removing all water soluble substances from freshly prepared leather, treatment with alcohol will extract varying amounts of tannin depending upon the hydrogen-ion concentration at which the leather was tanned. For example, hemlock and gambier leathers tanned at $p_H+ = 3$ will yield about 25 per cent. of their fixed tannins to alcohol extraction, a smaller amount when tanned at $p_H+ = 5$, and practically none when tanned on the alkaline side of $p_H+ = 5$. If the leathers are drastically dried before alcohol extraction, very little alcohol soluble matter is found. These preliminary experiments are to be continued with the view of throwing more light upon the differences in kind or degree of tannage at differing hydrogen-ion concentrations.

The tannin-gelatin reaction: ARTHUR W. THOMAS and ALEXANDER FRIEDEN. The mutual precipitation of tannin and gelatin depends to a very large degree upon the hydrogen-ion concentration of the solution. It has been shown that the gelatin-salt test for tannin is sensitive to one part of tannin in 110,000 to 200,000 parts of water, depending upon the source of the tannin, and provided the hydrogen-ion concentration of the solution is adjusted to its optimum. This optimum varies with different extracts, ranging from $p_H+ = 3.5$ to 4.5. The details are given in the original paper. It is also shown that it is unnecessary to prepare the gelatin-salt test reagent daily. This reagent kept for two months at summer temperature when covered with a layer of toluene and its delicacy was not impaired in that time. How much longer it would keep is unknown.

Are vegetable tannins amphoteric? ARTHUR W. THOMAS and STUART B. FOSTER. Six common vegetable tanning materials were investigated by the electrophoresis method indicating that all are amphoteric, *i. e.*, changing from anodic migrating to cathodic in the p_H+ range of 2.5 to 2.0. Hydrogen-ion concentration precipitation curves are also given for the extracts studied.

The practical color measurement of vegetable tan liquors: R. O. PHILLIPS and L. R. BROWN. It is suggested that color measurements are best made by tanning pieces of skin under standard conditions.

The acidity of synthetic tans: S. KOHN, J. BREEDIS and E. CREDE. The active principles of most synthetic tans are sulfonic acids in the preparation of which an excess of sulfuric acid is used. It is relatively easy to find out whether or not sufficient alkali has been added to neutralize this excess. But sulfuric acid being neither the sole nor the worst of the undesirable ingredients occurring in some syntans, it is important to devise methods by which preparations containing undesirable ingredients can be detected. To the methods suggested previously a new one is added which is based upon comparative observations of the part played by the acidity of syntans in the precipitation of gelatin.

The colloid chemistry of basic chromic solutions: FRANK L. SEYMOUR-JONES. A review of the literature upon the nature of chromic solutions showing their very complex and as yet unsettled condition of solution. Ultrafiltration experiments failed to show the presence of any colloidally dispersed chromium compound in the ordinary single bath chrome liquor. The experiments are preliminary in nature and further investigation is contemplated.

The electrophoresis of chromic solutions: FRANK L. SEYMOUR-JONES. The Thompson-Atkin theory of chrome tanning, which postulates a negatively charged chromium complex as the tanning agent, is criticized and shown not to be of general application, if at all, since chromic solutions which did not show any evidence of negatively charged chromium complexes tanned hide powder. It is true, however, that in certain basic solutions of chromic sulfate, part of the chromium exists in a negatively charged complex, while this does not occur in the basic chloride nor yet chrome alum.

The interpretation of the influence of acid on the osmotic pressure of protein solutions: JACQUES LOEB. When osmotic equilibrium is established between a solution of casein and hydrochloric acid enclosed in a collodion bag and an outside aqueous solution free from protein, the hydrogen-ion concentration is always greater in the outside solution than in the casein solution. The observed osmotic pressure is accounted for quantitatively by the difference in concentration of hydrochloric acid in the two solutions, without taking into consideration any possible osmotic pressure of the casein itself. The observed potential difference between the two solutions in millivolts always has the numerical value equal to 59 times the difference in p_H value between the two solutions at 24°, proving that the inequality in p_H value is determined by Donnan's equation for membrane equilibria.

A preliminary study of a plunger type of jelly strength tester: S. E. SHEPPARD and S. S. SWEET. In previous papers the authors have described an instrument for measuring in absolute units the rigidity of gelatin jellies. They have used the results to check the performance of plunger types of jelly strength testers. In these instruments a plunger resting on the jelly is loaded to produce a fixed arbitrary depression or distortion. The authors have devised an instrument with a balanced beam, and continuous chainomatic loading. Hence the load : deflection, or stress : strain curves can be plotted for constant rate of loading. The points investigated were: (1) Effect of shape of plunger. It is found that with plungers having a rounded base the area of contact varies with the load, and unreliable load : deflection curves are produced. The most satisfactory plunger is a frustum of a cone, with the larger base resting on the jelly surface. Families of straight lines passing through the origin are obtained in good agreement with Hooke's law. (2) Ratio of diameter of plunger to diameter of vessel. Using plunger heads of above shape, this ratio should be less than a certain value, or spurious rigidity; hence spurious jelly strength will be obtained. This is a function of the absolute jelly strength (rigidity) so that comparisons for grading may be vitiated. (3) Ratio of depression to height of jelly. Similarly the depth of jelly must be large compared with the depression, using the same plunger diameter. These results are discussed in connection with recent work on the structure of jellies.

On the non-isotropic swelling of thin sheets of gelatin: S. E. SHEPPARD and S. S. SWEET. By coating definite amounts of gelatin solution of various concentrations, etc., on suitably prepared glass plates, after drying flat sheets of definite thickness and area can be stripped off. The swelling of these in water and aqueous solution is not isotropic, *i. e.*, not uniform in all directions, but greatest for the thickness. It is found that the *ratio* of volume increase to area increase differs for different gelatins, and also depends upon the treatment, becoming lower, for example, on hardening with formaldehyde.

The preparation of gelatin free from ash and hydrolytic decomposition products: S. E. SHEPPARD, FELIX A. ELLIOTT and MISS A. J. BENEDICT. A 5 per cent. solution of commercial gelatin is electrolyzed in a cell of electrofiltros for three to four weeks, the salts passing through the cell into the electrode chambers. This reduces the ash to ca. 0.10 per cent. This deashed solution is then precipitated with acetone, thus removing hydrolytic decomposition products and further reducing the ash to ca. 0.01 per cent. This gelatin is then redissolved in conductivity water, chilled in sheets and dried. The reaction of a solution of such gelatin in solution is about 4.8 H-ion. This gelatin is useful for all research work on gelatin as well as providing a definite material for culture media which can be brought to any particular reaction with complete knowledge of salts present.

The hygroscopicity of hide glues and the relation of tensile strength of glue to its moisture content: E. BATEMAN and G. G. TOWN.

The two forms of gelatin and their isoelectric points: JOHN ARTHUR WILSON and ERWIN J. KERN. In a tenth-molar phosphate solution of increasing p_H value, gelatin shows two points of minimum swelling, one at 4.7 and the other at 7.7. It is suggested that the two points of minimum represent the isoelectric points of the gel and sol forms of gelatine, respectively.

Some modern problems in leather chemistry: EDMUND STIASNY. The striking feature of modern research in leather chemistry is the entirely different point of view in the choice and treatment of problems as compared with the period previous to ten years ago. The older experimentation was entirely from the standpoint of direct practical investigation, while in pure research for the purpose of deep understanding of the processes, entirely unfettered by any thought of immediate practical utility, in which the entire structure of modern science is employed, activity has become evident only within the past decade. Professor Procter is the connecting link between these two eras and the example set by him in his scientific attitude is especially evident in the United States. A few of the problems of timely interest are the chemical nature of collagen, the mechanism of bating and what is called the astringency of vegetable tannins. (The author reviews the results of his experimentation upon these problems which will be published in full later). The ultimate aim of all research in leather chemistry is the widening and deepening of our fundamental knowledge of this as yet very undeveloped field.

DIVISION OF GAS AND FUEL CHEMISTRY

A. C. Fieldner, *chairman*
R. S. McBride, *secretary*

Chemistry of combustion: W. K. Lewis. The present state of knowledge of combustion is reviewed, the field being divided into, first, combustion within the fuel bed; second, distillation of the volatile matter in the fuel; and, third, the burning of the combustible gases over the fuel bed. The composition of the gases within the fuel bed is discussed and the effect of increased rate of combustion shown. The velocity of the reaction of C plus O_2 equals CO_2 is shown to be dependent on the speed of diffusion and not on the specific reaction rate. The modern concepts of the combustion of hydrocarbons are also discussed.

Combustion of powdered coal: Henry Kreisinger and John Blizard. This paper considers essential factors in burning powdered coal, and gives a review of some tests carried out by the U. S. Bureau of Mines and the Combustion Engineering Corporation. The size of the particles, their motion relative to the surrounding air and methods of bringing them into contact with fresh supplies of air as they burn are discussed. A furnace and burner designed for burning powdered coal are shown and the principles of the design explained. The principal results of tests carried out on a large boiler are shown graphically.

Simultaneous combustion of CO and hydrogen: R. T. Haslam. A review of the literature shows that doubt exists whether the combustion of hydrogen and carbon monoxide is of the second or third order. Experimental evidence is offered to show that when carbon monoxide and hydrogen burn simultaneously with oxygen in free space the combustion reactions are both trimolecular and that the ratio of the reaction velocity constants in the equation $\frac{d}{dt}(CO) = K_1(CO)^2(O_2)$ and $\frac{d}{dt}(H_2) = K_2(H_2)^2(O_2)$ is $\frac{k_1}{K_2} = 0.35$.

Some aspects of combustion of gases: Henry L. Read.

A study of the water gas reactions: R. T. Haslam, F. L. Hitchcock and E. W. Rudow. The action of steam on carbon through the temperature range of 650 degrees centigrade to 1200 degrees centigrade was studied by means of varying the pressure of the steam and results indicated: First, that below 900 degrees the major reactions are (B) C plus $2H_2O$ equals CO_2 plus $2H_2$; (D) C plus CO_2 equals 2CO; whereas above 900 degrees the reactions are (A) C plus H_2O equals CO plus H_2; (B) C plus $2H_2O$ equals CO_2 plus $2H_2$; (D) C plus CO_2 equals 2CO; second, that the undecomposed steam is shown to be the controlling factor in the CO and CO_2 ratio rather than the temperature at which reactions take place; third, equations are given showing the per cent. of CO_2 as a function of the undecomposed water; fourth, considering the rate of reaction (B) as unity it was found that (A) at temperature below 900 degrees centigrade reaction (A) is practically non-existent and that the velocity constant of reaction (B) is 2.0; (B) at temperature above 900 degrees the velocity constant of reaction (A) is 1.0 and that of (D) is 2.18.

Producer gas reactions: W. K. Lewis. Application of equations in previous article (water gas reactions—Haslam, Hitchcock and Rudow) showing effect of temperature, steam-air ratio and time of contact on composition of producer gas.

The combustion of gaseous fuels: George F. Moulton. Gas fuels commonly distributed for domestic and industrial purposes by gas companies vary in heating value from 450 to 1,100 B.T.U. per cubic foot. These gases vary in specific gravity from 0.35 to 0.70, and the pressures at which they are delivered to the consumer's appliance vary from 2 to 12 inches of water. The result of these large variations in heating value, specific gravity and pressure is that the manufacture of efficient gas appliances has been greatly retarded; the knowledge of correct adjustment of appliances is very vague, and modification of existing standards of quality has been made difficult because the effect of these changes on quality of service, efficiency of utilization and safety of operation has been difficult to determine. The range of operation of burners as well as the efficiency that can be secured will depend primarily on the characteristics of the flame. This paper shows how these flame characteristics are modified by a change of injection of primary air which may be caused by variations in gas rate, pressure, composition of gas, etc.

Combustion in engine cylinders: H. C. Dickinson. The process of combustion in engine cylinders presents some very interesting problems which demand a radical departure from the usual methods of reasoning and experiment. When a combustible mixture of gases burns at constant volume no two successive portions of it are burned at the same pressure or the same temperature or at the same time. The reactions do not take place simultaneously throughout the mass and the law of mass action does not apply, except to infinitesimal elements of the charge. The times involved are excessively short and it is doubtful if chemical equilibrium is ever attained at any point until the important phases of the process are passed. The importance of the internal combustion engine in the present scheme of things demands much more precise knowledge of the chemistry involved in its operation.

Factors governing the selection and use of fuel for industrial heating operations: J. A. DOYLE. This paper deals with factors governing the selection and use of fuels in the production of chemical products subjected to the action of heat in the process of manufacture. The necessity for considering the physical form and chemical association of a given form of fuel, in addition to the heating value of that fuel and the mechanical characteristics of the appliance for generating, applying and utilizing heat in the product is stressed. The influence of excess air upon the heating value of the different fuels, the composition of the atmosphere surrounding the material to be heated, the changes in composition of the combustible mixtures and the products of combustion of the different fuels with varying amounts of air are shown. The influence of process requirements and plant conditions upon the choice of fuel is outlined. The above points are illustrated by graphic charts showing the relation of the various factors and their influence upon the final result. The paper is in substance a plea for a broader consideration of the problem of fuel utilization from the standpoint of the quality and cost of the finished product, and the necessity for developing a better understanding on the part of those concerned with industrial heating operations of the influence of the conditions governing combustion upon the use of fuel and the utilization of heat.

Methods of utilizing the coke produced by low temperature carbonization of coal: HARRY A. CURTIS. The coke obtained by low temperature carbonization of coal is soft, light and quite unsuited for general use as a smokeless fuel. Attempts have been made to increase the density of the coke by compressing the coking coal mass in the retort, but these methods have not attained commercial success. By pulverizing the soft coke it can be burned efficiently in powdered fuel equipment, but preliminary tests of the fuel on a Coxe stoker gave unsatisfactory results. By grinding the coke, briquetting it and carbonizing the briquets a very high grade smokeless fuel is obtained, but the cost of these operations is high.

The forms of sulfur in coke—a physico-chemical study of the sulfur held by carbon at high temperatures: ALFRED R. POWELL. A phase rule study of the system, carbon-sulfur, at high temperatures showed that the sulfur exists in two distinctive forms: (1) a very stable form which exhibits all the properties of a solid solution, and (2) free sulfur physically absorbed by the carbon. Coke may contain both of these forms in addition to some sulfur combined with iron as ferrous sulfide. At temperatures in the neighborhood of 500° C. the ferrous sulfide of coke oxidizes very readily in the presence of air to ferric oxide and free sulfur. This reaction seems to occur during the quenching of coke and explains the disappearance of ferrous sulfide from coke rather than any reaction which occurs during the coking process.

A specific apparatus for gases: T. R. WEYMOUTH, R. P. ANDERSON and J. R. FAY. This new device consists of a thin orifice and a small capillary tube in series and makes use of the fact that the differential pressure resulting from the steam-line flow of gas through a capillary tube is independent of the specific gravity of the gas while the differential pressure resulting from the flow of gas through a thin orifice varies directly with the specific gravity of the gas. The flow of gas through the orifice is kept constant by holding a certain differential pressure on the capillary tube and the differential pressure on the orifice is calibrated to read specific gravity of the gas.

The examination of low-temperature coal tars: JEROME J. MORGAN and ROLAND P. SOULE. A critical review of the adaptability and limitations of procedures available for examination of low-temperature tars. The lower boiling phenols are determined by Raschig's nitration method together with methods based upon freezing point and densities of binary and ternary mixtures. Paraffins and naphthenes are freed from unsaturates and aromatics by 98 per cent. sulfuric acid. The proportions of paraffins and naphthenes in their mixture are found from density-boiling point curves. For qualitative examination non-saturated hydrocarbons are separated by liquid sulfur dioxide. No method is known for estimation of unsaturates in presence of aromatics.

The Becker combination coke oven: HAROLD J. ROSE. The latest advance in by-product coke oven design is represented by the Becker combination oven, a modification of the Koppers oven. Greater heating efficiency, better coke quality and increased strength of construction are obtained by a novel design which provides for the heating and regeneration of the coke and pusher ends of each oven as separate units. In this construction, gases of combustion pass over the top of each oven and down through the opposite flues of the same end, instead of passing longitudinally to the end of the same line of flues. Details of design will be fully illustrated by means of lantern slides.

Methods for studying the macrostructure of coke: HAROLD J. ROSE. The study of the structure of coke has been greatly neglected, due largely to the difficulties involved in preparing specimens, and in satisfactorily reproducing the structure photographically. This paper opens the way to the comprehensive study of coke macrostructure, by the use of novel methods. After sectioning the coke, the author impregnates the cut surface with a white hydraulically hardening compound, after which it may be polished to any desired degree. The excellent contrast of black coke with white impregnating compound makes detailed study and reproduction an easy method. Another novel method is the direct reproduction of the coke surface as obtained by inking the polished coke surface and printing with it on enameled paper. The article is copiously illustrated with macrophotographs.

A new electric furnace for the determination of the by-product yields of coal: HAROLD J. ROSE. The by-product yields obtainable from coal when coked in a by-product coke oven may be determined by laboratory distillation tests. Since the yield of by-products is seriously affected by small variations in distillation conditions, the laboratory determination requires the most rigidly controlled testing conditions. For this purpose a furnace, consisting of a deep trough formed from a number of U-shaped electrical heating units with individual control, has been developed, and is in regular use for research and testing purposes. Typical results are given to show the agreement of duplicate determinations made with this apparatus. The furnace is described and fully illustrated.

The combustion of coal which has been a long time in storage: S. W. PARR and T. E. LAYNG. It has been fairly well demonstrated that coal in storage does not lose any appreciable number of heat units. Previous investigations show the seeming loss in B.T.U. to be due to a corresponding increase of weight resulting from absorbed oxygen. However, when coal, especially fine material which has been long in storage, is burned, the result is very likely to show a low efficiency and indeed such coal sometimes seems to be unwilling to burn at all. The results noted in this paper account for the behavior of such coal to be due to the fact that coal in the finer sizes, especially coal of the mid-continental type, has a very large absorptive capacity for oxygen, that, because of the colloidal character of the coal substance such absorbed or adsorbed oxygen is held so tenaciously that when discharged by heat it has reached the combining stage and goes off as CO_2. The blanketing effect of this gas over the fuel bed results in a deadening of the fire and a loss of efficiency.

A study of solvents for the separation of coal into its type constituents: R. S. FISHER with S. W. PARR. The greatest advance in coal studies during recent years has resulted from the use of solvents which separate the coal into its type constituents without decomposition of their chemical structure. British and continental investigators have made much use of pyridine, which, however, seems to lack this prime requirement of a true solvent in that it enters into chemical reaction with certain of the coal constituents. The work here described gives data in the use of benzene, toluene and xylene, with methods for the use of the latter solvent which excels all others in the amount and completeness of removal of the soluble material. This is a preliminary report only as the work is being actively followed up because of the promise of larger yields more easily recovered than by methods in vogue heretofore.

The softening point of coal—its determination and significance: T. E. LAYNG, W. S. HAWTHORNE and A. W. COFFMAN, with S. W. PARR. References to the softening point of coal are frequent in fuel literature. The term heretofore has had a very vague meaning. This paper describes a method for its determination at once simple and accurate. The interesting fact has been developed that under uniform conditions the softening point repeats itself with marked constancy. Moreover, it is evidently a characteristic factor for varying types of coal as also for coal which has been for different lengths of time in storage. That is to say, it is a value which runs parallel with the oxygen content. No less striking is the solidifying temperatures, which result in a curve symmetrical with the range exhibited for the softening-temperatures. Description of the apparatus with results on numerous coals are given. The results are exceedingly interesting and may answer such questions as: What is the type of coal? What would be its behavior in storage? What kind of coke would it make and what modification of existing methods would improve its coking qualities? The report is preliminary only and further experiments are in progress.

The fractional decomposition of coal and coal components: S. W. PARR and T. E. LAYNG. Next to the fractionation of coal by solvents the fractional decomposition of coal in its combined form and also of its separate type constituents has furnished the most valuable data concerning the character of different types of coal and their behavior in the process of decomposition. Investigators in this field heretofore have failed to appreciate the significance of oxygen either combined or absorbed, but especially the rôle of the oxygen held in some form of absorption. The results as interpreted from the standpoint of this investigation have an entirely new meaning and are of fundamental importance in connection with studies along the line of coal carbonization.

A proposed theory of coal carbonization: S. W. PARR and T. E. LAYNG. This paper presents the summarized results of the several contributory lines of investigation on topics directly related to the carbonization of coal. The evidence seems to be conclusive that a correct theory for coal carbonization has yet to be written. It is not to be inferred that its final formulation is attempted in this paper. However, the results now in hand point out the general outline. The basic principle seems to be that the bonding effect which results in the production of a coherent mass is due not only to the presence of bituminic material, but to the absence or control of deleterious products of decomposition from the cellulosic substance, which under certain conditions may weaken or completely nullify the bonding property of the bituminic bodies. The production of coke is therefore not a simple matter of destructive decomposition of organic matter, but a destructive decomposition accompanied by cross reactions which may, under varying circumstances, produce an altogether different result as to the physical character of the final product. The paper is a preliminary report only.

Utilization of gas at low pressures: ANNA P. WARREN. So much has been said about the use of gas and so little information of practical value to the domestic consumer is available that experiments under actual home conditions are in progress to determine the conditions necessary for maximum thermal as well as practical efficiency at the minimum pressure and rate of consumption of gases varying in heating value from 1,150 B.T.U. to 500 B.T.U. per cubic foot. Up to the present time, under standard conditions, natural gas is the only commercial gaseous fuel that will give relative high thermal as well as practical efficiency under one ounce pressure.

Available hydrogen in coal and a direct method for its estimation: JOSEPH D. DAVIS. Available hydrogen, called "disponsible" hydrogen by German writers, is hydrogen contained in coal in excess of that required to satisfy the total oxygen calculated to water. It is customary to calculate the available hydrogen of a coal from its ultimate analysis. The method described in the paper is volumetric. It is similar to that used for the analysis of combustible gases wherein the slow combustion pipette is used. The coal is burned in a known volume of oxygen and the volume contraction observed after the combustion has taken place is due to oxygen consumed in burning the available hydrogen to water.

Thermal operation of modern regenerator coke ovens: D. W. WILSON, H. O. FORREST and C. H. HERTY, JR. Briefly stated, there have been included in this report: first, discussion of data needed to show completely the thermal operation of a modern regenerator coke oven battery; second, description of the experimental methods employed to obtain the needed data together with a table giving experimental figures obtained; third, a table balancing total heat input against total heat output is given, with a discussion of this and a calculation of the efficiency of the ovens; fourth, a so-called sensible heat balance is tabulated, the net heat effect of the coking process is discussed and the relation between the sensible heat balance and the exothermicity of the conversion from coal to coke is indicated.

Producer gas from powdered coal: R. T. HASLAM and L. HARRIS. Aside from the possibility of using a low grade fuel, the use of powdered coal for the manufacture of producer gas would give a constant composition gas free from tar, thus being easily cleaned, and the producer would be flexible, rapidly handling changes in load up to full capacity. As a result of experimental work not yet completed a gas of 12.0 per cent. CO and 7.0 per cent. CO_2 has been generated. Theoretical and experimental considerations show that the main factors are, first, high temperature in the combustion chamber (1,100-1,300° C.); second, air for combustion highly pre-heated (900-1,000° C.); third, coal finely pulverized, and fourth, air and coal well mixed together and so maintained until the end of the reaction.

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