

from an economic as well as practical viewpoint, but the bacterial reduction produced by comparatively short detention periods prior to final purification by means of filtration or sterilization with chemicals has much to appeal to the practical side of this question. The potent advantages in favor of such preliminary treatment are the reduction of all forms of

bacterial life, but particularly the removal to a very large extent of the pathogenic germs, and the general physical and chemical improvements of the water ensuring more uniform control and economical operation of the final purification system, due to the equalizing effect that reservoirs of this type produce.

100 W. FAYETTE STREET
BALTIMORE, MARYLAND

LABORATORY AND PLANT

AN EXPERIMENT IN THE EDUCATION OF CHEMICAL ENGINEERS¹

THE TWENTY-FIFTH ANNIVERSARY OF THE AUDUBON SUGAR SCHOOL

By CHARLES E. COATES

In these days of preparedness, the training of chemical engineers has taken on a consequence which is interesting both to the college and the country at large. The part which the chemist has played in modern development, we have known in a way for some years, of course, but we are appreciating now as never before, the vital and imperative importance to our nation of a body of men who cannot only discover chemical principles but can also apply them industrially.

At the same time, it has been generally acknowledged that college courses in Chemical Engineering have hitherto been lacking in some essential ingredient. Numerous efforts have been made to remedy this state of affairs. Among the most recent are the industrial fellowship system of the Mellon Institute and the plan lately outlined by the Massachusetts Institute of Technology, accounts of which have appeared in *THIS JOURNAL*. The English journals are full of new schemes for the training of chemical engineers; indeed practically all the larger schools have changed such courses materially within the past few years. In view of this and inasmuch as experience, after all, is the only safe guide in the jungle of educational theory, it has been thought that a brief sketch of the origin and development of the Audubon Sugar School might not be untimely.

Few people realize how very largely the sugar industry of to-day is a chemical industry. A little over a century ago, when sugar was first made from beets, the root was low in sucrose and the process gave a poor yield of an inferior grade of sugar with an almost valueless molasses. The chemist and the agronomist, working together, slowly raised the sucrose content of the beet root until it was more than doubled; the chemist and engineer, working together, slowly improved the processes until a good yield of sugar was turned out, practically pure, and both the molasses and all the other by-products became sources of profit and not of loss. In consequence the net cost of beet sugar fell year by year until it became a serious competitor of cane sugar and, finally, it was offered at prices closely approaching the cost of cane sugar production.

The sugar planters of Louisiana, as a class, are cer-

tainly among the most intelligent agriculturalists in America. Seeing the increasing gravity of the situation, they decided to meet the competition of beet sugar by the same methods which made that competition possible. In the late eighties they called to Louisiana Dr. W. C. Stubbs and established, under his direction, the Sugar Experiment Station at Kenner, Louisiana, which was subsequently moved to Audubon Park, on the outskirts of New Orleans. This station was financed entirely by the planters of Louisiana. A complete sugar house was erected on a scale large enough to give commercial results, and altogether, perhaps \$100,000 worth of equipment was obtained either by purchase or gift.

As soon as the work was fairly under way, it became evident that there were many leaks in the sugar industry as carried on in Louisiana and that these could be stopped by proper scientific control. But when the planters began to look for chemists and engineers, they were simply not to be obtained. Up to that time, the cane sugar industry throughout the whole world had been carried on largely by rule of thumb. Few men scientifically trained in sugar chemistry were to be found outside of Europe. In 1890, therefore, at a meeting of the Louisiana Sugar Planters' Association, it was decided to establish, in connection with the Sugar Experiment Station, a school for the training of experts in sugar work. This was placed under the direction of Dr. Stubbs and was opened in 1891 as the Audubon Sugar School. So far as I know, this was the first instance in America in which any industry established both laboratories for the scientific investigation of its problems and a school for the college training of men to put the theory into practice.

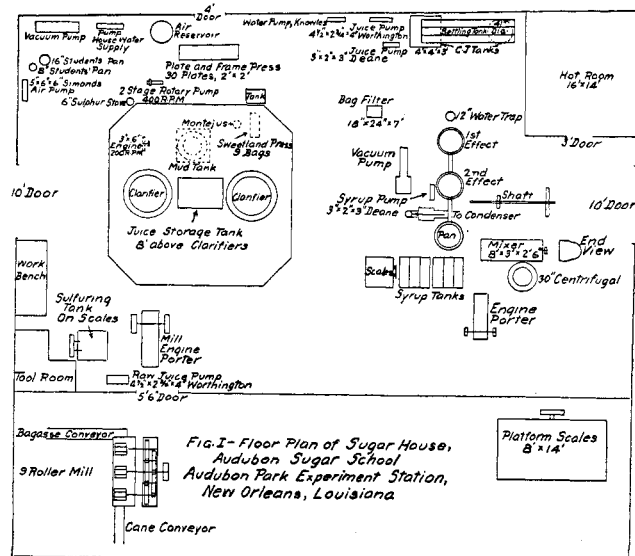
POST-GRADUATE CHARACTER OF WORK

As first outlined, the Audubon Sugar School was intended to appeal mainly to graduates of schools of engineering, and the course was distinctly post-graduate in character. The faculty was composed of some of the ablest men in the country, special stress being laid on research work. It soon became evident, however, that the number of college graduates who appreciated the opportunities in the sugar industry was quite small, and that the demand for training came mainly from men who had not received very much undergraduate training. Moreover, there were a number of applicants from tropical countries, whose preliminary studies had been of such a type as to make it impossible for them to take up, successfully, the advanced

¹ Presented at the 53rd Meeting of the American Chemical Society, New York City, September 25 to 30, 1916.

scientific work offered in the Sugar School. At the outset, therefore, the greater number of students were special students, very un-uniform in educational training, which, of course, handicapped the school materially. The course was two years in length, classes were held at the Experiment Station, and during the sugar season the students did the actual work in the fields, in the laboratory, and in the sugar house.

The school was successful from the outset and, in a couple of years, more students were applying for admission than could well be accommodated. In the meantime the Sugar Experiment Station was taken over by the State of Louisiana as part of the Louisiana State University, and the Planters' Association withdrew its financial support. With limited funds, the increasing demands upon its staff along purely research lines, and the growing magnitude of its routine work, the Station found it impossible to handle students also. In 1896 the school was, accordingly, incorporated with the Louisiana State University, preserving



the name by which it had become known. In 1908 its numerical importance was such that it was reorganized as a college of the University.

From the first the writer and his colleagues were given a free hand by President Boyd in formulating the course of study, and changes were made year by year as experience or circumstances dictated. As the instruction was now given by the regular university staff, the students were, of necessity, ordinary college students, subject to the college entrance requirements. Moreover, as the chemical, mechanical, and agricultural subjects having to do with sugar technology had to be based upon chemistry, physics, mathematics and the biological sciences, it was necessary to require these subjects of all those taking up the purely sugar work. The enforcement of these two regulations worked, at the beginning, to eliminate a number of applicants whom the University would have been glad to welcome, if possible. They were, for the most part, men of maturity, from 25 to 40 years of age, who had had

previous experience in sugar house work, and were anxious to supplement their experience with a certain amount of theory. For several years the University received these men as special students, but it soon became evident that, in spite of their laudable ambition, they were, in nine cases out of ten, merely wasting their time. They were taught certain things in a mechanical way, such, for instance, as how to polarize sugar, but they did not know the principles on which these things depended and their studies did not lead them anywhere. They were deceiving themselves in thinking they were studying sugar chemistry when they were merely becoming chemical mechanics. Only after it was too late did they recognize the necessity for the foundations and the futility of short cuts to learning. From the beginning, the writer counselled these men against their undertaking, but, as they were ordinarily both intelligent and self-confident, he could not keep them from following their own ideas. Finally, the advanced courses were closed to students of this type. We expected some criticism at first, but none came. The questions which were asked by certain men as to why they could not be admitted were readily answered to their complete satisfaction.

As men of this class present, collectively, a problem of a general nature, I may say here that I do not believe that it is possible to receive them in the same classes with the ordinary college student. The latter is presupposed to have a certain fairly uniform preparation for his work; the preparation of the former, on the other hand, is almost always inadequate and much has been forgotten of what had once been known. The college student, therefore, can be taught in the conventional way, but men of maturity must be taught each as a separate problem, with different difficulties to solve. Then, again, the college student is joyfully ignorant of practical experience and responsibilities, and the college teacher must bring these home to him as best he may; the practical man, on the other hand, has learned them in the school of hard knocks, and not infrequently comes better equipped than his teacher, so that what is good advice to one man is a platitude to the other. But the greatest difficulty in teaching the practical man lies in his unwillingness to fill in the gaps in his training. He probably knows no mathematics, and without this he cannot study to advantage college physics, without which problems in mechanics and machinery are unintelligible. The same holds along other lines.

The purpose of the school when first organized was to offer to the citizens of Louisiana the opportunity to secure such training as would qualify them to enter most advantageously the sugar industry of the state. The underlying idea, therefore, was to train men who would be competent to manage plantations which both grew cane and made sugar; that is to say, they were to be trained in agriculture, engineering and chemistry.

FOUR-YEAR COURSE CHANGED TO FIVE

The course, as formulated in 1897, was four years in length. During the last two years the students

spent the sugar season at the Sugar Experiment Station at Audubon Park in practical sugar house work. It soon became clear, however, that a satisfactory foundation could not be given to high school graduates in two years, so, in 1899, the course was made five years in length, the first three years being devoted entirely to foundation subjects and all technology being avoided. During the fourth and fifth years the student was sent, as heretofore, to the sugar house at Audubon Park, returning at the end of the sugar season and taking up his work for the rest of the year. At the end of the fifth year the graduates received the degree of Bachelor of Science. Here, too, there was a little dissatisfaction. The Sugar School students thought that if the Engineering students received their B.S. degree at the end of the fourth year, so should they. At the end of the fifth year they could then receive another degree. There was a certain specious justice in this claim, but it was not granted. At the end of the fourth year the

students than it could well care for and they have been men of an exceptionally high class, which merely goes to prove again that, in matters educational, if a thing is well worth while the best men do not count the price, whether in time or money. So far as the writer knows, this was the first five years' course in Chemical Engineering ever offered in this country.

From the beginning, there was a strong demand for the graduates of the Sugar School. Ordinarily they were placed six months before they graduated and, as they made good without any exceptions, the requests became year by year more pressing. Most of the larger sugar houses began to put in laboratories and chemical control slowly displaced the old rule of thumb. About 1901, the demand for chemists became so great that two or three of the best fifth-year men were allowed to omit the second year of the practical course at Audubon Park. Instead they were sent to a sugar factory where they were paid the regular salary of an assistant chemist and worked through

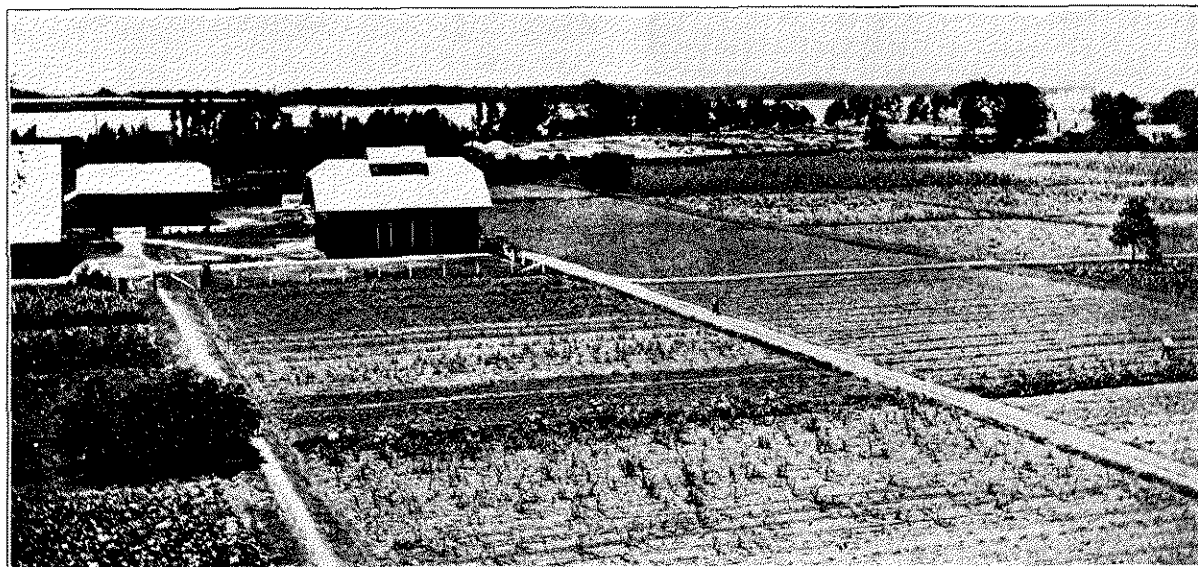


FIG. II.—GENERAL VIEW OF PLATS AT EXPERIMENT STATION, AUDUBON SUGAR SCHOOL

sugar school student would not be sufficiently trained. If he were to receive a degree then, however, he would be more than likely not to appreciate the deficiencies in his training. A degree is a *summum bonum*—an end in itself to most college students. These students were also anxious to get into practical work. Why work a year longer for a degree when they already had a degree? This argument would have been conclusive with many students and most parents. So the course was fixed at five years and the student got his B.S. degree in five years instead of four. This was done because the five years were necessary and those who did not like it were told that it was a rule of the school and could not be changed. The results justified the means and to-day the students take special pride in this particular feature of the course.

There was some fear, at first, on the part of the authorities, that a five years' course would drive away the desirable students, but such has not been the case. As a matter of fact, the Sugar School has had more

the season under strictly commercial conditions, returning to the University when the season was over. It was immediately apparent that these men had gained something which gave them a marked advantage over those students who were taking the routine fifth-year course at Audubon Park, but it was a little hard to tell wherein this advantage lay. Perhaps each man had benefited in a different way. To one it gave self-confidence, to another an appreciation of actual working conditions, to a third a knowledge of men as distinguished from boys; to all, a certain sense of responsibility and a maturer point of view.

FACTORY WORK IN FIFTH YEAR

The fifth-year practical course had been formulated and carried out at Audubon Park and in the laboratory with great care. It contained many things which the student, by going to the factory, would not get, and which it was desirable he should get, so the actual factory practice was permitted with some degree of

reluctance and a little fear that we were making a concession to a popular demand. But its undoubted advantage, largely psychological, over the routine course was so marked that in 1903 the sending out of the fifth-year students became a part of the established policy of the School and has remained so ever since. The planters met the movement more than half way and have given the students every possible assistance.

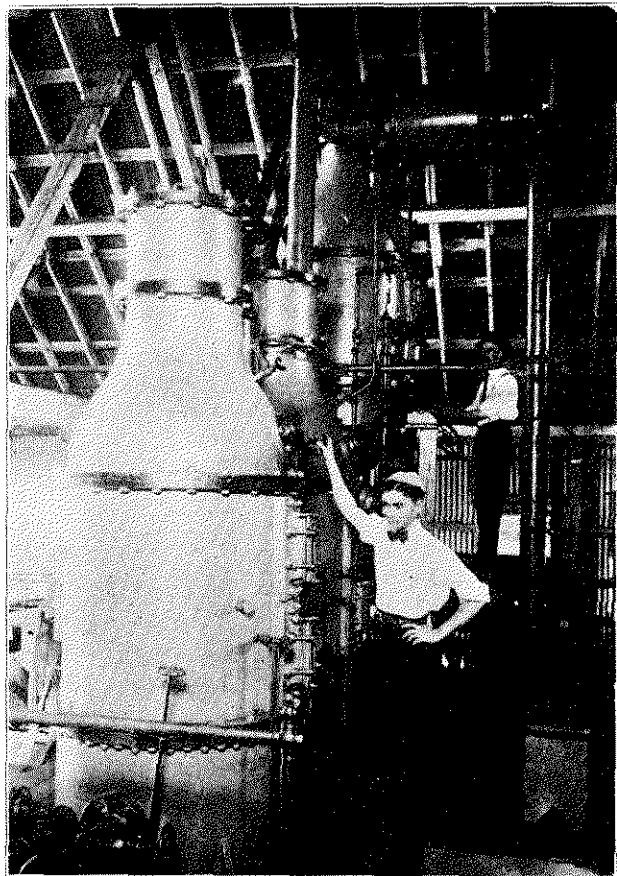


FIG. III.—EVAPORATORS AND PAN IN SUGAR HOUSE

These young men receive the same salary as other assistant chemists and for more than ten years there has not been one who failed to receive employment. An incidental but most important result has been the strengthening of the relationship between the sugar planters of Louisiana and the Louisiana State University. The students bring back to the University an intimate knowledge of the actual conditions in the various sugar houses and of the practical problems which are continually presenting themselves. The planters, on the other hand, discuss these conditions and these problems with the various officials of the Sugar School, sometimes personally, sometimes by correspondence, but always with perfect freedom.

In order to get a certain breadth of view as to the Louisiana cane sugar industry it has been the custom of the writer to visit the various plantations during the sugar season. After a good many years of personal experience, the writer has come to the definite conclusion that this personal contact between the students and teachers in the School of Chemical Engineering,

on the one hand, and the chemical plant, together with its responsible officials, on the other hand, is absolutely necessary if the school is to attain even reasonable efficiency. In each industry this contact may be obtained in a different way. In the Audubon Sugar School the practical method has just been outlined.

As these students are absent from the University in the fourth and fifth years for eight to ten weeks of the first term during the sugar season, they cannot be taught in the same classes with other students during the eight or ten weeks when they are present. They are, therefore, taught in different sections from the other students during the first term, the second term, of course, presenting no difficulties. This method placed some extra labor on the teaching staff, but it was the only logical way and has worked well in practice. There seems to be no reason why it could not be applied more generally to the articulation of courses in chemical engineering with the various industries studied. In this connection, the writer might say that he is convinced that, in the fifth year of a course in Chemical Engineering, the student should get away from generalizations and try to master reasonably well the details of some one particular industry. The confidence in his own ability which a student gains by thus narrowing his field of study, stays with him should he, by chance, find his opportunity in some other line of chemical industry.

INTRODUCTION OF AGRICULTURAL AND ELECTRICAL COURSES

As soon as the Sugar School was fairly under way, students began to come from all parts of the world and as, at the time, it was easier to secure a position as a sugar chemist than as a sugar agriculturalist, there was a tendency on the part of the student to stress Chemistry and Engineering at the expense of Agriculture. This tendency was encouraged by the unsatisfactory state of agricultural teaching twenty years ago. As the old professor of agriculture slowly began to resolve into his component parts and the professors of Agronomy, Soil Physics, Animal Industry and the like took his place, there was a notable tightening up along all lines of agricultural pedagogy. Full-term courses were offered where two or three weeks had sufficed and the increased efficiency of agricultural teaching began to appeal to students generally. But the Sugar School students found themselves in need of a very special type of tropical and subtropical agriculture, where the conditions were altogether unlike those in ordinary American agronomy. To meet this demand, it was decided in 1907 to offer such courses in Sugar Agriculture in the last three years of the Sugar School, these applying specifically to the conditions on cane plantations in Louisiana. At about the same time, Congress made it possible for the Experiment Stations to do experimental work in Mechanical Engineering. In Louisiana, this work was placed in charge of Professor E. W. Kerr, as professor of Mechanical Engineering in the Audubon Sugar School, and was concentrated on the specific problems in the sugar houses of Louisiana, such, for

instance, as evaporation, bagasse burning, boiler efficiency and the like. As new fields in Sugar Agriculture and Sugar Mechanics began to develop, it became evident that even five years was not sufficient time to give students satisfactory courses in these and in Sugar Chemistry as well, so, in 1912, a course



FIG. IV—STUDENTS KEEPING CHEMICAL CONTROL IN THE FACTORY AT THE AUDUBON SUGAR SCHOOL.

was formulated in Sugar Agriculture with Professor A. F. Kidder in charge of the special work in agriculture, the course including Chemistry and Agriculture, being distinct from Sugar Engineering which included Chemistry and Engineering. The practical work on the plantations and at Audubon Park was the same for each course. The student chooses one course or the other at the beginning of his junior year, and as there is an increased number of openings for scientific agriculturalists in sugar countries, this division has its fair share of students. It is possible that students under exceptional circumstance might find it desirable to specialize in Sugar Agriculture and Engineering, leaving out most of the work in Chemistry. Though no demand for this has yet arisen, the courses are so formulated that the demand can be met without any difficulty.

It is fair to infer from our experience in this respect that after a school of Chemical Engineering has been mainly associated with some given industry for a term of years, it would become necessary to arrange that the students have suitable latitude in elective subjects for the last year of the course. For instance, during the last year or two, many of the larger sugar mills have been changing over from the steam drive to the electric drive and it is generally believed that electrically driven machinery will largely supplant steam driven machinery in the near future. For this reason, there has arisen lately a demand for more Electrical Engineering in the sugar course, which demand we are now prepared to meet by offering as electives, special courses in that subject.

ADMISSION OF COLLEGE GRADUATES

As the value of scientifically trained men became recognized by the sugar industry throughout the world, students came to Louisiana from practically all of the sugar-producing countries. Japan, China, the Philippines, Mauritius, Tahiti, Hawaii, South Africa, France, Spain, Italy, Germany, Sweden, Norway, England and every one of the South and Central American countries have sent students to the Sugar

School. In many cases these were already college graduates, and there was some difficulty in articulating their previous training with the regular Sugar Course. The first three years of the Sugar School, however, are devoted to pure science, and technology is avoided as far as possible. Students get Mathematics through Calculus, Inorganic, Organic, and Analytical Chemistry two years each of Physics, Mechanical Drawing, Mechanical Engineering, and one year of Electrical Engineering, together with English and some foreign language. As these subjects are covered in the Chemical Engineering courses at Cornell, Boston Tech., Illinois and other standard institutions, we decided to credit the first three years' work done in such institutions for the first three years of the Sugar School, without endeavoring to make a substitution of subject for subject. The last two years of the Sugar School, therefore, were made, so far as possible, of graduate nature, open to students who had had three or four years of college training and who were prepared to take the courses offered. In this class there have been graduates of various universities both in the United States and abroad. These have been matriculated as graduate students, candidates for the degree of M.S. Their courses have ranged from one to two years in length, depending upon the nature



FIG. V—APPARATUS FOR EXPERIMENTAL STUDY OF EVAPORATION MECHANICAL LABORATORY, LOUISIANA STATE UNIVERSITY

of the preliminary training. This system of articulation of a highly technical course with an undergraduate degree has been in use now for about 12 or 15 years and has worked out admirably because of the elasticity in electives permissible to the graduate student.

There has been a decided tendency on the part of the graduates in Mechanical, Electrical and Chemical Engineering to apply for graduate courses in the Sugar School. We have arranged courses for such students and have found that they can cover nearly twice as much ground in a year as can the average undergraduate. A number of these men have gone into practical work with uniform success. In other words, the attitude of the Sugar School towards graduate students is something like this: For the mature man who is a college graduate and wants to take up this kind of work, it is fair to assume that he knows what he wants, so he is treated not as a boy but as a man and, in electing his course, he is allowed every latitude compatible with common sense. For instance, these courses hitherto have included the practical course at Audubon Park and some sugar house experience, but both these requirements would be waived in the case of the man who was already familiar with sugar house processes.

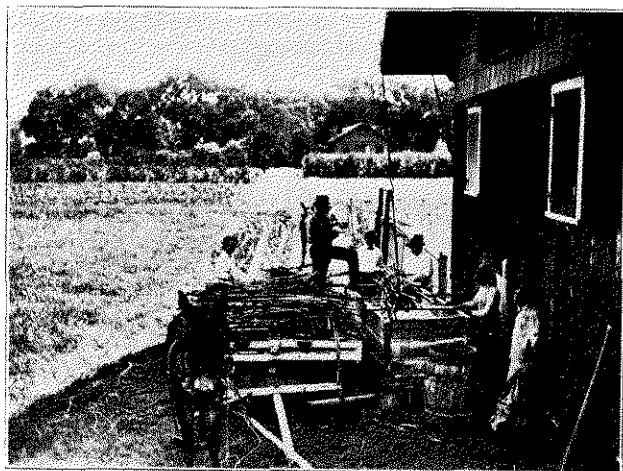


FIG. VI—DIPPING CANE IN WHALE-OIL SOLUTION
EXPERIMENT IN CONTROL OF SUGAR-CANE MEALY-BUG

As at present organized, then, the course of the Audubon Sugar School is five years in length and leads to the degree of B.S. The first three years are given to general scientific training similar in type to that given in most standard schools of Chemical Engineering. The technical work is given entirely in the last two years, which, therefore, include most of its distinctive features. As the method of articulating the practical and the theoretical is the result of a number of years of experiment and experience, it might not be amiss to give it in detail. At the beginning of the fourth and fifth years, the student reports to the university about the 20th of September. He stays there until the opening of the sugar season, the date of which depends somewhat upon crop conditions, but ordinarily ranges between the 18th and the 25th of October. This gives him one full academic month at the university. The sugar season in Louisiana lasts until from the 10th to the 25th of December, some smaller estates finishing earlier and a few larger ones, somewhat later. The university assumes that they all close before the end of the Christmas holidays at which date the student must again report to his

classes. This gives him one academic month before the mid-term examinations in February. He is therefore present at the university during the first and last month of the first term and is working at the sugar house during the second and third months, allowing a margin of about a week for overlapping, due to crop conditions.

FOURTH-YEAR WORK

The subjects taken by these students while at the university during these two months are of two types: The first type is strictly technical and special, as for example sugar house control, sugar machine design and sugar chemistry. Lectures in these subjects stop when the student leaves the university and begin when he returns. The second type includes general engineering and chemical subjects which are elected by other students, such as thermodynamics and machine design. The Sugar School students take half the usual number of such subjects for twice the usual number of hours per week, which requires extra sections. During the second term they report with the regular college classes in all subjects. This increases the work of the instructors for the first and fourth month and lessens it for the second and third, but as the number of class hours involved is not large, the method has worked well in practice. Laboratory subjects present, of course, no special difficulties.

During the first month of the fourth and fifth years all the students concentrate mainly on the technical chemistry and engineering of sugar house practice. As considerable planting is done during this period, they also visit the plantations under the direction of the professor of Agronomy, as occasion presents itself. The whole sugar squad is under the general charge of a special instructor in sugar technology who is generally one of the superintendents of one of the larger tropical sugar houses and is thus in immediate touch with the industry in its most recent developments. He accompanies the fourth-year sugar squad to the Sugar Experiment Station, Audubon Park, New Orleans, and remains with them during the sugar season, at the close of which period he leaves for his regular work in Cuba or elsewhere.

When these fourth-year students reach Audubon Park, they have been drilled in the routine analytical processes of sugar house laboratories and in the general mechanical principles of sugar house machinery. At Audubon Park, the university has a sugar house, cane fields, chemical laboratories—both control and research—bacteriological and entomological laboratories and a full equipment of all apparatus necessary for the investigation of any ordinary problem, chemical, mechanical or agricultural which might arise in connection with the cane sugar industry, the whole representing an investment of something over \$100,000. Under the direction of an instructor, the student squad is brought into personal contact with each of these various lines of activity, and, to the same end, the squad is visited once a week by the Dean of the Sugar School, the professor of Mechanical Engineering or the professor of Agronomy. The United States Government maintains at the Park a department for

the investigation of insects injurious to cane, and the students must keep up with the progress of these investigations. Immediately after reaching the Park, the students are put to work planting cane. This fall planting is finished in three or four days and is done by the students themselves in the most approved manner under the supervision of the director of the Sugar Experiment Station. At the end of this time the field hands begin to cut cane and deliver it to the sugar house. Thereupon the sugar squad is divided into ten sections which are assigned each to a specific station. The sugar house has a nine-roller mill grinding somewhat less than one ton of cane per hour, the juice being discharged into a cane weigher. This is Station I and the work is done by one division of the squad. From the weighing tank, the juice passes to the sulfuring and liming tanks, which make up Station II, thence to the open clarifiers, Station III, thence to the settling tanks and filter presses, Station IV, thence to the double effects, Station V. The syrup from the double effect passes to the vacuum pans, Station VI, and the grained massecuite passes to the mixer and centrifugal, Station VII. There are also bag filters, plate presses and a Sweetland press through which the juices are run for experimental purposes; these make up Station VIII. There are around the house a number of small engines and pumps; the care of these make up Station IX. To each of these stations, a small squad of students is detailed for two or three days so that every man makes the round of the stations about twice. The chemical control is Station X and rotates with the others. Samples are taken of the cane, the juice, the press cake, the bagasse, the syrup, the massecuite and the molasses and the requisite analyses made. A very elaborate system of chemical control has been instituted in as great detail as in the 2000-ton houses, specially printed blanks being provided for this purpose, the whole system being practically identical with that of the larger Cuban and Porto Rican sugar corporations. The laboratory is provided with an adding machine and also one for multiplying and dividing, so that the students may become familiar with these important labor-saving devices. Complete daily and weekly reports are made out and special stress is laid on the arithmetical side of sugar house control. The importance of this phase of chemical engineering is sometimes overlooked. It not only helps make the chemist a more valuable employee, but it also helps him to realize what he is doing and why.

From the engineering standpoint, in addition to the foregoing stations, certain squads make detailed reports on the efficiency of the various pumps, the mills and the evaporating apparatus.

From the agricultural standpoint other squads study the result of the field experiments at Audubon Park for the last twenty-five years, and learn the practical methods employed in agricultural research as applied to sugar cane.

During the fourth-year season, the squad is sent, two at a time, to the state sugar factory at Angola, La., a 1500-ton house, thoroughly equipped for making

either white or 96 test sugar. Here they help in carrying out sugar house control on the large scale and under competent direction.

FIFTH-YEAR WORK

At the end of their first season, therefore, the students are fairly familiar with the technique of every part of the sugar house, though of course they are not skilled artisans. They are able to make out a complete report on the chemical control of the sugar house and, to some extent, on the chemical efficiency of the process. In the case of the students in sugar agriculture, they can also make out a report on the condition of the cane fields and their various agricultural requirements, such as fertilizers, drainage and the like. Most of the work on the purely theoretical side of both sugar chemistry and sugar engineering is given to the students on their return to the university, to which end a special equipment has been provided. For instance, there has been installed an elaborate apparatus

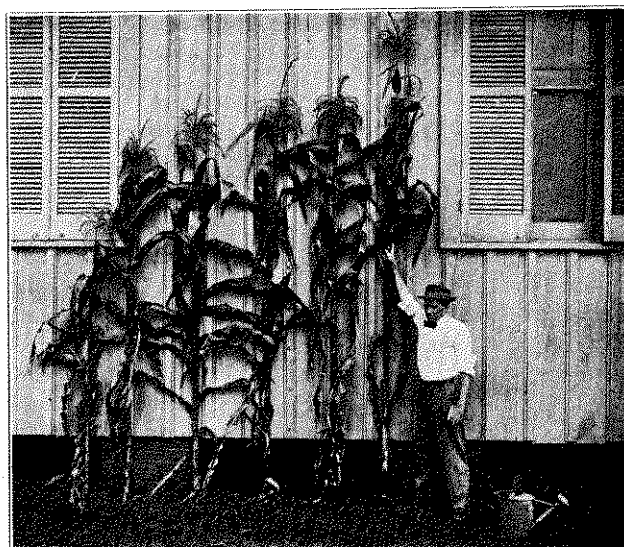


FIG. VII.—SHOWING RESULTS OF FERTILIZER EXPERIMENTS

for the experimental investigation of evaporation which has made possible a considerable quantity of research work along this line.

The fifth-year students, also, put in the first month at the university, concentrating on the details of various phases of sugar technology and paying special attention to speed and accuracy in their analytical work. They likewise study the principles underlying the various instruments they are to use in the chemical and mechanical control of the sugar house—as for example, the polariscope and the indicator card. When the season opens they go into actual sugar house practice at various factories over the state and stay through the sugar season. These students are treated simply as employees, are given no special favors and expect none. They draw the same salary as any other sugar chemist and hold their positions only on their merit. The Dean of the Sugar School makes an annual inspection of these factories during the sugar season and thus learns both what the students are doing and what the management expects them to do. After their return to the university at the end of

the sugar season, they devote the rest of the year to the various subjects outlined in their courses.

The fourth and fifth years of the sugar school, therefore, are quite special in their nature and are open to graduates and senior students of standard schools of engineering. The student of the graduate type is classed according to his preliminary training and allowed to elect such subjects as he may be able to carry out profitably, the utmost latitude being given him.

The Audubon Sugar School is now twenty-five years old. The number of students during the past five years has been 124, 94, 65, 70, 75. The School graduates each year from 10 to 25 students. These young men have made good without exception. They are scattered all over the sugar world and occupy many of the most important positions in the sugar industry, which facts are taken to indicate that the school is founded upon correct pedagogic principles.

CODE OF ETHICS

Just one thing more might be mentioned in closing. It is somewhat difficult to discuss this and yet its extreme importance is beyond question. From the time a student enters the Audubon Sugar School until he leaves, it is the writer's custom to call frequent attention to the fact that no student can hope to learn much chemistry or mechanics or anything else of that sort at college. He merely learns where the literature is, what the problems are and how to study them for himself personally. One thing, however, he can learn at college and that is the standard of character necessary for success in Chemical Engineering. These men are not expected to stay engineers or chemists; such positions are only stepping-stones. Each man should hope to be, at some time, a superintendent or administrator and if positions of this type are to be won by merit, that merit must include absolute personal integrity. Any lapse from the highest possible code of honor will destroy the usefulness of a chemist or a superintendent. Absolute truthfulness in work and in reports, loyalty, willingness to coöperate—these things are essential to the highest success in the sugar business.

This is the code of the students in the Sugar School, insisted upon by themselves from the time they enter the university. Lapses are treated with the rude but efficient justice of student self-government and, by the time a man graduates, these standards are ground into him and are a part of his professional character. It is a matter of record in the Sugar School that in all the years of its history, there has not yet been one of its alumni to prove recreant to its personal standards, during the after years of his actual contact with the business world. The graduates of the Sugar School are more or less well-trained in the sugar industry, fair scientists or excellent as the case may be, but in all instances they are honorable men, trustworthy and loyal. They have had this record for a quarter of a century without a break. This is the one point in which the Audubon Sugar School feels it has a right to be proud.

AUDUBON SUGAR SCHOOL
LOUISIANA STATE UNIVERSITY
BATON ROUGE

THE CONCENTRATION OF SULFURIC ACID

By E. H. ARMSTRONG
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Owing to the unusual demand for munitions and as sulfuric acid is largely used in the manufacture of these products, there has been created a great demand for high strength sulfuric acid running from 93 to 97 per cent H_2SO_4 .

In the old days the high strength sulfuric acid required was made very largely in iron and platinum stills. There are a number of other methods used for concentrating sulfuric acid but as all these give a small output and as the demand for the last year required a large tonnage, the tower method, in a large number of cases, has been resorted to by a great many chemical companies; in other cases the acid is first passed down a tower where it gets a preliminary concentration, bringing it up to 62 to 63° Bé. and thence through cast-iron pans that set in a furnace, one above the other; by the time it gets to the last pan, which is directly over the fire, it has attained the concentration of from 93 per cent to 98 per cent H_2SO_4 . In this case the gases of combustion from the furnaces pass under the pans to the tower, at which point they become mixed with the vapors from the pan; the mixed gases pass through the tower and thence through a system of scrubbers to the atmosphere.

There is quite a difference in the methods pursued in building the towers, and also the arrangements of the scrubbers for the recovery of the distillates. But the principle of concentrating in towers is the same, as practically all the engineers engaged in constructing the plants use quartz for the packing and an oil flame for generating the heat.

The writer has had considerable experience recently in supervising the operation of some concentrators. There was very little known in the South, previous to the last year, about concentrating acid to such high strength; this being true, it was largely a question of experimenting to find the best method of operating.

CHEMICAL DISINTEGRATION OF QUARTZ PACKING

One of the first conditions that the writer observed was that an apparent obstruction would develop in the towers after a week to ten days' operation, necessitating shutting the plant down and washing the tower, after which the plant would usually run very satisfactorily for another week or so. During the above-mentioned washouts, the writer observed a very heavy non-gritty substance coming from the tower. It was then concluded that this substance must be silica and as silica could only come from a chemical disintegration of the quartz in the tower packing, the writer became convinced that the quartz was undergoing a chemical disintegration, most especially as there was a considerable quantity of aluminum in the acid passing over the tower.

This was finally proven to my entire satisfaction by the fact that after some weeks' operation, the plant would show all symptoms of the tower being too open and, in one case, it was found that more than one-half of the quartz originally in the tower had gone in solution and passed out. In others it was found that chan-