ADDRESSES.

(Concluded from the October No.)

SOME PROBLEMS IN CHEMICAL ENGINEERING PRACTICE.¹

By F. W. FRERICHS.

THE CLASSEN LIGNUM CO.

On April 18, 1903, there was submitted to me a circular issued by bankers in New York, Chicago and St. Louis, offering 5,000 shares of 7 per cent. cumulative preferred stock of the Classen Lignum Co. at par, each share of preferred stock to receive one share of common stock as a bonus.

The total capitalization of the company was \$2,500,000, divided into \$600,000 of 7 per cent. cumulative preferred stock and \$1,900,000 of common stock.

Everything was in readiness to put the stock on the market, but before doing so the bankers submitted to me a full typewritten statement of forty pages, setting forth the nature of the process as described by the inventor, and a number of reports on its working, made by chemists of reputation, on the strength of which subscriptions were to be solicited on the stock-market five days hence.

I was requested to make a final comment on the proposition and complied with this request two days later, on April 20, 1903.

Dr. A. Classen, of Aachen, Germany, described his process as follows: The object of the process was to turn sawdust into valuable products, and the Classen Lignum Co. proposed to work the large accumulations of sawdust in the northwestern lumber districts of the United States. The Classen process utilizes the action of sulphurous acid upon wood, which is a dissolving action without converting it into glucose. Subsequently, the surplus acid is oxidized to sulphuric acid by the oxygen of the air, and the sulphuric acid thus produced converts the soluble cellulose into glucose of a quality which is readily converted into alcohol by fermentation.

The insoluble part of the sawdust, which is called the tailings and consists of about three-quarters of the original weight of the sawdust used, is pressed into briquettes, from which, by dry distillation, wood tar, methylic alcohol, acetone, acetate lime, and charcoal are obtained, and as an important feature of the process, it was taken into account that the products from the tailings would not only pay the cost of the sawdust and of the entire Classen process, but would moreover yield a fair profit by themselves. The calculation of cost and probable profits of these by-products was among the papers submitted to me. To this I shall refer later on.

In two experimental plants at Aachen and Chicago, the alcohol part of the process was tested by experiments of many months' duration. It was proven that the product was really alcohol, but no figures were given which could prove anything about its cost. By guess work the conclusion was reached that the

manufacture of alcohol from sawdust would not cost more than the manufacture of alcohol from grain.

This conclusion seemed entirely satisfactory since the calculation of the by-products was showing for itself a large profit, and was expected to carry the process to a successful end. Full reliance was placed upon the judgment of the men who had conducted the tests, and to secure public confidence in the proposition, the full titles and honors of those engaged in the investigation were given for the purpose of characterizing the men, who were recommending subscription to stock in the company.

In such condition the reports came to me. There was no time to repeat experiments since the paper was ready to be put on the market. Moreover was it likely that the experiments were correctly conducted since chemists of good reputation had signed their name to the reports, but some of these chemists were men of science and for this reason the calculations seemed to require my attention.

The only calculation in the report was for the by-products and it was made for European conditions. It had not occurred to any one of the investigators that the same calculations might not apply to an American plant. I made a calculation for American conditions, based upon the same figures for weights and quantity, time and materials, which were used in the European calculation by constructing the table given below, in which is seen a comparison of the rentability of the process in Europe and in the United States.

This table (Table I) I submitted with the following comment:

Line 1.—The price of 4 Pf. per kilogram, or 10 cents per bushel of charcoal may be right for Europe, but is entirely too high for the United States. I was buying at that time single car-load lots at 6 cents per bushel, f. o. b. place of production, and since it was proposed by the Classen Lignum Co. to use the charcoal for blast furnaces, even 6 cents would be prohibitive, and it was believed that not more than 4-5 cents could be obtained at that time. Figuring 5 cents would reduce the income for charcoal to one-half.

Line 2.—Calcium acetate, 80-82 per cent., was valued at 1½ cents per lb. This was entirely too high. As a matter of fact, acetate lime at that time was manufactured at a great surplus in the United States and exported to Europe, where it was sold at 1½ cents per lb., but this included the freight from the place of production to European markets and included also the profits of a firm in New York, which had monopolized the article, so that the manufacturer in Michigan at that time received less than 1 cent per lb. for his product. As a matter of fact, the price of acetate lime, 74 per cent., f. o. b. place of production in Michigan, had not been higher than 0.8 cents for ten years. This caused another shortage in the receipts of the proposed works.

Line 3.—It is true that the nominal value of wood spirits in the United States at that time was 65 cents per

¹ Address delivered at the semi-annual meeting of the American Institute of Chemical Engineers, June 21, 1911.

gallon, but the price actually received by the manufacturer was much less, since the American market at that time did not absorb more than half of the production. The price for the whole consumption was kept up artificially by an American syndicate and the surplus was exported to foreign markets. In my opinion, not more than 50 cents per gallon could be obtained, which makes another reduction in the receipts of the proposed works.

Line 4.—1250 kilograms of pine tar were valued at 125 M. While pine tar in Germany may have this value, it has in this country no value at all. In

and an equal amount for general expenses, bookkeeping, stationary, postage, storage, and taxes is none too high.

Line 14.—Lime and other materials are very high in the northern states, and \$2,000 in place of 6,500 M. is very low figuring.

Lines 17 and 18.—The buildings and machinery, the cost of which is estimated at 278,560 M. under European conditions, cannot be erected in the United States for less than \$125,000 and 10 per cent devaluation on this amount will add \$12,500 per year to the expense account. To run the works, at least \$25,000

TABLE I.
Estimate of prospective profits on working 25 tons tailings a day from Classen's Alcohol Process by Heidenstom's patent.

				For Europe.		For the United States.	
				Marks.	Marks.	Dollars.	Dollars.
1.....	Charcoal.....	12,000 kilograms..	0.04	480.00	..	..	..
1.....	Charcoal.....	1,200 bushels....	..	..	0.05	..	60.00
2.....	Calcium acetate 80/82...	575 kilograms..	0.15	86.25	..	..	..
2.....	Calcium acetate 80/82...	1,265 pounds.....	..	..	0.01	..	12.65
3.....	Wood alcohol.....	87.5 kilograms..	0.70	61.25	..	..	..
3.....	Wood alcohol.....	28 gallons.....	..	..	0.50	..	14.00
4.....	Pine tar.....	1,250 kilograms..	0.10	125.00	..	..	..
4.....	Pine tar.....	1,250 kilograms..	..	..	0.00	..	..
5.....	Total per day.....	..	..	752.50	..	..	86.65
6.....	For 300 working days.....	..	..	M. 225,750.00	..	..	\$25,995.00
EXPENDITURES.							
7.....	25 tons sawdust.....	2.00	..	50.00	..	..	..
7.....	25 tons sawdust.....	..	..	..	0.50	..	12.50
8.....	15 tons sawdust, for fuel.....	2.00	..	30.00	..	..	..
8.....	15 tons sawdust, for fuel.....	..	..	..	0.50	..	7.50
9.....	40 shifts' wages of 12 hours each.....	3.00	..	120.00	..	..	..
9.....	40 shifts' wages of 12 hours each.....	..	..	..	1.50	..	60.00
10.....	Total per day.....	..	..	M. 200.00	..	..	\$ 80.00
11.....	For 300 working days.....	..	..	M. 60,000.00	..	..	\$24,000.00
12.....	Superintendent per year.....	..	..	2,000.00	..	..	2,000.00
13.....	Expenses, taxes, insurance, storing.....	..	..	15,000.00	..	..	7,500.00
14.....	Lime and sundry materials.....	..	..	6,500.00	..	..	2,000.00
15.....	Sundries and repairs.....	..	..	10,000.00	..	..	2,500.00
16.....	Patent license.....	..	..	10,000.00	..	..	2,500.00
17.....	Devaluation on machinery and buildings, 10% on M. 278,500.....	..	..	27,850.00	..	..	..
18.....	Do. 10% on \$125,000.....	..	..	..	..	..	12,500.00
19.....	Interest, 5% on M. 320,000.....	..	..	16,000.00	..	..	..
20.....	Interest, 5% on \$150,000.....	..	..	..	..	..	7,500.00
21.....	Total expenditures.....	..	..	M. 147,350.00	..	..	\$60,500.00
22.....	Total receipts.....	..	..	M. 225,750.00	..	..	\$25,995.00
23.....	Profit.....	..	..	M. 78,400.00	..	Loss.....	\$34,505.00

Europe it is used for painting sheds and cheap buildings, but in the United States nobody would think of using pine tar for this purpose. The odor imparted to the buildings by this paint is of such a character that no American would live in the same. In reality, all the American charcoal works run the pine tar to waste, or use it for fuel, and there is no value to it.

Line 9.—The wages for every twelve-hour shift were figured at 3 M. or 75 cents. This was too low. No laborer in the United States would work twelve hours for less than \$1.50.

Line 12.—The manager who is at the head of works, costing about \$125,000 could not be had for a salary of 2,000 M. or \$500 a year. \$2,000 a year would be a small salary for an efficient man.

Line 13.—The rate of insurance in the lumber district being 3 per cent would amount to \$3,750,

working capital would be necessary, which makes the entire capital used for the plant, \$150,000, the interest of which at the rate of 5 per cent, equal to \$7,500, must go to expense account.

The result of the comparison was that there was to be a probable yearly loss of \$34,505 for an American plant, against a yearly profit of 78,400 M. for a plant of the same description operated in Europe.

This argument made up on the short notice of one day and submitted to the interested parties caused the prompt withdrawal of the entire proposition, rendering valueless the expert examination of many months considered necessary by scientific chemists, and saved a large sum of money to easy investors.

THE PLANT OF THE KENTUCKY SODA ASH CO.

In April, 1892, I was approached by a syndicate of about twelve prominent men of the highest stand-

ing in the City of Louisville, Ky., to assist them in the erection of ammonia soda works. They were desirous of drawing that industry to the neighborhood of their home city, since near Brandenburg, Ky., about forty miles distant from Louisville, salt works had been operated for a long period of years with natural gas as fuel, which was emanating from the salt wells, together with the brine. In their opinion this occurrence of natural resources could be the foundation of a soda ash industry.

They had the capital, had secured detailed information about the ammonia soda process, and had a man among their number, whom they thought capable of serving as a foreman to run the works. Realizing that the ammonia soda process is largely a process of handling ammonia, they came to me as an experienced ammonia maker, to assist them in the construction of the works.

On the Mooreman farm, near Brandenburg, Ky., salt works had been operated for many years. There were two or three wells, which had supplied the works with salt brine and natural gas.

Since the production of salt had been limited, I had some doubts whether the available quantities of brine and gas would justify the erection of a large plant in that locality, and wrote before commencing work on the plant, on May 5, 1892, to the Kentucky Soda Ash Co. as follows:

"I do not believe that it is advisable to start with the soda ash works before you have proven beyond doubt that you have salt and gas of good quality, and that you have plenty of it. Cheap salt and fuel is the great advantage of your enterprise, and before you spend any money on the soda plant you should be perfectly sure of the first part. If you first sink salt wells and find no sufficient supply, you lose only the money for the wells. If you first build the soda works, sink the wells afterwards and find no supply of salt, then all your expenditures will be a clear loss."

To this I received the reply, that they knew their territory and were willing to take the risk. Moreover, they considered the erection of a 10-ton plant in the nature of an experiment, and would erect a very much larger plant on a different site—possibly in the neighborhood of Detroit, Mich., if the supply of raw material should fail. Their principal aim was to demonstrate that they could make soda ash of good quality and at low cost, and they were decided to make the experiment in their locality.

With this understanding I consented to construct a plant for them and in doing so I directed the construction of the apparatus to the minutest detail, going to many expenses, which would be justified, if the plant were to be

only an experimental works as a forerunner to a larger plant.

Under these conditions, a plant capable of making ten tons of soda ash per day of 24 hours was erected, and I will state right here, that when completed it started off running without a hitch and in a three months' run demonstrated the successful operation at a low cost. But after three months the salt wells were exhausted and needed a rest of several months before they could be operated again, and it was necessary to shut the works down. In the meantime the financial crisis of 1893 had set in and had swept away the fortunes of some of the stockholders, and the plans for erecting a larger works could not be carried out. So the enterprise came to a termination by the Kentucky Soda Ash Co. going out of business.

Since all of the plans were carried out in great detail they well may serve as an example of going at a problem of chemical engineering, and for this purpose only, I have selected some of the work for presentation in this meeting.

You all know the chemical reactions underlying the ammonia soda process. For this reason it is not necessary to lose time on them.

The apparatus necessary for the process may be divided into the following groups, if brine, limestone and ammonia are given as raw materials:

First.—Lime kilns and carbonic acid washers to make carbonic acid and caustic lime.

Second.—Apparatus for making bicarbonate of soda and converting this into carbonate of soda.

Third.—Apparatus for slaking lime.

Fourth.—Apparatus for recovering ammonia.

Following this introduction a line of 65 lantern slides were projected on the screen with a view of giving one way in which the ammonia soda process might be demonstrated to advanced students in a lecture room. An attempt was made to reproduce these pictures for this publication, but it was found that at the necessary reduction to small size the details in the drawings were lost. For this reason the drawings are omitted and only an enumeration and description of the slides is given in this paper.

The first four slides represented apparatus assembled in the four great divisions of an ammonia soda plant as enumerated above.

Such a division is most desirable in order to facilitate the understanding of the entire and very complicated plant.

Slides Nos. 5-65 gave detail drawings and models of some of the important parts of the plant.

The following list gives a more complete idea of what was offered.

1. Lime kilns and carbonic acid washers to make carbonic acid and caustic lime.
2. Apparatus for making bicarbonate of soda and converting this into carbonate of soda.
3. Apparatus for slaking lime.
4. Apparatus for recovering ammonia.
5. Drawing of lime kiln.
6. Drawing of carbonic acid washer.
7. Drawing of column, general view.
8. Drawing of base of column.
9. Drawing of bottom of column.
10. Drawing of bottom section of column.
11. Drawing of dividing plate of column.
12. Drawing of center section of column.
13. Drawing of cooling section of column, outside view.
14. Drawing of cooling section of column, inside view.
15. Drawing of top section of column.
16. Drawing of cover of column.
17. Drawing of bolts for column.
18. Drawing of gaskets for column.
- 19, 20 and 21. Wooden models representing the parts of the column on the scale of one inch to the foot.
22. Drawing of vacuum filter.
23. Drawing of vacuum filter, displayed.
24. Drawing of roasting apparatus.
25. Detail drawing of same.
26. Top view of same.
27. Detail sheet of machinery on same.
- 28-29. Wooden model of roasting apparatus.
30. Drawing of ammonia still, general view.
31. Drawing of ammonia still, lower half.
32. Drawing of ammonia still, boiler iron work.
34. Drawing of ammonia still, bottom piece.
35. Drawing of ammonia still fittings.
36. Drawing of ammonia still, reducing piece.
37. Drawing of ammonia still, dividing bottom.
38. Drawing of ammonia still, top section.
39. Drawing of ammonia still, dividing bottom.
40. Drawing of ammonia still, cross section of same.
41. Drawing of ammonia still, drip plate.
42. Drawing of ammonia still, cover.
- 43-52. Wooden models made at the scale of one inch to the foot, representing parts of the ammonia still.
- 53-58. Detail drawings of absorbers.
- 59-65. Detail drawings of coolers.

All slides were made from good working drawings from which the actual plant was constructed. In

order to convey the meaning of the drawings more clearly to the pattern makers and to facilitate the arrangement in space of all the apparatus, complete models were made at a scale of one inch to the foot, and as an example 3 pictures of the models for the column are given in the accompanying cuts.

In the experience of the writer such models have been of great service to obtain the construction of chemical apparatus in conformity with drawings, particularly if they had to be made in machine shops where the construction of chemical apparatus is new, or done only at great intervals.

It also is thought that models similar to the ones presented at the meeting are highly instructive for students in chemical engineering. It is true that students even if they are highly advanced in manual training could not make such models themselves, since it takes the best of pattern makers to do that class of work. But it would pay well for any university to have a shop and to employ one or more

pattern-makers steadily to do such work. By so doing they might accumulate in time a stock of models, the manufacture of which will serve to train the instructors, while the models themselves will be a lasting aid in the instruction of students.

Two columns were actually constructed by these drawings and models. Each column was made up of 1 base, A; 1 bottom piece, B; 1 bottom section, C; 17 cooling sections, D, alternating with 16 center sections, E; 35 dividing bottoms, F, cast together with perforated plates, one bottom being located between each pair of sections; 3 top sections, G; and 1 cover H.

The entire finished weight of one column was 177,570 pounds and it was constructed for $3\frac{1}{4}$ cents per pound of machined castings, the price being understood free on board cars at place of manufacture.

Specifications as actually used in construction of the apparatus were accompanying the drawings, and the paper gave a full account of the construction and cost of a ten-ton ammonia soda plant.

SCIENTIFIC SOCIETIES.

REPORT OF COMMITTEE ON STANDARD SPECIFICATIONS.

INDIANAPOLIS MEETING, A. C. S., JUNE, 1911.

The Committee on Standard Specifications, appointed at the meeting of the American Chemical Society held in Boston in 1909 and consisting of Frank G. Stantial, Robert Job and the writer, submits the following report:

As has been noted in previous reports to the Industrial Division, your committee decided that the work could best be carried out by the appointment of a sub-committee for each of the materials selected as the subject of a specification, the personnel of these sub-committees to consist, so far as possible, of three members—two representing the consumers and one the manufacturers. The committee was further of the opinion that inasmuch as other societies were working along similar lines, our efforts should be confined for some time at least to those materials of a strictly chemical nature.

Nine sub-committees were appointed to formulate specifications for the following materials:

Alum,	Soda Ash,
Bleach,	Solder,
Caustic Soda,	Sulphuric Acid,
Muriatic Acid,	Turpentine.
Nitric and Mixed Acids,	

The personnel of these committees is as follows:

Alum.—William M. Booth, Chairman, Syracuse, New York; F. A. Olmsted, Willamette Pulp & Paper Co., Oregon City, Ore.; S. W. Wilder, Merrimac Chemical Co., 33 Broad St., Boston, Mass.

Bleach.—W. P. Atwood, Chairman, Hamilton Mfg. Company, Lowell, Mass.; Fred. W. Farrell, Emerson Laboratory, Springfield, Mass.; Charles E. Acker, 97 Cedar St., New York City.

Caustic Soda.—W. K. Robbins, Chairman, Amoskeag Mills, Manchester, N. H.; James W. Loveland,

Works Manager, B. T. Babbitt, Babbitt, N. J.; J. D. Pennock, Semet-Solvay Co., Syracuse, N. Y.

Muriatic Acid.—Fritz H. Small, Chairman, Graton & Knight Mfg. Co., Worcester, Mass.; J. T. Baker, J. T. Baker Chemical Co., Phillipsburg, N. J.; W. S. Williams, Arthur D. Little, Inc., 93 Broad St., Boston, Mass.

Nitric and Mixed Acids.—Arthur M. Comey, Chairman, E. I. duPont de Nemours Powder Co., Chester, Pa.; Henry U. Walker, Maas & Waldstein Co., Newark, N. J.; Oscar W. Pickering, 42 Holden St., Malden, Mass.

Soda Ash.—Henry W. Hess, Chairman, Libbey Glass Works, Toledo, Ohio; Martin L. Griffin, Emerson Laboratory, Springfield, Mass.; A. F. Shattuck, Solvay Process Company, Detroit, Mich.

Solder.—Carl F. Woods, Chairman, Secretary, Arthur D. Little, Inc., 93 Broad St., Boston, Mass.; W. M. Corse, Lumen Bearing Company, Buffalo, N. Y.; George O. Bassett, Western Electric Company, 463 West St., New York City.

Sulphuric Acid.—Fred B. Porter, Chairman, Chemist Swift Fertilizer Works, Atlanta, Ga.; W. M. Kelsey, Supt. Acid Department, Mineral Point Zinc Co., Depue, Ill.

Turpentine.—J. E. Teeple, Chairman, Hudson Terminal, 50 Church St., New York City; C. H. Herty, University of North Carolina, Chapel Hill, N. C.; L. F. Hawley, U. S. Forest Service, Washington, D. C.

The sub-committees on bleach and solder specifications have completed their work and have submitted the requirements of these respective materials. These have been drafted into a form agreed upon by the main committee and are submitted to the Division for adoption or whatever action may be deemed proper.

Bleach.—The specifications for bleach are, so far as we know, different from any others in use. It