

Weight formaline. Gram.	Weight undigested fibrin. Gram.	Digested fibrin. Per cent.
0.00	0.0393	96.07
0.00	0.0290	97.10
0.00	0.0155	98.45
0.05	0.0585	94.15
0.05	0.0413	95.87
0.10	0.0905	90.95
0.10	0.0752	92.48
0.30	0.1101	80.99
0.30	0.1045	89.55

While all the substances tested in these experiments show some influence on the digestive action of pepsin, only alum exhibits a marked effect. Although it is not possible, on account of the complex conditions existing in the stomach, to draw any conclusions from these results on what should take place in natural digestion, it would seem possible to conduct series of experiments on digestion within the stomach, introducing into the food suitable proportions of the antiseptics, and to determine the effects on the blood, and in other directions within the system. But such experiments are within the domain of physiological chemistry.

REVIEW.

SOME RECORDS OF RECENT PROGRESS IN INDUSTRIAL CHEMISTRY.

During very recent years, progress in industrial chemistry, as in practically every field of human activity, has been peculiarly marked. Competition between manufacturers, depression in trade and commerce from various causes, the opening of new channels of consumption, have all done their share to establish that necessity, which from all time, has been such a vigorous stimulant to investigation and invention, and the results, as a rule, have been proportional to the needs presented. It is apparent in the advances being made that there is an increasing recognition of the value of rational over empirical work and of the effort of carefully educated men over that of men who, ignorant of the cardinal and fundamental principles of the processes they control, grope darkly after the ends they would attain. And so for us here, and at the present time one of the most important signs of progress is to be found in the increasing and exacting interest being manifested in all the leading manufacturing countries of the world in the education of technologists, and the im-

provement in means to that end. Germany and England have been particularly aroused regarding their special needs in this direction, and have been forced to it by the intense competition existing between the two countries in the different fields of industrial chemical activity. The education of technical chemists has therefore been the theme of discussion in the legislative halls, in the conventions of technologists and manufacturers, and in the meetings of the scientific and educational associations, and the feeling almost universally expressed is to the effect that the work of education should be made more thorough and exacting, and that it should be carried up from the technical high schools to the universities, and that the same care should be applied to technical instruction as is considered necessary in university work. So Dr. Böttinger, addressing the House of Delegates of Germany, urges upon the ministry the establishment of departments of technical chemistry with the necessary corps of instructors in the university and state examination of all technical chemists as soon as they shall have been graduated. Dr. Althoff, replying to Dr. Böttinger, calls attention to the extension of technical chemical work in the different institutions and particularly in the University of Berlin, and at the same time he calls attention to the more thorough study of physics, theoretical and applied, as it is particularly carried on in Göttingen. Dr. Lippmann declares that if progress in the chemical industries is to continue, the facilities for the education of technical chemists, (this class constituting ninety-five per cent. of the about 4,000 chemists in Germany), must be greatly improved. Similar ideas have been expressed by Professor Wichelhaus, Dr. Duisberg, Dr. Ostwald, and others of highest authority in both educational and technical fields. Dr. F. Fischer has treated the subject most exhaustively in a paper entitled "The Study of Technical Chemistry in the Universities and Technical High Schools of Germany and the Examination of Chemists."¹

A congress, devoted to technical education, was held in London, June 17, 1897, the Duke of Devonshire presiding. In his opening address he compared the technical schools of England with those of other countries, extolling the organization and work of the technical schools of France and the Realschulen of Germany, and enlarged upon the value of thorough preparatory training of those who will enter the field of technical work with prospects of success. This Congress was likewise addressed by Dr. O. N. Witt, of Berlin, Dr. Lunge, of Zurich, and Dr. J. H. Gladstone, of London.

¹ The subject was further eloquently discussed in the general meeting, during the past summer, of the German Electro-Chemical Society, by Dr. Ostwald, Prof. v. Baeyer, Dr. Böttinger, Dr. Holtz, and others. The discussion is worthy of careful study.

Responding to the general demand, the new University of Brussels has established in the Gährungs Institut, under the direction of Dr. J. Effront, a summer course of study on subjects relating specially to the fermentation industries. It consists of lectures by eminent authorities in the different departments, accompanied by illustrative exercises in the laboratories for analytical chemistry, bacteriology, yeast culture and fermentation.

In our own country, while the demand is probably not so imminent, the possibilities of it have been most wisely foreseen by the directors of many of the educational institutions, and the extension of study to the applications of the principles of chemistry and physics is gratifying. In the East this is particularly manifest in the Massachusetts Institute of Technology, in Harvard University, Columbia University, Cornell University, and the University of Pennsylvania; and the institutions located west of the Alleghanies are working in the same direction with excellent results.

These are, it seems to me, the most important signs of fundamental progress in industrial chemistry that can be imagined or considered. We must all accept the expressed views regarding the better and more thorough education of the young men upon whom the responsibility for further progress must fall. For myself I have come to feel most acutely this necessity of our times and the desirability of a supply of young men who have had training not in the hurry of a year or two to make chemists who are analysts merely, and more frequently very indifferent analysts at that, but of those who have had the most careful training in the fundamental principles of the science, the physical relations of the elements and compounds, the thermal and electrical relations, the great theories upon which all productive practical work must be based. In many respects, heretofore, the tendency to specialization has been too marked and to the detriment of the all-round training necessary to effective work. Men carefully trained first in the fundamental principles and theories and then in the practice of observation and investigation are better able to apply themselves to specialties, than those trained as specialists are to meet the problems and difficulties which are likely to come to them in the conditions and situations in which they are sure, at one time or another, to find themselves. It seems to me, therefore, that the demand of the present time, and that of the immediate future, can be met only by broadly educated men; by men who have been trained not only in chemistry of itself, but in the great principles of physics as well. A good technical chemist must first of all be a good and thoroughly educated chemist; after that, to obtain the highest success in

this country, he must be educated in the principles of engineering; the production and applications of heat; the production and applications of electricity; the transmission of power; the movement of liquids; in general the means whereby the reactions of chemistry, which he may be called upon to apply, may be carried out in a large way. If the young men are to occupy commanding positions in the great chemical works, they must have preparation in these lines before they leave the educational institutions or they must acquire it after they have been graduated from them and have entered upon their life work. I agree with Dr. Duisberg, that whenever it is possible it is better to employ a chemist for chemical work, and an engineer for the engineering work in establishments where the best organization is to prevail, but in this country where the industries are in most cases not so largely developed as in Germany or England, and where beginnings have still to be made, the chemist will in very many cases be compelled to do his own engineering, even as in many cases the engineer must be his own chemist. We need, therefore, chemical engineers, and these in the nature of the requirements must be broadly and thoroughly educated men. While they must be trained for the work of the research laboratories, which are being organized in connection with many of the great industries, they must likewise be prepared to put into practical operation in a large way the results of the researches they have been called upon to make.

In this connection I cannot refrain from urging upon educators the importance of impressing upon young men that the controlling principle of successful work is the search for and establishment of truth; that honesty is after all the foundation of true progress; that absolute accuracy and personal responsibility are the prime necessities, and will be as firmly exacted in the valuation of a commercial product as it must be in the determination of an atomic weight.

It is not my purpose in this paper to enter further into the discussion of this great, interesting and absorbing question. I touch upon it by way of introduction, because of the great progress the present and continued agitation of it indicates, and the enormously important results which in the near future must flow from it.

Another important manifestation of progress in industrial chemistry is to be seen in the organization of the series of International Congresses of Applied Chemistry to be held once in two years in the different capitals of the world. The first of the series was held in Brussels in 1894, and the second was held in Paris last year. The latter was organized under the direction of the Association des Chimistes de Sucrerie et de Distillerie de

France et des Colonies, and met in Paris from July 27 to August 7, 1896, with over one thousand delegates in attendance from different countries, and nearly every branch of chemical industry represented. The several sections into which the congress was divided held more than sixty separate sessions, and it is stated that the report of the proceedings will require three volumes of at least 500 pages each.

One of the useful results of the work of the congress was the adoption of the proposition of the Verein Deutscher Chemiker, regarding the preparation and standardization of chemical measures. Two committees, one French, and another German, were appointed to consider this subject, and before the conclusion of their labors they are to meet together to prepare a report to be delivered and discussed in the next congress to be held in Vienna in 1898.

Most important results may be expected to flow from the labors of these eminent authorities, and the establishment of the committee illustrates most forcibly the demand for exactness and accuracy in technical work.

No less important as indications and records of industrial progress are the expositions of the products which are being held from time to time in different parts of the world. The Berlin Exposition held during the past year is an excellent illustration of this fact and the report of Dr. O. N. Witt upon it may be studied with profit by those who would gain a good knowledge of the progress of industrial chemistry in Germany as illustrated in the commercial products and manufacturing apparatus there exhibited. He describes the means for the use of liquid and pulverized fuel; the utilization of gas-house wastes for acid manufacture and as an accompaniment of this process the preliminary recovery of the ammonia and cyanides from the crude product; the production of material for the Welsbach mantles in which so great progress has been made during the past few years; compressed gases for various uses; the production of five chemicals; the persulphates and the admixture of these new and useful substances with the cyanides to be used in gold extraction; colors and organic disinfectants and remedies; fats and candles; soaps; artificial ethereal oils; and other substances of interest to chemists and of value to the industries. The information offered concerning the products exhibited and the principles upon which their preparation is based is extensive and the entire paper is characteristic of its author.

In like manner the report of Dr. Oppler on the department of chemical industries of the Bavarian Landesausstellung held in Nürnberg and opened May 14, 1896, is of most interesting value. The distribution of the exhibitors in this department is

an indication of the character of the information offered in the report of Dr. Oppler and the numbers in each class respectively are as follows: Salines, 4; heavy chemicals, 2; ordinary chemical preparations, 16; colors, 21; aniline colors, 1; explosives, 3; matches, 4; artificial fertilizers and glue, 17; resins and pitch, 6; soap-boiling and perfumery, 16; stearin and wax candles, 11; ethereal oils and petroleum distillates, 2; varnish lacquer and cements, 8; asphalt and roof covering, 2; rubber manufactures, 4; impregnating, 1; mineral water manufactures, 4.

That this exhibition should have been important was to be expected from the fact that in Bavaria, of a total population of 5,268,761, at least 685,298 are employed in the industries; that the Badische Anilin and Soda Fabrik in Ludwigshafen, which employed last year 4,800 persons including 100 educated chemists and 30 trained engineers, is to be included in the works represented. Besides the products of the truly chemical industries, metallurgical products, fuels and cements were largely represented and are exhaustively treated by Dr. Oppler in his report.¹

The further register of the progress attained in the industries is to be found as well set forth in the literature of patents of invention as in other published matter. For it must be acknowledged that however much of careful work may be done in the research laboratories of the great industrial establishments or however important may be the immediate results of the application of new processes, the knowledge acquired finds its way to the published records but slowly and is generally held back because of the necessities of the active competition involved in the struggle for commercial supremacy. The protection afforded by the patent laws serves therefore a doubly useful purpose: that of preserving to the inventor or investigator the commercial results of his labor, and of bringing before the world without delay the truths which have been developed to serve as suggestion or incentive in further efforts in like or different directions. It will profit us therefore to consider briefly some of the developments which in this way the past year has brought forth.

It would be impossible in the time which could reasonably be allotted to such a paper to cover the entire field of industrial chemical activity and we must therefore be content with a limited scope. Some of the departments can be treated intelligently only by specialists working in them; and this applies particularly to the carbon compounds used as colors and dyes, as disinfectants and as remedial agents, the progress in the production of which has been enormous and most rapid. It is also true of the fermentation industries which have been so materially advanced by

¹ The exhibitions of Brussels and Leipzig have been very important and must have a marked influence upon all departments of industry and those involving the applications of chemistry must share the impulse. Valuable reports will doubtless be made of these two exhibitions.

biology and biochemistry; of the clay and cement industries which have been so much stimulated from the engineering sides. In metallurgy besides the further development of the basic process for manufacture of steel and the utilization of its wastes, the electrolytic production of aluminum, the electrolytic refining of the heavy metals as lead, copper, silver, and gold, considerable activity has been shown in the development of the cyanide and other processes for the extraction of gold from low grade ores by lixiviation. The cyanide process of MacArthur and Forrest has received special attention and has been improved by the addition of various agents to the solution for lixiviation to render it more active. Keith adds mercuric cyanide equal in weight to half that of the alkaline cyanide used and claims that the mixed cyanides act more rapidly and effectively than the alkaline cyanide alone. Mactear proposes the use of cyanuric acid equivalent to about five per cent. of the weight of potassium cyanide and to produce the compound within the solution by adding hypochlorite or hypobromite thereto. He claims that the solvent action of the cyanide is increased and that saving of cyanide is effected by reducing its action upon the base substances in the ore. The Chemische Fabrik auf Actien, recognizing that oxidation is necessary to the effective reaction between gold and the cyanide, and recognizing the disadvantages and losses attending the use of the metallic peroxides, permanganates, ferricyanides and hypochlorites because of their power to oxidize the cyanides to cyanates, have found that the persulphates, while they have no oxidizing action upon the cyanide even with considerable concentration and a temperature as high as 45° C. when mixed with the cyanides, render them peculiarly active as solvents for gold and silver. The solution is more active in the presence of free alkali which serves to combine with the acid liberated by the decomposition of the persulphate, and to form a compound which may be stored, transported and readily used, the company mix together ten parts of potash, forty parts of potassium persulphate and fifty parts of potassium cyanide. The mixture is dissolved in water in the usual way and in the usual proportions.

The same company have found that the nitro and nitroso-carbon compounds and the salts of their sulphonic acids have a similar intensifying influence upon the solvent power of the cyanides. For instance the addition of nitrobenzene to the cyanide solution is claimed to make it act from forty to fifty times as rapidly as the plain solution of equal strength.

For ores, to the treatment of which the cyanide process is not applicable, Lodge and Cassel and Hinman propose the use of weak solutions of bromine. A solution containing 0.15 to 0.25

per cent. of bromine is suggested and digestion of the ore with the solution is to be continued about two hours before final lixiviation. It is claimed that the solvent power of bromine is greater than that of chlorine and that it is further more effective because it carries less of baser metal into solution.

Endeavor in the separation of zinc from its ores and admixture with other metals has been active, and the results secured by Siemens and Halske seem to be of practical value. These authorities leach the ore containing zinc oxide with a solution of aluminum sulphate whereby basic aluminum sulphate is produced and zinc is carried into solution as the sulphate. The leach is electrolyzed when zinc is deposited at the cathode and the aluminum sulphate is regenerated at the anode. Kellner leaches the ore with a caustic solution, dissolving the oxide, obtaining a leach from which the metal may be extracted by well-known methods. And Mond modifies it by placing within the solution some sodium amalgam, plunging into the amalgam a rod of metal electronegative thereto, when the zinc is deposited on the rod.

Mond has further developed his process for the extraction of nickel dependent upon the production of the volatile carbonyl compound of the metal. In practice the metal is first reduced in the ore by means of hydrogen and the cooled ore transferred to the volatilizing chamber where, descending from one tray to another, it meets an ascending current of carbon monoxide gas. The carbonyl compound is carried to an adjoining chamber where decomposition takes place and the metal is deposited.

The example of Whitehead in the preparation of tellurium on a comparatively large scale has been followed by Farbaky in Schemnitz who has succeeded in obtaining an ingot of 820 grams of the purified product.

Hilbert and Frank have improved upon the production of phosphorus in that they avoid the intermediate preparation of the crude material by heating the latter in an electric furnace similar to that used for carbides. For instance ordinary calcium phosphate is ground up with carbon and the mixture heated in a properly constructed furnace. Reduction promptly occurs, calcium carbide is formed, and phosphorus and carbon monoxide liberated. Aluminum phosphate serves as well.

In the commercial production of the carbides some progress has been made. The production of the silicon compound, carborundum, is reported to have amounted in 1896 to 1,191,000 pounds of the crystalline variety. The amorphous product which accompanies the crystalline variety has thus far been of little or no commercial value but it has been suggested as a substitute for ferro-silicon in steel manufacture. It has been estimated that Ger-

many alone could use annually 2,500 tons of the product and an endeavor will be made to supply it.

The brilliant work of Moissan in the application of the electric furnace to the production of the carbides has brought forth among many others the titanium carbide which excels in hardness all known substances and which without great delay will probably become a commercial product.

The production and application of calcium carbide are extending. The Neuhausen Aluminum Company have established new works at Rheinfelden and the electro-chemical works at Bitterfeld have acquired land for the same purpose. The former company it is said will produce carbide at a cost below forty pfennigs per kilogram, a price scarcely encouraging. In spite of the extension of the manufacture comparatively little progress has been made in the process used beyond the mechanical appliances for making it continuous. The reduction in the cost of the product must be effected by reducing the cost of the power used.

What is true concerning the carbide is likewise true of the acetylene gas produced from it. Hundreds of devices have been made for liberating the gas for use in various ways all differing but little in principle and only as regards mechanical construction. Compared with coal gas and taking into account its illuminating capacity when used alone or mixed with air it is probably no more expensive but the prejudice prevailing regarding its sensitive character and the consequent danger attending its use in spite of the official reports regarding this quality will deter its wide application. Experiments with the gas in engines gave results unfavorable to its use in that way.

For use to enrich coal gas for illuminating, acetylene has proved less effective than benzene with which at the present time at least five per cent. of the gas used in Germany is improved. The declining cost of benzene due to its increasing recovery from coke-oven gases makes it available for this and many other uses from which, on account of cost, it has heretofore been excluded. It has been found particularly effective in the crude state when mixed with spirit for use in the incandescent spirit lamp. Experiment has shown that spirit mixture containing fifteen per cent. of xylene gives a temperature of $6,700^{\circ}$ C. If the crude benzene in the spirit mixture be increased to $33\frac{1}{2}$ per cent. it is stated that it may be used as a substitute for petroleum in coal-oil lamps.

In Germany the process of extracting the benzene from the coke-oven gases has consisted in passing the latter through a tower against a finely divided stream of high boiling-point hydrocarbon oil and subsequently separating the benzene by fractional distillation, while the oil is cooled and returned to the tower. The quantity so produced up to the beginning of 1896 amounted

annually to from 4,500 to 6,000 tons and it is estimated that if the production should increase according to expectation it should reach as high as 80,000 tons.

Heinzerling proposes to recover benzene by compressing and cooling the gas and to this end the compressed gas is made to pass through a series of pipes which are cooled by a current of the gas from an expansion cylinder whereby a temperature of -70° to -80° C. is produced within the tubes. Two sets of condensing tubes are used alternately and the moisture and dust, which would seriously interfere with the process, are carefully removed. With a consumption of 240 horse-power produced from gas from the ovens 60,000 cubic meters of gas yielding 1,200 kilos of benzene are daily condensed.

Nikoforow has attempted to break up petroleum and its residues by repeated fractional distillation at temperatures ranging from 550° C. at ordinary pressures to 700° C. and even $1,200^{\circ}$ C., with pressures up to two atmospheres, securing a yield of benzene equal to about twelve per cent. of the material used.

Mabery and Byerly convert petroleum residues into asphalt by passing a current of air through the heated mass. The distillation is begun at 450° C. and is continued until a temperature of 650° C. is attained. One of the products secured is said to be similar in its qualities to the natural product gilsonite.

In the desulphurization of petroleums Heussler proposes heating them with about five per cent. of aluminum chloride for twenty-four hours. At the end of the period, if the exhalation of gaseous products has ceased, the oil is distilled. Better results were obtained by doubling the quantity of the chloride and continuing the heating to 120 hours. Hinrici finds that equally good results may be obtained, with as great economy, by heating the crude oil with an equal weight of oil of vitriol of 66° B. With crude oil containing one and two-tenths per cent. sulphur he obtained a solar oil distillate containing 0.063 per cent. of sulphur. At this rate he finds the acid no more expensive than the chloride and equally effective.

Many of us will remember that somewhat more than a year ago, Nikodem Caro published the results of his experiments in the preparation of alcohol from actylene after the reactions established by Berthelot, obtaining a yield so far below what theory requires, as to render the reaction a practically hopeless one. The production of synthetic alcohol has been revived by Fritsche who has made use of the reaction discovered by Faraday and subsequently studied by Berthelot to whom it has often been credited. Attempts had been made successively by Berthelot, Cattelle and Mallet, to extract the ethylene from coal-gas and convert it into alcohol but all failed because of the presence of other

substances which were extracted at the same time and interfered with the subsequent reactions. But since the establishment of the coke-ovens and the extraction of the tar, ammonia, and benzene so completely from the gas Fritsche concluded that the ethylene could be profitably recovered and utilized. The eighteen coking establishments of Germany using a million and a half tons of coal, yielding gas containing one to one and eight-tenths per cent. of its volume of ethylene should represent an annual possible production of 95,000 hectoliters, (nearly 2,500,000 gallons) of alcohol. The large number of experiments made showed that complete absorption of ethylene may be effected by strong sulphuric acid, and when the acid is kept at 140° C. the absorption is very rapid and may be carried to a concentration of 50 per cent. of the compound produced without exhausting the absorbing power, so that 100 pounds of vitriol will serve for the absorption of 14 kilos of ethylene which will yield 18 kilos of alcohol. For the production of 100 kilos of alcohol, 350 kilos of 66° B. sulphuric acid will be required and for the complete recovery of the alcohol this must be mixed with at least 500 liters of water. The water is subsequently evaporated and the acid recovered.

Fritsche expresses doubt if, at the present cost of alcohol, the process, which gives yields very close to theory, may become profitable. But for the production of such alcohol derivatives as potassium ethyl-sulphate, ether and acetic ether, etc., he considers it has some possibilities.¹

In the manufacture of the acids and the bleaching compounds some advances have been made, but in this department of industry progress is necessarily slow. Attempts have been made to replace the lead chambers in vitriol manufacture by stoneware towers, but thus far the adoption of the improvements claimed has not been extensive. The demands of the color and explosives manufacturers for pure nitric acid of high concentration have naturally stimulated endeavor to meet them and with good results. Dr. Hart's condenser with its return connections has already found very extensive application and has proven most effective in yielding a high grade and pure product. Dieterle and Rohrmann endeavor to attain the same end by passing a current of air into the distilling chamber and providing return connections in the condensing coils to a side pipe for the escape of the air carrying the halogen and other impurities. The nitrous compounds are said to be oxidized to nitric acid and the high grade distillate to be therefore free from these troublesome substances. Dreyfus decomposes alkali nitrates at a temperature carefully regulated at 170° to 190° C. in a vessel in which a vacuum may

¹ Fritsche has since patented a process for manufacture of ether from ethylene and claims that practically theoretical results may be obtained.

be maintained. Main and Stevenson heat a nitrate and manganese dioxide together in a muffle and convey the nitrous compounds liberated to an oxidizing tower fed with dilute nitric acid. The nitric acid produced is finally distilled from strong sulphuric acid, yielding a product of high degree and the sulphuric acid is concentrated by evaporation for use in subsequent charges. The residue in the muffle is heated with steam, and sodium hydroxide and manganese dioxide recovered.

Valentiner recovers the nitric acid from waste acids by distilling it from strong sulphuric acid in a vacuum. He states that if a mixture of 800 kilos of strong sulphuric acid and 1,200 kilos of impure nitric acid of 1.40 sp. gr. be distilled *in vacuo* so that the temperature may not exceed 100° C., all the water and impurities will be held back and nitric acid of 94 to 96 per cent. of monohydrate will be obtained.

The Verein Chemischer Fabriken likewise distil the acid from strong vitriol. From a properly constructed vessel containing sulphuric acid the nitric acid vapors are carried into a tower fed with water heated to 85° C. and from here they pass to the cooling condenser. The warm water absorbs the impurities and returns them to the still and the pure acid issuing from the condenser is said to have a strength of at least 94°.

Jung and Steuer undertake to recover hydrochloric acid by a somewhat round-about process from the calcium chloride of the ammonia soda process. The properly concentrated chloride liquor is mixed with copper sulphate to produce double decomposition. The cupric chloride separated from the calcium sulphate is decomposed by hydrogen sulphide. The copper sulphide separated from the hydrochloric acid is exposed to the air in thin layers to be oxidized to sulphate for subsequent use in the process while the calcium sulphate is heated with carbon, in furnaces, to reduce it to sulphide, which, in turn, may be treated for sulphur by the Chance process. It is extremely questionable if the hydrochloric acid can be obtained in this way entirely free from lime salts, but the inventors suggest that these will not interfere particularly when the acid is to be used for the generation of chlorine by the Weldon process.

In view of the rapid extension of the production of chlorine by electrolysis, the reaction, occurring when aqueous vapor and chlorine are led over glowing carbon, producing hydrochloric acid and carbon monoxide, acquires a higher interest. It is possible that the process based upon this reaction may yet prove profitable, and certainly it will be free from the growing objection of the old process, that it will leave behind no residue of cumbersome sodium salts.

In the generation of chlorine from hydrochloric acid, a great

deal of experiment and investigation have been carried on. The improvement of the Deacon process by passing air along with the acid gas, Mond's substitution of nickel for the copper of the Deacon process, and the various modifications of the reaction between nitric acid and hydrochloric acid have all had their supporters. The latter reaction has had the largest share of attention, but in spite of all the thought and energy which seem to have been devoted to it, the promise for its future is not brilliant. All the processes and forms of apparatus devised for carrying out the reaction depend upon bringing the nitrosyl chloride into proper contact with vitriol. The process and apparatus seem to have the merit of greater simplicity, at least, than the others described, and the essential part thereof consists in perfecting the oxidation of the hydrochloric acid and the decomposition and removal of the nitrous compounds by systematically subjecting the gas alternately to the action of nitric acid and hot sulphuric acid. To effect this they arrange two vertical towers, each divided into compartments by diaphragms with hydraulic seals. A stream of nitric acid is made to flow downward through one tower and hot sulphuric acid to descend through the other. Gas from the decomposing apparatus and containing nitrous compounds is introduced to the bottom of the lower compartment of the nitric acid tower and passes from the top of this to the bottom of the lower compartment of the vitriol tower. From the top of this, in turn, the gas passes to the bottom of the next upper compartment of the nitric acid tower, then from the upper part of this compartment back to the bottom of the second compartment of the vitriol towers and so by zigzag course from one to the other, until it finally passes out from the top of the vitriol tower dry and free from hydrochloric acid and nitrous compounds. The acids used in the towers are regenerated for use in subsequent charges.

As before stated, this differs practically only in the mechanical arrangement for effecting the oxidation and the purification of the chlorine gas, and is therefore similar to the processes of the Wallis chlorine syndicate, of Sadter and Wilson, Scott and Vogt, Verein Chemische Fabriken zu Mannheim, Krause, and others, which have been described within the past year and a half. The complicated character of the apparatus required, the difficulty in moving the corrosive gas, the losses of nitric acid, all conspire against the extensive application of any of these processes in competition with the new electrolytic processes for the same purpose. The latter are being adopted with enormous rapidity, as may be gathered from some statistics from Germany for 1895 and 1896. Thus, from January 1 to the end of September, 1896, the imports of chloride of lime were 3,342 tons, and the exports 50,549 tons; while for the corresponding

period of 1895 the imports were 10,232 tons, and the exports 23,636 tons. In Austria, it is stated, that works using 200 horse power are in operation, and those requiring 3,000 horse power in process of erection. In England these processes have been received with peculiar favor and thousands of horse power are being consumed in the works devoted to them. At Saltville, Va., the Matthieson Alkali Company have made a beginning and have projected works to be erected at Niagara Falls covering twenty acres of ground. These works, when completed, will use the Castner process, and employ 150 men and 2,000 horse power.

The methods which have been found most effective and acceptable are those without diaphragms, like that of Castner and Kellner, and those with diaphragms similar to that of Hargreaves and Bird. Thus far the former have had the widest application, although it is claimed that the Hargreaves cell can be operated with a lower consumption of power. The difficulties in the operation of both kinds are, however, being rapidly overcome, and we are likely, in the near future, to be called upon to record the entire replacement of the old chlorine and soda plants by those operating the electrolytic processes.

Before leaving the subject of electrolysis in the production of bleaching compounds, we may not overlook the new and interesting peroxidized substances—persulphates and percarbonates—which bid fair to replace many of the well-known oxidizing and bleaching agents.

Persulphuric acid and the persulphates are produced by the electrolysis, respectively, of the free acid or the acid salts. The most useful, however, are the potassium, ammonium, and aluminum salts, that of ammonium being the most stable. In like manner Constam and von Hansen produce the potassium percarbonate by electrolyzing a saturated solution of potassium carbonate, kept at a temperature of -10° to -15° C. Platinum electrodes are used in a cell with a diaphragm and the product obtained, which decomposes readily, must be protected from heat and dried quickly. It is comparatively stable in iced water, but in warm water it breaks up with production of free oxygen. Both classes of salts may be used as oxidizing agents, and the persulphates, as already stated, have been recommended for use in the cyanide gold extraction process, to intensify the solvent action of the cyanide solution.

Wolfenstein finds that hydrogen peroxide solution, if free from certain impurities, may be concentrated by ordinary evaporation to about fifty per cent. To concentrate it further it may be extracted with a substance, like ether, insoluble in water. After removal of ether the product may be distilled in a vacuum

of sixty-eight mm. and a temperature of 84°-85° C., yielding a distillate containing ninety-nine per cent. of the peroxide.

It is probably true that in no field of chemical industry has greater activity been manifested than in the production of the compounds of nitrogen, and particularly ammonia and the cyanides. The increasing demands of agriculture, the manufacture of the various nitro compounds for colors and explosives, and the new gold extraction processes, have long served to stimulate the search for new sources of combined nitrogen and the effort expended is beginning to bear fruit. Heretofore, the principal known sources of combined nitrogen have been animal or other organic matters, and coal and the niter beds of South America. The latter has been an almost constant source of supply. That from animal matter has grown with the growth of the great meat-packing industries and the recovery of their waste products, while the improvements continually being made in the gas and coking industries would seem of themselves almost capable of meeting the demands. It is interesting in this connection to compare the English statistics for sulphate of ammonia production in 1886 and 1895, respectively.

	1886. Tons.	1895. Tons.
Gas works.....	82,480	119,645
Shale works.....	18,090	38,335
Iron works.....	3,950	14,588
Coke works.....	2,100	7,083

The iron works ammonia is produced largely in Scotland, where, it is stated, as much as two and a quarter million dollars are invested in its recovery.

Hagenstock, of Dalhausen, states that Rhenish Westphalia alone produces annually 6,000,000 tons of coke, using 8,000,000 tons of coal. On the basis of the recovery of ammonium sulphate, equal to one per cent. the weight of the coal, the amount annually recovered should be 80,000 tons, worth \$4,000,000. Knublauch gives some interesting figures regarding the distribution of nitrogen in the distillation of coal and finds that about fifty per cent. of the nitrogen remains in the coke, thirty per cent. remains in the gas, twelve to fourteen per cent. is converted into ammonia (corresponding with 10.55 pounds sulphate of ammonia per ton), nearly two per cent. into hydrocyanic acid (equivalent to 1.42 pounds ferrocyanide per ton), while one and a half per cent. is found in the nitrogen bases in the tar. On the basis of a yield of 0.20 to 0.25 per cent. of the weight of the coal, the 1,000,000 of coal, which he estimates is daily consumed in the gas-works and coke-ovens in the world, the sulphate available should amount to 10,000 to 12,000 tons. Yet Truchot, quoting Legrand, declares that Belgium uses in agriculture but

one-sixth, Germany one thirty-sixth, France one fifty-fourth, and England one sixty-sixth the nitrogenous manures they might use with advantage. If this estimate of Legraud be correct it is easy to see that the possible demand is far from being met at the present time.

The indirect utilization of atmospheric nitrogen by vegetation has now been fully established. Von Beyerrinck, Hellriegel, Wilfarth, Nobbe, and others, find the most important agent in this connection to be the bacteria of the root nodules of leguminous plants. And Nobbe and Heltner find that these nitrogen-fixing bacteria, when introduced to soils free from them and unsuited to the cultivation of leguminous plants, produce in the roots of such plants nodules or tubercules, in which fixation of free nitrogen and its conversion into assimilable forms is effected. Soil wanting in assimilable nitrogen, and therefore practically sterile, becomes fruitful and will produce good leguminous crops when inoculated with the bacteria.

The bacteria are produced in agar gelatine containing sugar and asparagin or the green substance of the plant. The culture medium, when saturated, may be dissolved in water and so be used to moisten the seed, or it may be mixed with dry earth, which is sown broadcast. The firm of Meister, Lucius & Bruning, in Höchst on the Main, have undertaken to produce cultures of the bacteria commercially and supply them in form convenient for transportation, preservation, and distribution. The cultures are enclosed and marketed in small bottles, each containing sufficient to inoculate half an acre of ground. The success of the new industry remains to be established.

In the production of ammonia from sources other than those mentioned, Sternberg proposes the ignition of such organic matters as sugar-house waste, with alkali aluminate made by melting together lime, crude potash, and bauxite or clay. This, finely ground, is mixed with the organic waste, such as molasses, and charged to the top of a vertical retort so arranged that the gases generated may be drawn over the hotter charge at the bottom. From time to time the aluminate is drawn off at the bottom to be used again, and fresh material is charged to the retort at the top. Nitrogenous gases may likewise be passed over the hot material for ammonia production. This process has elsewhere been credited to F. O. Matthieson.

Raschen and Brock propose passing a mixture of nitrosyl chloride and hydrogen over heated platinized asbestos whereby, in presence of some excess of hydrogen, reduction is effected and ammonium chloride is produced. The vapor is conducted into a chamber maintained at 100° C., where the salt is deposited. In like manner it is stated that nitrogen oxides may be reduced to ammonia.

Lord Rayleigh has lately made a study of the oxidation of free nitrogen under the influence of the electric spark. He made a large number of experiments and obtained the best results by confining in a flask a mixture of eleven parts of pure oxygen and nine parts of air, passing through the mixture a spark from a current of forty amperes and 8,000 volts. In practice he forced a solution of potash into the flask in such a way that its walls were constantly washed, the liquor being kept cool, and passed the mixed gases through the flask while the current was in operation. His results showed the efficiency to be equal to twenty-five cc. of absorption per Watt hour.

Following the same line of thought, Siemens and Halske claim that when air or oxygen and nitrogen are mixed with ammonia and subjected to the influence of the silent electrical discharge a profitable yield of ammonium nitrate may be obtained. It is important to the efficiency of the reaction that the air or gases and the ammonia shall be perfectly dry before they enter the apparatus, and that the air be previously ozonized. In practice the dried air and ammonia gas in proper proportions, which are found to be one volume of air and 0.01 to 0.02 volume of ammonia are passed slowly through an apparatus similar to that for producing ozone, and it is claimed that if the precautions described are carefully observed, the whole of the ammonia will be converted into ammonium nitrate. From the results obtained by Lord Rayleigh and by Siemens and Halske, it would seem that the presence of an alkaline substance to combine with the oxides at the instant of their formation is necessary to the reaction.

Since the discovery of argon and the application of magnesium and lithium to the removal of the nitrogen from the deoxidized air by the formation of the nitrides, considerable attention has been devoted to the commercial production of these interesting compounds. Rossel and Franck studied the subject experimentally following the suggestion of Winkler that the combination of magnesium and nitrogen is favored by the presence of an indifferent substance to prevent oxidation, heat together at red heat in an open crucible, a mixture of calcium carbide and magnesium powder, and find that the magnesium is practically all converted to nitride. They state further that under similar conditions aluminum, zinc, and iron will take up nitrogen.

Mehner, and likewise Willson, following the same idea, expose such elements as boron, silicon, magnesium, and titanium as are capable of combining with nitrogen at high temperatures, to the heat of an electric furnace in presence of carbon and nitrogen, using a current of high tension. Franck obtained aluminum nitride by heating the finely divided metal with powdered calcium carbide in a crucible and declares that when the metal is

heated with dry slaked lime the nitride may be obtained in large quantity. Practically all the nitrides yield ammonia when mixed with water. In the cold the aluminum compound decomposes but slowly, and Franck suggests that on this account it may have considerable manurial value. The production of nitrides in the electric furnace by the methods of Mehner and of Willson may become profitable sources of ammonia.

Experiment in the production of cyanides has been particularly active and practical advances have been made toward the acquirement of sources heretofore unavailable. In the old method of fusing nitrogenous organic matter with alkalis and iron, comparatively little improvement has been made. Bower adds iron thiocyanate to the melt toward the end of the operation and claims to secure thereby an increased yield. Reichard and Bueb submit lyes and molasses to dry distillation and slowly pass the gases generated through flues heated to $1,000^{\circ}$ to $1,100^{\circ}$ C. The gases finally pass through an absorber charged with a solution of iron salts. For such absorption Holmes recommends the use of an alkaline liquid in which ferrous carbonate is suspended. Drehschmidt recommends a mixture obtained by decomposition of a ferrous salt with calcium or magnesium carbonate and declares that this mixture is particularly favorable to the extraction of the cyanides from illuminating and coke-oven gases when much carbon dioxide and hydrogen sulphide are present. From the gas of coke-ovens the quantity of cyanides to be obtained is said to be variable according to the temperature of the oven. Thus a published report states that with a temperature of 900° C. eight grams of sodium ferrocyanide was obtained from a cubic meter of gas, while with a temperature of 950° C. the yield was increased to fifty-six to ninety-five grams of the salt.

Aitken proposes special construction and operation of blast furnaces with a view to the production and recovery of cyanogen. Two stacks erected alongside each other and rather higher than usual are connected by a lateral tube or pipe at the top. When the blast has been shut off from one and the slag and metal are being drawn off, a draft is started through an opening near the tuyeres and gases from the second furnace, drawn downward through the heated charge of the first. When the charge has finally been drawn off, the draft is stopped and the blast started again. When the second furnace is being tapped, the draft is made from a similar opening near the tuyeres and gases from the first furnace drawn downward through the charge of the second. In this way the furnaces are operated alternately and the gases drawn off are said to be particularly rich in cyanogen.

Nikodem Caro, in *Die Chemische Industrie*, and Couroy, in a paper presented to the Society of Chemical Industry, of England, have discussed the production of cyanides in a most interesting and instructive manner, the former from a more or less theoretical standpoint and the second from the results of a series of critical experiments made for the United Alkali Company. Both of these papers are full of practical suggestion and well worth careful study by every one interested in this branch of chemical industry. Naturally, both these authorities classify the methods used and available, as follows: (1) those producing cyanides directly and involving the use of atmospheric or other nitrogen and heat, and (2) wet methods with intermediate production of the thiocyanates. Neither, however, recognize the methods involving the reduction of oxidized nitrogen compounds. Under the first class Caro discusses the history of the reaction, and the work of Liebig, Karmrodt, Beilby, Barr and MacFarland, Siepermann, and others, in which, in various ways ammonia gas is brought into contact with carbon, impregnated with potash. Karmrodt obtained a yield of only about twenty per cent. of the theoretical. Beilby hoped to improve upon it by adding to the carbon-alkali mixture twenty per cent. of potassium cyanide, whereby it could be kept fluid, allowing the mass to flow over gratings arranged in a vertical column, while the ammonia gas was passed upward through the same column. Barr and MacFarland considered cyanide to be formed by double decomposition of carbon monoxide and ammonia, and Siepermann proved that the reaction between potassium carbonate and ammonia was possible without the intervention of carbon forming cyanate, potash, and water. To avoid the subsequent reduction of the cyanate with carbon he proposed mixing the potassium carbonate with barium carbonate and carbon, making a single operation of the reactions, and Caro declares that experience with the process shows it to be perfectly operative.

Couroy, discussing these reactions from the standpoint of his own experiments, states that operating with the process of Grüneberg, absorbing the ammonia at a low temperature and reducing the resulting cyanate at a higher temperature with carbon, he obtained a yield of only four per cent. of the ammonia entering the apparatus. With the process of Young and MacFarland, heating in a bent tube to $1,000^{\circ}$ to $1,200^{\circ}$ C. caustic potash and carbon in the proportion of 10 : 1 by weight, adding powdered charcoal from time to time till the weight added reached twenty to thirty per cent. of the weight of the potash used, he passed through the molten mass a carefully dried mixture of nitrogen, carbon monoxide, and ammonia, and secured a conversion to cyanide of thirty to thirty-three per cent. of the ammonia used. Time seemed to be an important element in the

reaction and production seemed to increase with the proportion of cyanide present.

Caro, discussing the methods involving the use of free nitrogen and heat, offers an extended review of the history of the reaction and process depending upon it from its discovery by Bunsen and Playfair to the present, and accepts Berthelot's explanation of the reaction that it depends upon the formation of potassium carbide, which in the heated condition may combine with nitrogen to form potassium cyanide. This, he considers, would satisfy the conditions of the process of Lambilly which, he says, consists in heating a mixture of potassium, sodium or barium carbonates with carbon as long as carbon monoxide is evolved and passing over the resulting mass at white heat, equal parts of nitrogen and illuminating gas, under pressure corresponding with ten to fifteen cm. of mercury. But Lambilly subsequently modified his process by first producing pure acetylene and passing this in admixture with pure atmospheric nitrogen over the hot alkali and carbon. Again, in the application of the Fogarty process in Pittsburg, whereby a mixture of finely divided lime and coke were fed into the top of a narrow vertical furnace provided with baffling plates and heated from the top to a temperature of 2,200° F. by the products of the imperfect combustion of a natural gas, cyanides were produced under conditions favoring the production of acetylene and its subsequent contact with heated alkali and carbon. A question naturally arises as to the possible part of acetylene in this reaction.

Both Caro and Conroy seem to consider the wet method of Gelis and its modifications to be the most promising. This, it will be remembered, consists in heating together ammonia and carbon disulphide, converting the ammonium thiocyanate into the corresponding calcium salt and this, in turn, by means of potassium sulphate into the potassium salt, which may then be desulphurized with iron. The process is said to be carried out by Grolich and Wichmann, in Hamburg, but the desulphurization by iron is found to be satisfactory only when filings are used in double the theoretical quantity and the whole heated under pressure to 110° to 120° C., whereby 80 per cent. of the theoretical yield is obtained.

Conroy, like others, found the consumption of ammonia, due to the production of sulphide, to be inconveniently high, and the pressure resulting from the production of hydrogen sulphide to be troublesome. He favors the suggestion of Hood and Salomon that manganese dioxide alone, or mixed with lime, be added to the charge, whereby their cyanides and sulphides are produced, leaving all the ammonia available for conversion into cyanide. Operating under the suggestions of Crowther and Ros-

siter, and of Hurter and Hethrington, Conroy heated together in a properly constructed jacketed vessel slaked lime, water, ammonia, and carbon disulphide, agitating the mixture and keeping it at a temperature of 100°C . for two hours. The thiocyanate remains in solution after distilling off the excess of ammonia and precipitating the lime with carbon dioxide. Conroy obtained quantitative results with this method.

From the results of his experiments he concludes :

1. "That the reaction between carbon disulphide and ammonia to form thiocyanate proceeds easily and completely. The addition of lime does not influence the yield one way or another, provided ammonia is present in excess, but simply serves to reduce the pressure within the apparatus.

2. "That carbon disulphide and calcium sulphide combine quantitatively in theoretical quantities when treated under suitable conditions to form soluble thiocarbonate. The combination takes place in the cold or at 100°C ., but especially well at 50° to 60°C .

3. "That the solution of calcium thiocarbonate may be quantitatively converted under suitable conditions into thiocyanate. For good yield, large excess of ammonia must be present."

It has been proposed to replace part of the lime by magnesia, which under pressure absorbs hydrogen sulphide, evolving the gas below 100°C ., or release of the pressure, while the base is precipitated for reuse.

For desulphurization of the thiocyanate Conroy favors the use of iron. To secure a good reaction (1) the material must be perfectly dry, (2) the iron must be finely divided, (3) the substance must be intimately mixed, and (4) a reducing atmosphere must surround the reacting mass.

Since the publication of these papers of Caro and Conroy, many interesting developments in the production of cyanides have been made, modifying or extending the old processes or introducing new ones. Troyman passes the gases issuing from the Bessemer converter between the cooling period and the drop of the flame into a basic-lined chamber filled with coke saturated with alkali carbonate, and recovers the cyanide by subsequently leaching the coke. Swan and Keudal mix carbon and tungsten, or saturate charcoal with potassium tungstate, heat the mixture in a properly protected tube of nickel or iron, cause a current of fused potassium carbonate to flow through the tube along with free nitrogen or ammonia, collecting the resulting cyanide in a suitable receiver at the lower end of the tube. Rad and Rosenfels heat such carbides as barium and calcium in a current of nitrogen or ammonia gas and get better results when the carbides are mixed with alkali carbonates. When ammonia is

used, hydrogen is liberated. Caro and Frank find that cyanogen compounds are formed when nitrogen and aqueous vapor are passed over carbides heated to dark redness in closed vessels. In practice they charge finely divided barium carbide into a tube-shaped retort, provided with inlet and outlet for gases and vapors. Nitrogen gas saturated with moisture is passed through the retort, and at the end of two hours the reaction is complete and the charge is withdrawn. They subsequently modified their process by passing ammonia gas over the heated carbides, forming alkaline cyanide and free hydrogen.

Pflege has made the interesting discovery that the absolute exclusion of oxygen is not necessary to cyanide formation. He uses a flat, covered, magnesia-lined furnace, whose sole is covered with a mixture of carbon and alkali in thin layer, and through which air may freely circulate. The space in the furnace above the charge and under the cover is proportioned to the quantity of air needed for local combustion. The furnace is so heated from below that the carbon may become ignited in contact with air, and during the resulting combustion cyanide production is said to proceed rapidly and with very high yield. The reaction is completed at the end of three hours. He modifies his process by placing 1,000 parts of potash and 100 parts of carbon in a crucible and heating the mass to 900°C ., producing fusion. Then through a tube passing through the cover and projecting into the mass, he introduces a rapid stream of ammonia. As the carbon is consumed an additional quantity is blown in with the ammonia. At the end of three hours the alkali should all be converted into pure cyanide without by-products or impurities.

Bergmann, by passing a mixture of ammonia and coal-gas over carbon heated to $1,180^{\circ}\text{C}$., obtained conversion of sixty per cent. of the ammonia to cyanogen. One-half the residual ammonia was recovered and the remainder split up. Exclusion of oxygen seemed favorable to the reaction.

With all the manifold uses of the electric furnace it is natural that it should be applied to the production of the cyanides. Willson heats a metal or metalloid together with carbon in the electric furnace and subjects the heated mass to a current of nitrogen or producer gas, forming nitrides and cyanides, or the gases are passed through heated carbides in a separate furnace. Readman heats the oxides or carbonates of the alkali metals together with iron and carbon in an upright furnace with an electrode at the top and bottom and passes nitrogen or generator gases over the incandescent mass, collecting the fused cyanide or ferrocyanide at the bottom. Horning generates metallic vapors in the electric furnace and mixes them with carbon or

carbon compounds, preferably hydrocarbon gas or vapor and nitrogen, using considerable excess of the carbon and nitrogen. Mehner charges a U-shaped furnace with carbon and a fusible cyanide such as the barium compound and electrolyzes the mass, liberating cyanogen gas at the positive pole and barium at the negative pole. Generator gas is passed through the mass during the operation, the nitrogen combining with the carbon to form cyanogen which in turn combines with barium and is ultimately liberated at the anode. Blackmore prepares iron carbide in the electrical furnace, pulverizes the product, suspends it in a bath of fused alkali sulphide and passes nitrogen through the fused mass.

Castner makes use of the reaction between sodium and ammonia forming sodium amide and that between sodium amide and carbon producing the cyanide. His process is carried out in two operations in different apparatus. Sodium is fused and charged to a properly constructed retort from which air is excluded and heated to 300° to 400° C. Thoroughly dried ammonia gas is passed into the retort and the amide formed is conveyed to a second vertical retort which is charged with carbon and heated to dark redness. The amide dropping upon the carbon is converted into cyanide with the liberation of hydrogen and the resulting cyanide is drawn off from the bottom of the retort in a fused condition.

Moise utilizes boron nitride formed by heating borax in vapor of ammonium chloride for the production of cyanide. The compound mixed with carbon and potassium carbonate is heated to red heat in a crucible for about an hour. The resulting mass, consisting of potassium borate and potassium cyanide, is leached with alcohol dissolving the cyanide, leaving the borate for reuse.

Finlay mixes equal parts of carbon and alkali or alkaline earth (preferably barium carbonate), heats the mixture in a retort to 1,000° C., and subjects it at this temperature to a current of nitrogen and sulphur dioxide gases. When sufficient barium cyanide has been formed, the mass is pulverized, the barium cyanide and thiocyanate leached out, the leach decomposed with carbon dioxide and the cyanogen liberated collected in a soda solution. The barium carbonate is used in a succeeding charge.

Kerp has observed that when sodium acetate and sodium nitrite are fused together sodium cyanide is produced and that though in his experiment decided quantities of cyanogen gas escaped, the amount obtained was more than twenty-five per cent. of the theoretical yield.

Kellner found that when a nitrate or nitrite is subjected, either alone or mixed with nitrogen-free carbon, to the action of an arc between carbon electrodes of an electric furnace, cyanides

are produced, and Huntington has patented a process in which a mixture of acetylene and nitrous oxide in about equal volumes are drawn into the cylinder of a gas engine and exploded with a spark. The products of the explosion consisting of carbon monoxide, hydrogen, and cyanogen are passed through an alkaline solution whereby the cyanogen is absorbed and the other gases are allowed to pass along to be used as fuel.

Hood and Salomon produce thiocyanates by heating together caustic soda, carbon disulphide and ammonia, and desulphurize the resulting compound with lead or zinc. They find further that for the production of cyanogen compounds carbon disulphide may be replaced by carbon dioxide. In utilizing this principle, which seems opposed to past experience in this branch of chemical industry, they mix alkaline carbonate with finely divided zinc or manganese, heat the mass in a retort provided with a stirring gear and pass over the heated mass a current of ammonia gas. If sodium carbonate and zinc are used the products of the reaction are sodium cyanide, sodium hydroxide, zinc oxide, and water. It is recommended that a small quantity of carbon be added to the mixture to increase the yield of cyanide. The zinc oxide is reduced and enters again into the reaction.

Goerlich and Wichmann heat together in an autoclave provided with a stirring gear, a mixture of sodium nitrite, carbon disulphide, and hydrogen sulphide for the production of thiocyanate. The temperature is maintained at 150° C. and the operation continued until the manometer indicates a lowering of the pressure and therefore the end of the reaction.

According to Raschen and Brock, desulphurization of thiocyanate may be effected by treating it with nitric acid with exclusion of air. If sodium thiocyanate for instance is allowed to flow into dilute nitric acid, hydrocyanic acid and nitric oxide are liberated. The gases are passed through a scrubber with water at 80° C. to retain the nitrous vapors and the hydrocyanic acid passing along is collected in cold water or an alkaline solution. Nitric acid is regenerated from the oxide for reuse.

Lutke secures desulphurization of the thiocyanates by mixing ninety-seven parts of the potassium compound with sixty-five parts of zinc dust and heating the mass in an iron crucible with stirring. When the mass glows the external heat is withdrawn and the reaction allowed to progress. The reaction applied in this way is stated to furnish ninety per cent. of the theoretical yield.

Bower first converts the soluble thiocyanate into the copper salt by double decomposition with cuprous chloride. The copper compound is suspended in an autoclave with finely divided

iron and heated under pressure. Copper sulphide and ferrous cyanide result and the latter is treated with an alkali to produce soluble ferrocyanide.

Tscherniak mixes thiocyanate with ninety per cent. of its weight of dried oxide of iron and heats the mixture at 450° C. for one hour. The resulting mass contains an amount of cyanate corresponding with 90 per cent. of the theoretical yield, together with a little alkaline sulphate. The cyanate is purified by recrystallization at 0° C. when the sulphate separates.

To prevent the production of cyanates in the treatment of ferrocyanide for cyanide, Chaster grinds together the anhydrous ferrocyanide and alkaline carbonate in proper proportions and mixes the mass with finely divided wood-charcoal, or with gas-tar, resin, bitumen or similar substances, after which it may be treated in the furnace in the usual way.

In the reactions and processes here set forth, even though they may not all be operative and though some may even be questionable, there is food for fruitful study and much help for future work. And they illustrate the promptness with which rational investigation responds to the commercial demand.

WM. McMURTRIE.

OBITUARY.

VICTOR MEYER, who died on the 8th of August, was born in Berlin on the 8th of September, 1848. His first published chemical investigation appeared in April, 1869, and was published from the laboratory of Professor Baeyer, who was at that time professor of chemistry at the Gewerbe Academie in Berlin.

In 1871 Meyer was made professor of chemistry at Stuttgart; in 1872 he was called to Zurich; in 1885 he went as professor of chemistry to the University of Göttingen, where he remained until 1889, when, upon the retirement of Professor Bunsen, Meyer was called to his place as professor of chemistry in the University of Heidelberg.

Meyer was an extremely active and able chemical investigator. His activity is shown by the fact that since the appearance of his first paper in 1869 there have appeared in the *Berichte der deutschen chemischen Gesellschaft*, up to the time of his death, 275 separate papers from his pen, with hosts of other papers from his laboratory, the work of which was suggested and inspired by him. Besides the papers published in the *Berichte*, occasional