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SOLUTIONS
of
TEXAS' GAS AND INDUSTRIALIZATION PROBLEMS

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BUREAU OF INDUSTRIAL CHEMISTRY

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CHAPTER I

The Texas Gas Problem - Its Solution

By Means of Industrialization and The Use of Lignite

by E. P. Schoch*

PREFACTORY NOTE

The Texas Railroad Commission held an informal hearing on December 19, 1944 on the conservation of natural gas. Here some citizens vigorously voiced their belief that gas exportation - if allowed to continue unchecked - will soon deprive Texas of this great resource. But attorneys conversant with the facts stated that nothing could be done by way of legal measures affecting exportation alone. While some valuable suggestions were made on the matter of gas conservation, yet no suggestion was made to solve the problem of a possible early depletion of Texas gas reserves.

At the end of the meeting Chairman Jester expressed the desire of the Commission to obtain written suggestions on this matter. In response to this invitation, the writer is submitting what he believes to be a diagnosis of the main cause of the present gas situation, and a plan for its cure. This plan is believed to be duly considerate of all interests involved.

SUMMARY OF PROPOSAL

1. Gas to be used in large amounts (such as one hundred million cubic feet, or more, per annum) for purposes for which lignite or other cheap solid fuels can be used shall hereafter be excluded by the Railroad Commission from their estimate of market demand for public gas lines; but this provision should not be used to decrease the total volumes allowed for existing gas lines below the amounts they now carry.

2. The price to be paid to gas owners by pipe line operators shall be gradually raised from its present figure to a figure near or above 10 cents, in accordance with the market demand as defined in the preceding paragraph.

3. To increase the market demand in Texas, there shall be instituted an effective program of industrialization aided by specific provisions for new industries, particularly those using clays, cotton, and natural gas itself as a material for manufacture.

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READING ROOM

4. Gas supplies such as those used for carbon black, and for oil lifting which are now disposed of through other means than "common carriers" should be given special technical study with the view of reducing unprofitable or wasteful outputs of gas.

These four actions will bring the following results:

(a) the total income of gas owners will be increased from twenty-three million to one hundred million dollars per annum;

(b) the length of the gas age will be made three to four times as long as it would be without such a procedure;

(c) pipe line investors will suffer no losses of income on their investment;

(d) Texas prices of domestic and commercial gas will not be increased - perhaps even decreased; and special industrial gas will be available at lower rates than in the North-Eastern states;

(e) the higher fuel costs which large industrial users will have to bear will not affect them substantially because even with lignite, the fuel item is only one-third of the total power cost. Furthermore, these large industrial users will be merely reassuming a cost which in the meanwhile is being carried mainly by the well owners, and in lesser degree, by the other fuel users.

POSSIBLE LEGISLATIVE ACTIONS INVOLVED

The Railroad Commission may not have the power to make the above distinction between "gas replaceable with cheap solid fuels" and all other kinds of gas: If so, legislative action thereon should be secured as soon as possible. See also last page for "Recommended Legislative Action."

PROCEDURE OF RAISING THE WELL-PRICES

It is believed that the Commission has the power and duty to fix the prices which a pipe line should pay for gas offered to it by producers, and also, the power and duty to pro-rate the amounts to be taken from the different producers.

It is also believed, that the Commission has the power and duty to fix the prices to be charged for gas delivered: hence, if "cheap gas which now is replacing lignite" is no longer allowed as figuring in the <u>market demand</u>, then an increase in the volumes of gas used for the <u>other uses</u> will enable the Commission to raise the well-price and with it the price for industrial gas without disturbing the price of domestic or of commercial gas; and this procedure will gradually eliminate the use of gas which is replacing lignite. This procedure is strictly in accordance with the practice in the industrialized North-Eastern part of the United States,and hence, both legal and beneficial. If any legislative action is necessary to carry out this program, then steps to do this should be taken promptly.

THE STORY

In 1931, crude oil sold for as little as 10 cts. per barrel in East Texas, and this field was put under military law to control production. In order to prevent the recurrence of this condition, the Forty-Second Legislature passed the "Market Demand" proration law in 1932, and this has served to steady oil production ever since.

Gas is today in a situation similar to that of oil in 1931: It is sold at the wells at prices ranging from 1 ct. to 5 cts. per M.c.f. At this low price, it is being used for purposes for which lignite could be used and it is being exported in gradually greater amounts. Furthermore, large gas supplies which do not reach public pipe lines are used in a manner which secures a still smaller return than the gas reaching pipe lines. As a result of all this, the total amount of gas now withdrawn annually from the ground has increased to nearly two trillion cubic feet, and if this rate of increase is not checked, it may rise to three trillion in ten to fifteen years. Estimates of our known gas reserves range from fifty to seventy trillion cubic feet, and the probable discoverable amounts may double this; but this is strictly our maximum expectation. With an annual withdrawal of three trillion cubic feet, our gas age may be wholly at an end in forty years, or possibly thirty.

It is the low price now paid for gas at the wells which is responsible for the present situation; and just as with oil, so in this case, proration based on the proper estimate of the market demand can cure the whole situation. The law of 1932 gives the Railroad Commission the duty to do this; but the crux of this procedure is the determination of the market demand of gas. It is the writer's belief that gas designed to replace lignite in large plants is not a proper item to be included in the estimates of "market demand", and that the Railroad Commission should not use it in its future estimates. However, this should not be used to decrease the total volume of gas allowed for existing pipe lines below that now carried by them.

Gas distributed through "common carriers" is sold to two distinct classes of customers: domestic and small industrial and commercial consumers on one hand, and large industrial users on the other.

It is evident that the costs of supplying gas to different customers varies inversely with the customers' daily consumption. Hence, the cost of supplying gas to domestic and commercial users is greater per M.c.f. of gas than the cost of supplying gas to large industrial consumers.

But an additional item enters to affect the price that large industrial users are willing to pay - namely, the cost of other fuels available to them. In Texas, lignite is available, and the price of gas to large plants is now set so as to induce them to use gas rather than lignite. Some comparative costs of the fuels available to large industrial plants in Texas are shown in the following table: It shows why oil is no longer an industrial fuel, and that the cost of gas must be at a very low figure to be cheaper than lignite. One may also see that an addition of 5 cts. per M.c.f. to the gas price in the table will make gas costlier for steam production than lignite, and hence, will impel large industrial users back to using lignite. This is the basis for the 10 cts. well-price used in this discussion.

TABLE I

Comparative Costs of Fuels in Texas

At the Source	At Point of Consumption	Cost to Produce 1000 lbs. of Steam
Gas: 5 cts.per M.c.f.	Gas: 15 cts.per M.c.f.	From Gas at 85% furnace efficiency: 17.1 cts.
Oil: 75 cts./bbl	Oil: $1.50/bbl	From Oil at 75% furnace efficiency: 43.9 cts.
Lignite: 75 cts./ton	Lignite: $2.00/ton	From lignite at 65% furnace efficienty: 20.5 cts.

If a substantial portion of the gas carried by a line must be sold at a specially low figure, then the other portions must be sold at a figure sufficiently high to secure the total income necessary to pay for the whole operation; or the purchase price of gas must be low enough to make up for this difference. In the latter event, all forms of gas handled through the lines should show correspondingly lower sales prices.

It is not the purpose here to raise the question as to whether or not the prices of gas distributed in Texas has been fairly adjusted: It is merely intended to point out the facts and considerations that enter into these questions. The fairness of gas prices is a question involving so many special factors that it is impossible to render a decision without an extensive study of the details of each case.

However, a few general conclusions may be drawn from the statistics of the natural gas industry in other parts of the

United States, and for this purpose, the data in Tables II, III, and IV are submitted.

These tables present 1941 figures taken from the U. S. Department of Commerce Mineral Year Book of 1942.

Column 1 shows the amount of gas produced and consumed in the respective states (in millions of cubic feet!);

Column 2 shows the prices paid per 1000 cu. ft. by domestic consumers;

Column 3 shows the prices paid by commercial consumers, i. e. bakeries, hotels, etc.;

Column 4 shows the prices paid by large industrial plants;

Column 5 shows the prices paid at the wells in the respective states.

TABLE II

NATURAL GAS STATISTICS FOR 1941

U. S. Department of Interior - Minerals Yearbook

State	Total Gas Prod. and Consumed	Price to Dom. Users	Price to Com. Users	Price to Ind. Mfg.	Price at Prod. Wells
North Eastern States:	(M.c.f.)				
West Virginia	207,681	36.5	33.4	21.0	12.1
Pennsylvania	92,819	63.8	53.0	30.9	21.5
Maryland	----	77.4	65.9	29.1	--
Michigan	13,916	96.7	88.2	50.2	12.8
New York	10,456	87.5	74.8	53.0	19.6
North Central States:					
Illinois	10,053	125.5	86.8	21.4	1.9
Indiana	1,522	119.4	87.1	25.0	11.8
Ohio	41,858	65.3	57.1	35.2	16.3
Kentucky	69,067	58.3	49.1	28.0	13.1
Southern States:					
Tennessee	10	76.0	38.5	16.8	10.0
Mississippi	4,268	66.2	32.3	14.8	4.0
Alabama	----	100.6	51.2	17.0	--
Georgia	----	85.1	34.8	18.1	--

TABLE II

(Continued)

State	Total Gas Prod. and Consumed	Price to Dom. Users	Price to Com. Users	Price to Ind. Mfg.	Price at Prod. Wells
West Central States:	(M.c.f.)				
Kansas	111,121	59.0	34.3	12.4	4.1
Nebraska	----	75.5	56.8	17.1	--
Iowa	----	96.6	67.0	16.2	--
Minnesota	----	89.1	46.3	18.5	--
Missouri	196	90.4	62.2	18.0	8.4
Southwestern States:					
°Texas	1,086,312	69.5	43.9	10.4	2.0
Louisiana	403,855	70.3	33.5	10.4	3.2
Arkansas	19,148	50.0	35.3	10.7	4.0
Oklahoma	234,054	46.2	31.5	8.2	2.8
New Mexico	64,655	69.1	37.9	13.8	1.7
Western States:					
Arizona	----	121.8	55.2	20.1	--
California	374,905	72.8	45.5	13.5	6.0
Colorado	3,256	76.7	57.1	15.4	3.7
Utah	5,562	67.9	34.3	12.2	3.4
Montana	29,499	47.1	29.7	13.6	4.6
Wyoming	29,284	46.7	33.9	12.3	3.1

°The Texas price paid at the wells - as given in Column 5 - is as low as it appears on account of the low price paid for some gas used for carbon black. Without the latter, this average price would be about 2.45 cts.

A comparison of the Texas prices with the prices in the four largest gas producing states in our industrialized North-East is presented in Table III.

TABLE III

State	Consumed Production Millions cu.ft.	Prices			
		Domestic	Commercial	Industrial	At Wells
W. Va.	207,881	36.5	33.4	21.0	12.1
Penn.	92,819	63.8	53.0	30.9	21.5
Ohio	41,858	65.3	57.1	35.2	16.3
Ky	69,067	58.3	49.1	28.0	13.1
Texas	1,086,312	69.5	43.9	10.4	2.0

This indicates that the higher prices "at the well" are shown directly in the "industrial" gas prices, but not in the domestic and commercial prices.

A comparison of the prices in the six largest gas producing states is shown in Table IV. It shows that the "domestic and commercial" prices in the three largest producing states are not as low as they are in the three lesser producing states.

TABLE IV

State	Producing Millions cu.ft.	Prices Domestic	Commercial	Industrial	At Wells
Kansas	111,121	59.0	34.3	12.4	4.1
W. Va.	207,681	36.5	33.4	21.0	12.1
Okla.	234,054	46.2	31.5	8.2	2.8
Calif.	374,905	72.6	45.5	13.5	6.0
La.	403,855	70.3	33.5	10.4	3.2
Texas	1,086,312	69.5	43.9	10.4	2.0

Altogether these data support the conclusion that raising the price at the well to 10 cts. would raise the price of industrial gas but not the price of domestic or commercial gas.

Furthermore, the resulting higher price of industrial gas would still be low as compared with its price in other states in which there is much gas used in special industries such as, glass factories, fine clay ware plants, special metallurgical operations; etc. These are always operated with gas, and if they can afford to pay the high rates now charged in other states, then the <u>less-high</u> industrial rates which our "10 cts. well price" will require, will still be a real advantage to all such users in <u>Texas</u>.

Finally, it is not too much to hope that with a greater sale of commercial and special industrial gas in Texas, the Texas gas prices may eventually be decreased to correspond to the price now paid in other states, and still retain the well-prices near or above 10 cts.

A word about the effect of a "10 cts. well-price" upon exportation: exported gas is generally too costly at the point of delivery to be used as a boiler fuel or to come in competition with the cheapest solid fuel available there. But it competes with gas from other sources; hence, a rise in the Texas well-price will affect existing export lines in so far as this will reduce their margin of profit, or tend to limit their sales, and hence, it will decrease rather than increase the desire to export Texas gas.

We note that this raising of the well-price depends upon an increase in the "market demand" for gas used for other purposes than "to replace cheap solid fuels", and it remains to show how this "market demand" can be increased effectively: this is discussed under the next heading.

The procedure by the Railroad Commission to raise these well-prices with such increases in "market demand" has been presented above under the heading Procedure of Raising the Well Prices.

INDUSTRIALIZATION AS THE MEANS OF RAISING THE PRICE OF GAS "AT THE WELLS"

Texas now has 776,000 domestic and commercial gas consumers which use 0.120 trillion cubic feet per annum. Since the greater part of these are domestic consumers, averaging five persons per family, this indicates that about half the people in Texas use gas in their homes, and a great increase in the consumption of domestic gas cannot be expected. Since the pipe lines now distribute 0.556 trillion cu. ft. annually in Texas, it follows that a large increase in commercial consumers is necessary in order to consume most of the present pipe line capacities, and thus make it possible for the distributing companies to pay a higher "well-price". For Texas Gas Statistics, see Chapter VI.

This increase in "commercial users" requires extensive industrialization: Not the bringing here of industrial giants, who by their size may be enabled to arrange for their own gas supplies direct from wells, but the establishing of medium sized industrial projects which will draw gas from public pipe lines, thus increasing the demand for commercial and "special" industrial gas.

The effort to industrialize Texas has been made for some years. In order to be effective, such efforts must be made by many; and fortunately, that is the case. However, there is an important part of our industrialization program which has been left out of consideration by others; namely the setting up of industries with which our citizens are not familiar, or which are wholly new industries. Efforts to set up such new industries have been generally fruitless so far, because such ventures are unknown to investors, and difficult, and costly. Hence, investors have to be given special help in a manner described in the second chapter of this Bulletin - on "Investors' Institutes.

Such institutes, in order to be able to accomplish their tasks, must be specific for each industry, and of large scope. They must concern themselves with raw materials available in Texas, and must furnish the technological information, as well as the commercial information required.

The University of Texas has been making an effort for several years to set up such institutional services for three of our raw products; namely, clay, cotton, and natural gas.

The manufacture of fine clay products presents today the outstanding industrial possibility in Texas, and the procedure for setting up an Investors' Institute - or Commercial Production Bureau - for this industry is clearly outlined by successful examples in New York, Ohio, and Illinois. This matter is presented at length in Chapter III of this Bulletin. Plans for such a Bureau of Ceramics have been prepared by University of Texas officials and are now ready for consideration by the Legislature.

With cotton, we have a different picture: It is not the regular <u>mill</u> uses of cotton, but rather new uses that are required. Hence, there have been carried on at the University of Texas, extensive trials to improve Texas cotton fibers which consist of treating it with various chemicals and plastics, and then devising suitable spinning and weaving procedures. Through cooperation with the Texas Cotton Research Committee, the National Cotton Council, and the War Production Board, this research has attained large dimensions, and if the State of Texas will maintain it, it is ready to serve as the Investors' Institute for New Uses of Cotton. This subject is presented at length in Chapter IV of this Bulletin.

The effort to use natural gas itself for a raw material for manufacturing had its origin in the realization on one hand that Texas has relatively few other raw materials available, and on the other, that gas has real potentialities as a raw material.

The work done at the University of Texas in this connection consists in passing electric discharges through natural gas to make new compounds. The first product made successfully by these means is acetylene: but further developments of this process are in progress and indicate the possibility of making many other compounds. However, the process of making acetylene alone will return enough to the state to repay all past and future costs. The University owns the patent rights, and will grant non-exclusive licenses to all parties on the same basis. Only one license has been granted so far - and since this licensee has been unable to get adequate priorities for making installations - it is unlikely that other licenses will be granted until the priority situation is changed.

The importance of this work is indicated by the fact that a number of industrials - oil and gas companies as well as acetylene manufacturers - have contributed sums aggregating $180,000.00 to continue this research. These gifts are made without any conditions attached: they are outright, unconditional gifts.

Details of this work cannot be published at this time, but some indications of the nature and size of the work are given in Chapter V. From this it will be evident that the work concerns itself with a fundamentally new phenomenon in nature, a new electric discharge, which is likely to be far-reaching in its application. But the experimental work is difficult and the equipment very expensive. Hence, substantial as are the generous gifts made by private parties to the State for this project - they are inadequate to push the job as far as now appears to be desirable - and since the results should be available as soon as possible, corresponding additional sums - matching these gifts - will have to be secured for this project.

CHAPTER II

The Problem of New Kinds of Industries

Its Solution by Means of Investors' Institutes

by E. P. Schoch

SYNOPSIS

1. Investors must be trained and thoroughly informed on new enterprises before they will risk their capital on them.

2. The technical training and business information for new enterprises which investors must secure should be furnished at moderate cost by central state institutes devoted to specific industries.

3. Such institutes must be comparable to the research and development departments of large private concerns, and must be equipped and maintained accordingly. They should serve two distinct purposes: First, to carry on a continuous general research program for the benefit of a particular industry; and Second, to enable individual investors to secure the training and facts needed for their particular enterprises.

4. The cost of such institutes should be charged primarily to the whole state in order to secure adequate equipment and to maintain a permanent staff of specialists; and secondarily, charged to the private investors who secure individual help.

THE STORY

Post-War Plans Do Not Include Means for Starting New Kinds of Industry.

Post-war plans are being made competently and energetically by several agencies in Texas - such as, the Committee for Economic Development (C.E.D.), The State Planning Commission, many Chambers of Commerce, the Texas Bankers Association, and many private parties. But these plans, when carefully examined are found to be designed primarily for the multiplication of known - existing-enterprises, and not for new kinds of industries. Yet the development of the latter is one of the outstanding objectives of present statewide industrialization efforts: and post-war plans can be made much more beneficial if they are made so as to provide the means for introducing new industries.

Let us list some of the products which new enterprises could produce in Texas:

(a) Agricultural and dairy products, processed foods ready for the consumer, etc.

(b) Forest products, particularly pressed boards, plywood, paper products from saw-dust waste, etc.

(c) Non-metallic mineral products, particularly fine clay ware, art pottery, new wall tiles, etc.

(d) Tanning and leather products, ready for the trade.

(e) Cotton and wool textiles, and their products ready for the consumer.

(f) Chemicals, raw plastics and crude rubber from petroleum and gas.

(g) Manufactured articles from plastics and rubber.

This list shows that we have raw materials for many enterprises: what must we do to secure them? A prime need is pointed out below.

Investors Considering New Industries Must Acquire the Commercial Facts and the Technical Training Involved

What provisions must be made to help the development of new industries? Briefly this is expressed by saying that we must enable vanturesome minded individuals to secure the special information needed. We may class the information needed under two headings:

1. Knowledge of the technical facts involved;

2. Knowledge of the market conditions and possibilities.

For enterprises already existing in a community, that is, industries that have been known and practiced for many years, most communities have enough people in their midst who are possessed of the needed facts, and who can furnish the information needed for new ventures. It appears that only these well-known industries are contemplated in most of the post-war planning.

But many communities also desire to attract new industries to them. Realizing their lack of knowledge concerning such industries, they try to move them in from other places. However, when we consider our nation as a whole, then this procedure is seen to amount to "robbing Peter to pay Paul", and hence, not wholly advantageous. Again, this procedure fails to offer investment to Texas capital, and thus again, is not wholly advantageous. In contrast with this, the development of new kinds of industries in our midst would be advantageous to us and not hurt others.

But our own people cannot take part in new ventures as long as they do not know the technology and market conditions involved in such ventures. It is this lack of knowledge that renders most of our industrial development efforts ineffective.

Only Fragmentary Information is Now Available to Investor

The success of large concerns in developing new products is mainly due to the fact that they are able to do all the research and development work themselves. Small concerns and single individuals are not able to do this by themselves. They must be given help. Let us see what is being done along this line both elsewhere and here.

The industrial North-East has set up research organizations whose services are available to the general public. They have the Mellon Institute at Pittsburgh, the Battelle Memorial Institute at Columbus, Ohio, the New England Industrial Research Foundation in Boston, and many others,--and all these in addition to the many private concerns in their midst who originate new industries in their own laboratories.

Let us see what we have along this line. Many organizations such as public service corporations, chambers of commerce, the various railroads, etc., have employed technical experts to investigate the technical and commercial possibilities of new industries. However, the staffs thus employed are usually composed of one man only, and the work consists mainly of collecting information. While some worth-while results have been attained by these efforts, yet in general, the efforts are single-handed, and they do not include experimental investigations. Investors frequently complain that the information thus secured is inadequate.

During the last four years, the Governor's Office has served to direct enquiries for technical information to the available State agencies for answers. While this service has been helpful and valuable, yet is is rather "spotted" and incomplete. It has shown that much more experimental work must be done, and much more information gathered to render the service really effective.

An Illustration of the Job to be Done

To show what needs to be done, let us consider the development of a project for making fine china ware. For this, we must ascertain the availability of suitable raw materials, such as clay, feldspar, quartz, etc. Next, we must determine the exact behavior of these materials in the actual production of commercial products. Such work can be done only be experts with first-class equipment, and is unduly expensive unless it is done by a central laboratory operating for the benefit of the whole region, and financed so as to distribute a large part of the cost over the whole industry or region.

Then comes the location of the plant and its design — a job that again, can be done only by a competent ceramic engineer, and he must be given a chance to study the problem at length. Many accessory questions must be considered: a suitable fuel (which Texas can furnish better than any other state), suitable water, suitable shipping and distribution facilities, etc.

Next, comes the available market: this requires the services of an expert who is especially prepared in the matter of markets and commerce.

During the time that those studies are being carried on, the investors or their representatives should be constantly at the side of the research men in order that the investors may become acquainted with the details of the work. The mere reading of reports is totally inadequate to enable the latter to learn the valuable details needed by them. In other words, the experience gained in witnessing these investigations is an essential part of an investor's training and is an essential part of his future business knowledge.

Texas has made no provision for such service except for the dairy and some farm-products industries at the Texas Agricultural Experiment Station.

At the University, the Texas Industrial and Commercial Research Council gives advisory service along the lines of business administration, industrial chemistry, engineering, and economic geology. This service itself, has received no funds so far: it is furnished voluntarily by research workers occupied with specific research assignments, and hence, is not really financed to give the service contemplated here.

These statements are not made in a spirit of criticism, but rather as facts which must be dealt with in order to solve our industrial problem.

Plan of Operation and Financing of Institutes for Developing New Kinds of Industries

The first item needed for such institutes is a competent staff experienced in industry.

Next, we must have the means for making actual commercial products. Thus, to illustrate again from the clay industry, we must make full-size brick or tile or dinner ware, etc., instead of small test bricklets.

But this involves sums which neither the ordinary college nor the ordinary single business man has available. Hence, new ventures in industry have been left to large private concerns, and the number of small business enterprises has constantly grown smaller.

How can such institutes be financed? Experience elsewhere has shown that they should be primarily supported by state funds. This requires educating the public to see the need and wisdom of such an expenditure.

These incomes from state-wide sources should furnish the material equipment, and maintain the directing staff of specialists. Continuous employment of this staff is necessary to enable them to keep up with the progress of the industry, and to give the public the benefit of the staff's accumulated experience. The most economical way to maintain such a staff is to have them employed on research problems of fundamental importance to these industries, so that this research in itself justifies the maintainance of the staff. This research will not be interfered with when the staff is also called upon to direct investigations for individual investors, provided an adequate number of assistants is secured to do the extra work.

Requests for help made by individual investors or by community groups to determine the conditions for a particular enterprise will probable be presented at irregular intervals. The extra expense involved in complying with private requests should be borne in substantial part by the requesting parties. This income will not only serve to make the work more extensive and thorough, but it will prevent the presentation of thoughtless or unworthy requests; and it will enable the staff to cope with many more requests simultaneously than would otherwise be possible.

The University's Plans for Investors Institutes

For New Products From Clays, Cotton Fibers and Gas

The three most prominent natural resources which Texas has available for new industrial enterprises and for which she needs investors' institutes, are clays, cotton fibers, and natural gas. Realizing this, the University of Texas has carried on for a number of years, a definite research program on these materials.

This work has been successful, but its scale of operation is inadequate to do the job commensurate with the needs of the State.

It is now proposed to expand the work--so that Texas may be ready for the "after-the-war" period.

The following three chapters present what has been done so far by the University along these respective lines,--and what can or should be done from now on in order that these agencies may be able to do the job properly.

CHAPTER III

Development of Clay Industries Through A Commercial Production Laboratory and Research

by F. K. Pence°

The term "Ceramics" (Greek, Keramos) related to the Sanskrit word meaning "to burn", was formerly employed to designate that portion of the plastic arts which embraces the production and decoration of all objects formed by the molding, modeling, and firing of clay. In that sense, therefore, it was practically synonymous with the word "clay-working".

However, as used in connection with modern industry, the term "Ceramics" has gradually acquired a much wider significance, and now generally applies to the technology of the earthy or non-metallic minerals; that is, to the technology of nearly all mineral products except ores and minerals of organic origin.

The ceramic industry thus embraces the manufacture of all kinds of clay products, including table-ware, china and porcelain ware, such as electrical, sanitary, and chemical porcelains, floor and wall tiles, both vitreous and semi-vitreous; all types of glass products, containers, structural, and table ware glass; structural products, both glazed and unglazed, as brick, tile, terra cotta, sewer and conduit pipe. It also includes Portland cement, dental cements, lime, plaster, stucco, and a variety of gypsum products and special cements; fused silica and magnesia ware; enameled metals and sanitary ware; a great variety of insulating materials, both electrical and thermal, such as mica, vermiculite, steatite, rock wool; talc, chalk and slate products; abrasive materials, such as finely divided silica and carborundum and alundum products; rare earth products, such as mantels and tips for gas burners; refractories, bricks and standard shapes manufactured from clays, bauxite, magnesite, chromite, graphite, asbestos, talc, lime, quartz, alundum, and many other materials.

Among the ceramic raw materials processed for other uses are: Filler clays for the paper and rubber industries, bleaching clays for clarifying of vegetable and mineral oils, and drilling muds for the petroleum industry.

From an economical point of view many of the ceramic industries occupy a rather unique position, in that, owing to the practically inexhaustible supplies of their raw materials (clay, shale, limestone, etc.), they increase the wealth of the country without materially diminishing its natural resources.

It is an astonishing fact that Texas, with an abundance of ceramic raw materials coupled with the ideal fuel, natural gas,

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°Associate Director, Bureau of Industrial Chemistry, in charge of Ceramic Research.

is at the bottom of the list of ceramic manufacture as compared with any other state of comparable wealth and population.

The present Ceramic Division of the Bureau of Industrial Chemistry began activities in July, 1940. In the field of raw materials it was known that some excellent clays were available but information with reference to the full complement of clay minerals, particularly those required in the manufacture of white porcelain, was sadly lacking. The program therefore, was begun in this field. After a period of three years we were able to announce that all of the clay minerals necessary to produce white porcelain were available in this area and that methods for their processing had been worked out.

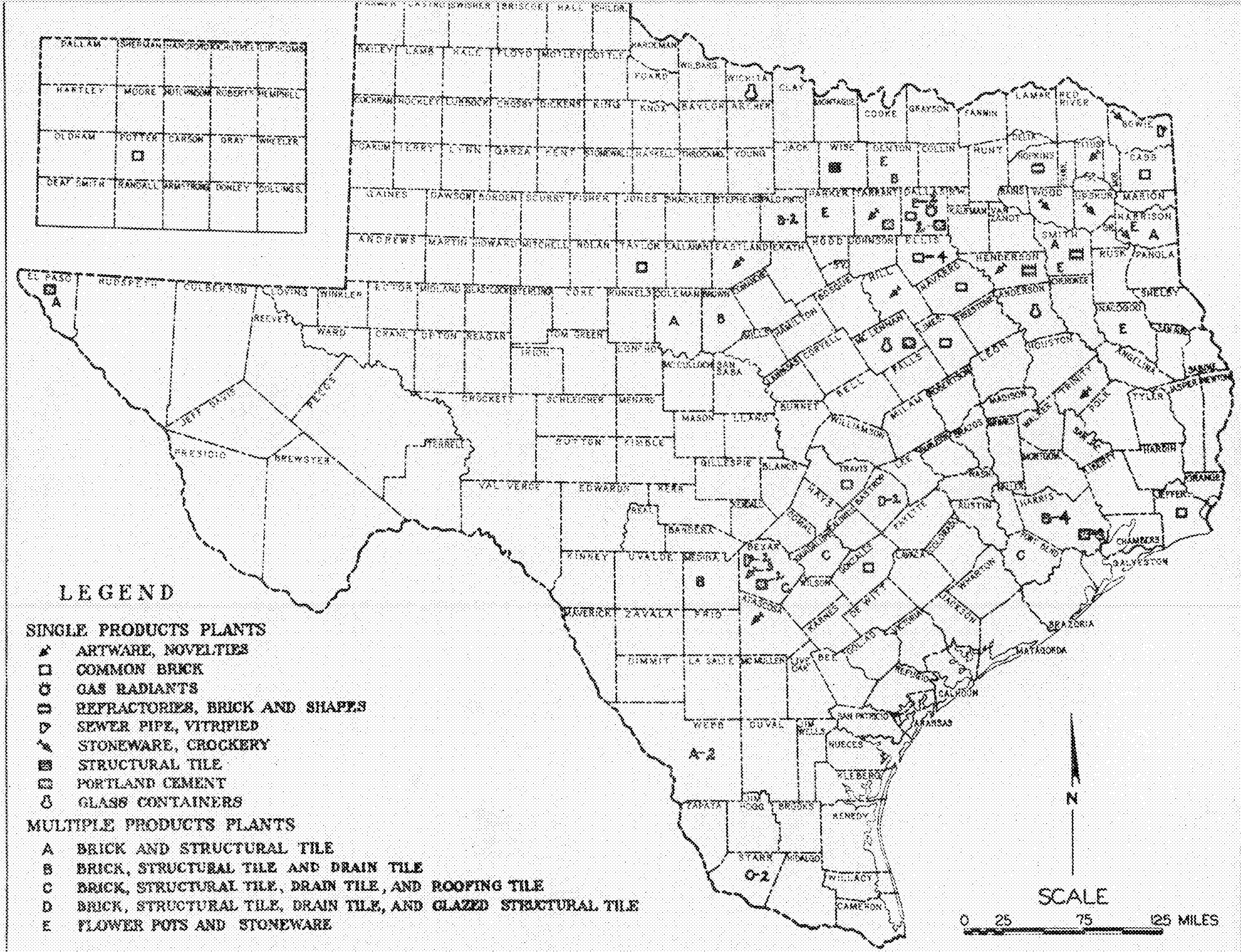
The principle locations of the four minerals used in porcelain are as follows: Kaolin, in west Texas near Marfa; Ball clays, in east Texas near Henderson; Feldspar and Pure silica, in the central or Llano region. In addition to these four basic minerals it was also discovered that there was an occurrence of white firing montmorillonite. This mineral, as a porcelain ingredient, imparts unusual properties and affords distinct advantages to prospective porcelain production in Texas. Standard porcelain mixtures were made up and sent to eastern factories, where actual wares were made and put through regular factory processing with very successful results. We therefore, have demonstrated the availability of raw materials for porcelain manufacture.

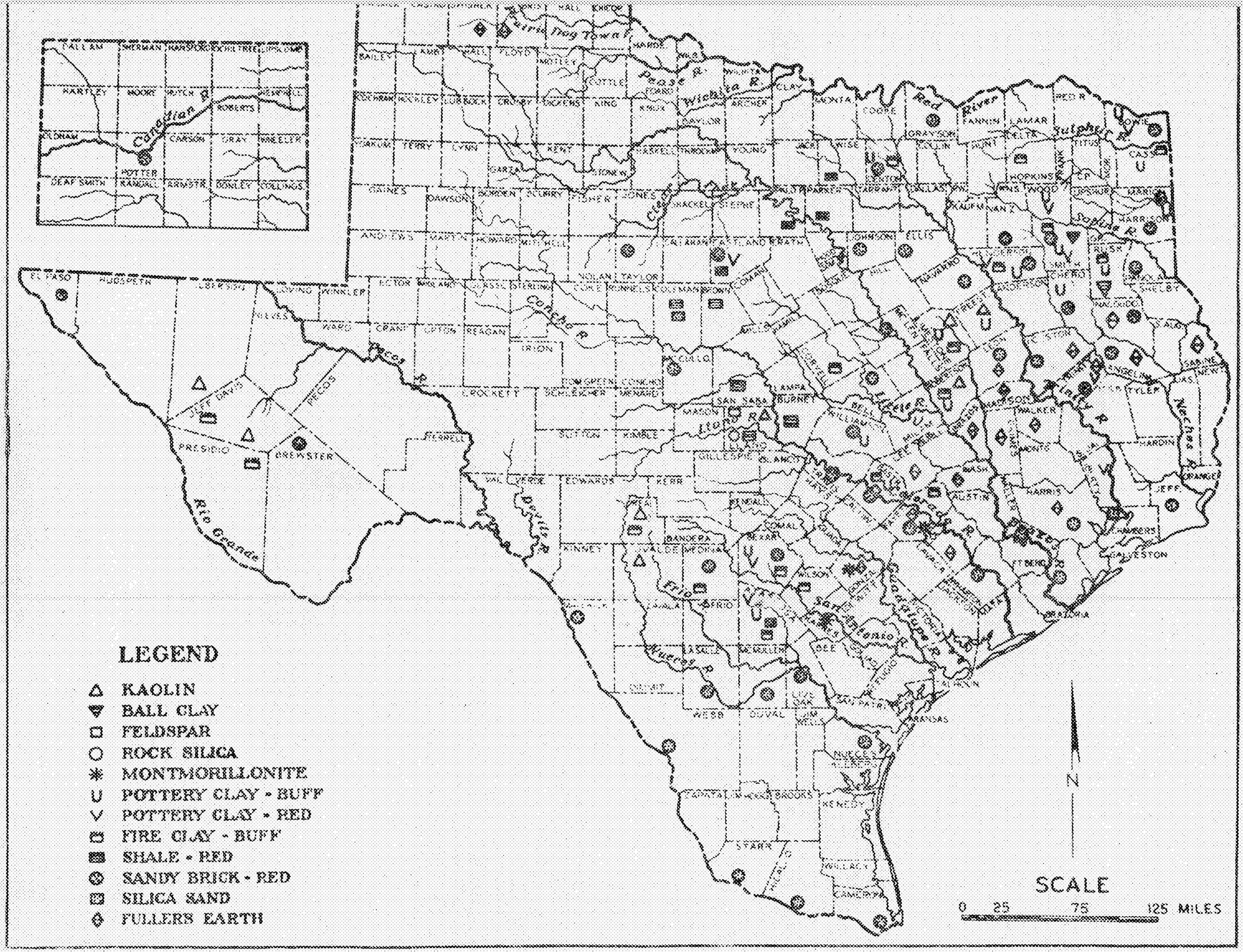
While this research on porcelain materials was being carried on, we were also studying raw materials necessary for other basic industries, particularly those pertaining to the war activities; namely, refractories, glass, and cement. While we do not claim credit for the new industries springing up in this field, we may say that in the past two and one-half years, we have two new large glass plants, two large refractory developments, and also manufacturing establishments of white Portland cement which previously was not produced in this State.

In addition to studies pertaining to these industries, we have also been in close contact with the factories which were established many years before our ceramic division was created. These are principally brick and building tile and some small art pottery establishments.

We are including herewith, two maps showing the location by counties, first, of Texas Ceramic Industries, and secondly, of Ceramic Raw Materials. In the case of Raw Material deposits, particularly those adapted to porcelain manufacture, much field work needs to be done to determine extent of the deposits. Such field work would also, doubtless, bring to light many deposits now unknown.

The contact of the Ceramic Division with the Ceramic Industry of the State led to the organization of the Texas Ceramic Society of which the personnel of these factories are members. Because the interest in this society expanded to neighboring states,


LEGEND
SINGLE PRODUCTS PLANTS
ARTWARE, NOVELTIES
COMMON BRICK
GAS RADIANTS
REFRACTORIES, BRICK AND SHAPES
SEWER PIPE, VITRIFIED
STONEWARE, CROCKERY
STRUCTURAL TILE
PORTLAND CEMENT
GLASS CONTAINERS
MULTIPLE PRODUCTS PLANTS
A BRICK AND STRUCTURAL TILE
B BRICK, STRUCTURAL TILE AND DRAIN TILE
C BRICK, STRUCTURAL TILE, DRAIN TILE, AND ROOFING TILE
D BRICK, STRUCTURAL TILE, DRAIN TILE, AND GLAZED STRUCTURAL TILE
E FLOWER POTS AND STONEWARE
N
SCALE
0 25 75 125 MILES



Ceramic Division, The University of Texas the name has recently been changed to Ceramic Society of the Southwest. Program meetings have been held semi-annually and the enthusiasm created has surpassed the most optimistic expectations. It was found that many of these plants were operating on clays which possessed troublesome properties. Fundamental research has been going on in the Ceramic Division to determine cheap methods of correcting these properties. Very interesting and helpful results have already been obtained.

The corner stones upon which ceramic industry is based are fuel, labor, raw materials, and market. The type of labor generally available in the Texas area, having the admixture of Latin Americans, is especially adapted to clay manufacture operations. The occurrence of the ideal fuel of ceramic manufacture, namely gas, is available in the State to a degree perhaps unequalled in any other section of the country.

Very recently the fourth supporting cornerstone of ceramic industry has been the object of some investigation, namely market. In conference with the Bureau of Business Research, local surveys have been made from which figures for the area could be made by prorating process. Due to the fact that normal building operations have been absolutely curtailed, it was not possible to include products catering to this industry in the survey. We have therefore, included only domestic and utility products; namely, fine china, table glassware, dinnerwares, hotel and restaurant ware, kitchenware, crockery and art pottery.

A survey for the year 1943 was conducted in various communities over the State through the cooperation of the Chambers of Commerce. It is significant that in all reports the statement was made that at least 50% to 100% more of these products could have been sold if it had been possible to obtain them. For this reason, the actual market demand is at least 50% greater than the figure given for actual sales.

The general classification given in the national publications, will of necessity be followed in the following tabulations. In order to arrive at the overall figures for the State of Texas, we have taken the annual production of manufactured ceramic products in the country as a whole and added to these the difference between imports and the exports in any classification. Since this sum represents approximately the figure for the value of ceramic products consumed by the nation as a whole, and since Texas is recognized by statisticians as representing an average consumption, the amount consumed by Texas may be obtained by pro-rating on the basis of population. The data available is scattered and does not extend beyond the year 1940. The products are grouped according to the data given by the United States Bureau of Mines, the Bureau of the Census, and a few other sources. In each case the figure shown is an average for the years indicated.

ANNUAL PRODUCTION IN THE NATION

Cement (1937-1940)................................ $ 176,457,224
Clay Products other than
  Pottery and Refractories (1937-1940)............ 108,584,555
Pottery... 96,387,000
Refractories (1937-1939, 1940).................... 46,544,000
Glass (1937-1939)................................. 337,211,000

IMPORTS

Clay Products other than
  Pottery and Refractories........................ $ 9,340,000
Pottery... 7,487,000
Glass... 6,042,000

EXPORTS

(Pottery is only ceramic item shown)

Pottery... $ 2,943,000

PRODUCTION PLUS IMPORT MINUS EXPORT

Item	Production	Import	Export	Total
Cement..............	$176,457,224	$	$	$176,457,224
Clay Products other than Pottery and Refractories...	108,584,555	9,340,000		117,924,555
Pottery............	96,387,000	7,487,000	2,943,500	100,930,500
Refractories.......	46,544,000			46,544,000
Glass..............	337,211,000	6,042,000		343,253,000

PRODUCED IN TEXAS

Available Data

Cement (1937-1940)................................ $ 11,941,485
Clay Products other than
  Pottery & Refractories (1937-1940).............. 4,372,429

CONSUMED IN TEXAS

Data from Limited Survey

Pottery and Glass (1945).......................... $ 15,000,000

Calculated Pro-Rata Consumption on Basis of Population

Cement.. $ 9,928,198
Clay Products other than
  Pottery and Refractories........................ 6,367,925
Pottery... 5,450,247
Refractories...................................... 2,502,576
Glass... 18,534,562

It will be noted from above that the total ceramic production for the nation available from published data is given as $764,985,779. The <u>total ceramic products consumed</u> for the State of Texas as calculated on the basis of population is <u>$42,783,608</u>. The <u>amount produced</u> in the State of Texas as shown by available data is <u>$16,313,914</u>. It will be noted also, that the ceramic products consumed in the State of Texas exceed the amount produced by a figure of $26,469,694. Referring back to our limited survey which included porcelains, art ware, and utility glassware, we see that this figure checks fairly well. The larger figure shown in the difference is accounted for by the fact that our survey did not include structural glass, nor did it include refractories. It should also be stated that the production figure in the State had no doubt been substantially increased during the last two years due to the operation of two new glass plants and two new refractory manufacturers. Assuming that the total produced in the State as of 1944 would be approximately $20,000,000; there is still a difference of something over $20,000,000 representing products consumed but not produced in the State.

Another point that should be stressed here is that ceramic production tends to be centered in those areas which have available raw materials and favorable fuel supplies. It has long been recognized that Texas has the most favorable fuel supplies of any state in the nation. It has only recently been brought to light that it also has the full complement of raw materials necessary to support any and all branches of ceramic manufacture. On this basis it could logically develop that Texas would produce at least 25% of the national production in this ceramic field which will follow in the post-war period. In other words, the potential production of ceramic products in Texas should be at least $100,000,000 annually.

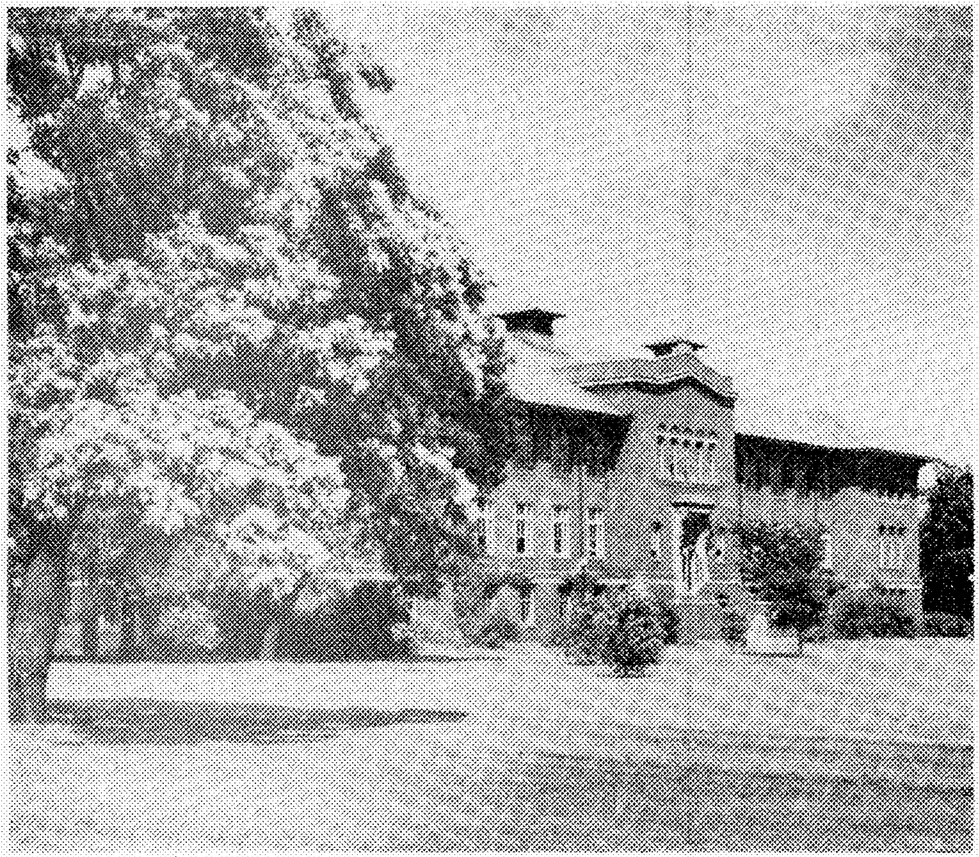
It is the recognized policy of any forward looking state to make available to all interested parties such information as can be obtained relative to its natural resources. It is also an equally well recognized policy to provide training for the job of utilizing these natural resources. The logic of this policy applies nowhere more forcibly than in the field of ceramics. It is notable that in the states in which ceramic raw materials have been developed, we find outstanding ceramic departments in their state supported universities. It is also noted that while ceramic manufacture has reached a high stage of development in many of these states, the facilities of these ceramic research and educational departments are constantly being substantially expanded. Many Texas ceramic raw materials possess superior qualities which offer distinct advantages in their utilization. In the program of ceramic operations in Texas the leadership and services of central production laboratories and curriculum in ceramic instruction is obviously indispensable. This should be set up immediately on a basis at least comparable to that found in any other state in the union. Such a ceramic department will not only train men for engineering positions in the larger industrial organizations, for which there are many calls, but can also include a curriculum which will give the necessary instruction to qualify a student for leadership in the smaller commercial industries that can be set up.

A program designed to foster small industry must first of all safeguard the economic success of that industry. A state-wide interest in the possibility of small ceramic industry is being expressed in increasing volume through Chambers of Commerce, civic and technical groups, and public spirited citizens. There is a general agreement that smaller communities as well as the larger cities can turn to new ceramic industry as a means of alleviating a substantial portion of the prospective post-war unemployment. It is also believed that one of the first steps in this movement would be the establishment of a central production laboratory which would cover all of the phases of ceramic industrial operations. This too, is following the modern procedure, as such steps are already being taken in the ceramic field by other states.

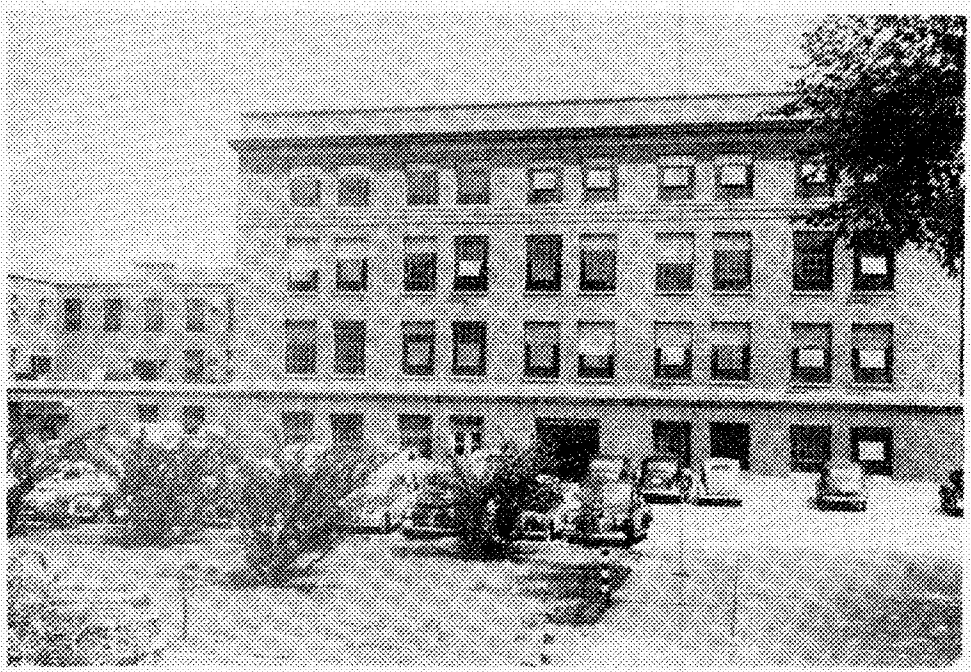
Included herewith are cuts of buildings which house ceramic departments, research and production laboratories of a few of the leading ceramic institutions of the country and forming a part of the state universities as indicated. It is impossible to give more than a very brief discussion of these various ceramic plants.

The first cut shows the building which houses the instructional department of the ceramic engineering at the Ohio State University. The Personnel of this department conduct a departmental research program and facilities for this activity are also provided in this building. The second cut shows the research plant which has been set up by the State of Ohio to conduct investigations in any industrial or mineral resource problem. Inasmuch as the mineral resource of the State lies principally in the non-metallic classification, the result has been that the activities of this engineering experiment station are almost wholly in the field of ceramics. The University of Ohio State has been offering for a number of years a curriculum in ceramic art. The instructional and laboratory facilities for this curriculum are housed in the building shown in the third cut. There has been set up in the past year a production laboratory program or what might be termed industrial pilot plant operation. This new activity is sponsored by all three of the ceramic divisions above listed and is being housed in the same building with the ceramic art. Actual ceramic product is made with special reference to improvement in quality and design. This product is submitted to marketing agencies for their criticism and approval. Through these agencies it may even be submitted to the public for final judgement and acceptance.

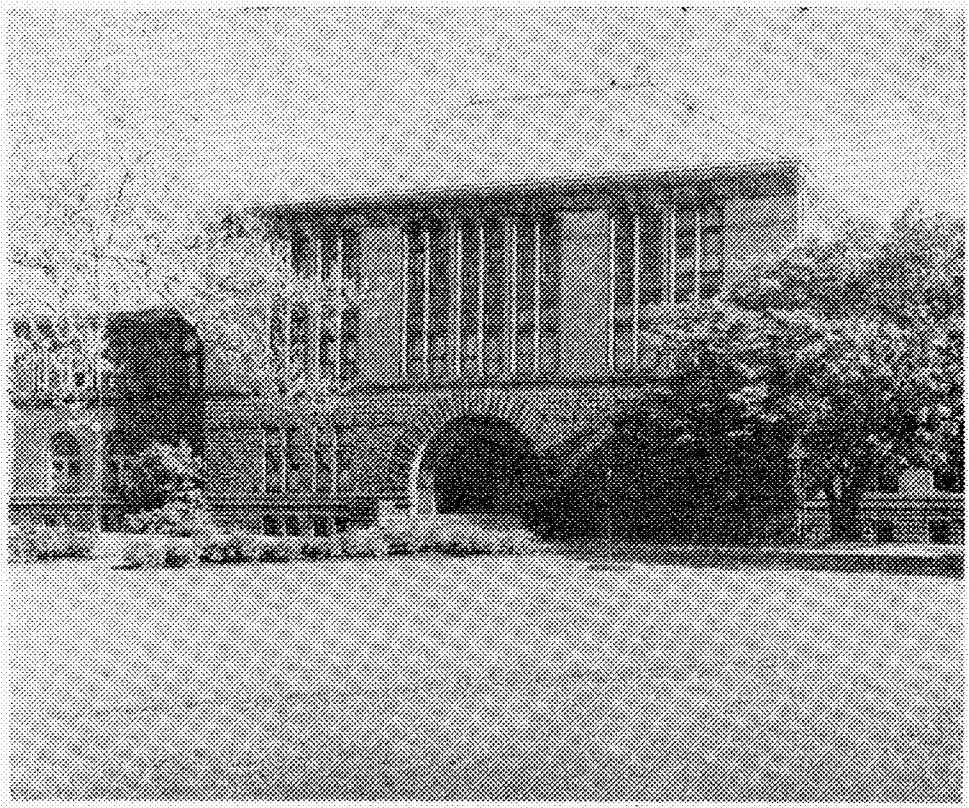
We are also including herewith a cut of the main building of the New York State College of Ceramics, Alfred, New York. This building is one of four major buildings which this college devotes to all of the various activities which have already been listed in the case of the Ohio State University. Two new buildings are now in the process of construction, and it is notable that one of these buildings is to be devoted to pilot plant and semi-industrial activities. We are also showing cuts of the Ceramic Plant at the



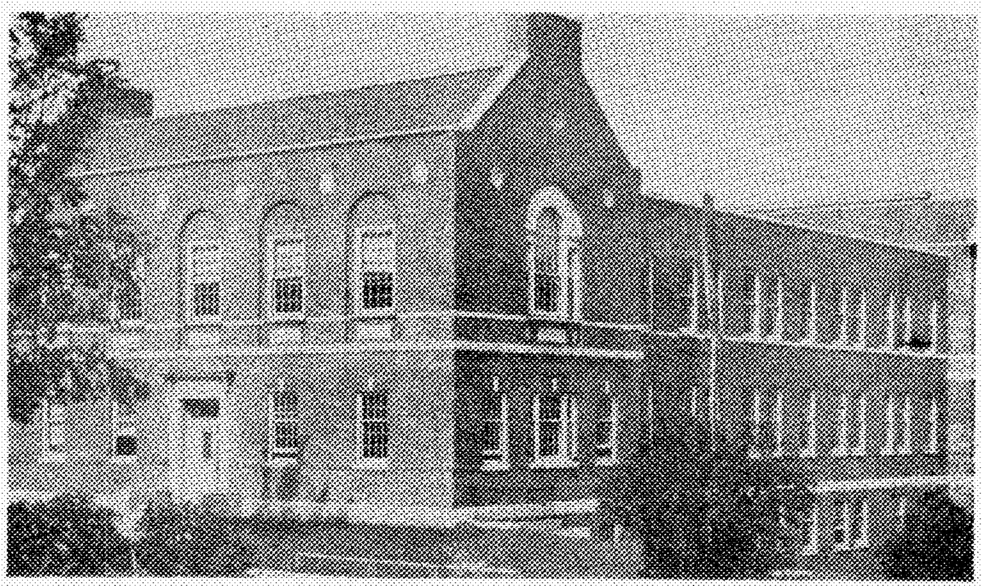
Ceramic Engineering Building, Ohio State University, Columbus, Ohio.



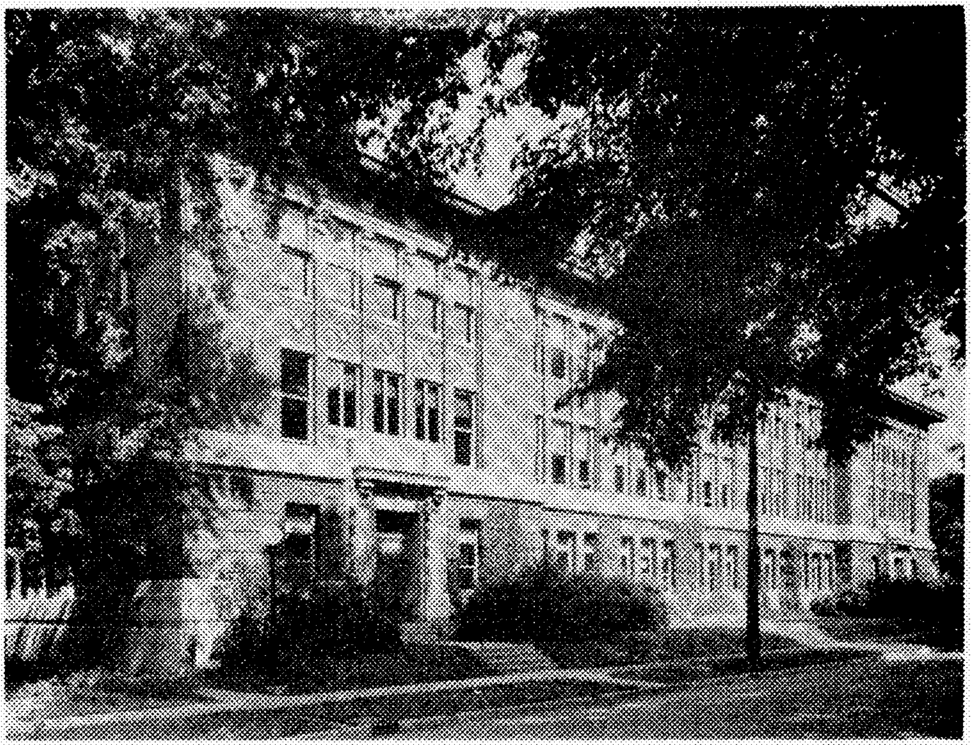
Ohio Engineering Experiment Station, Major Research in Ceramics,
Ohio State University, Columbus, Ohio.



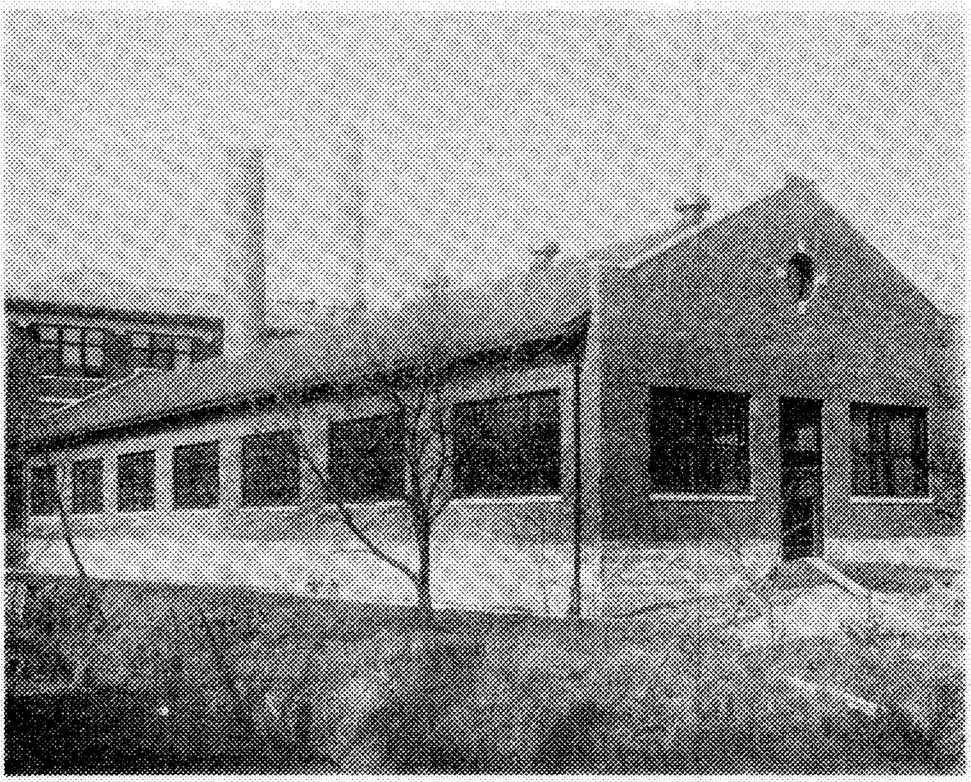
Ceramic Art and Ceramic Production Laboratories, Ohio State University, Columbus, Ohio.



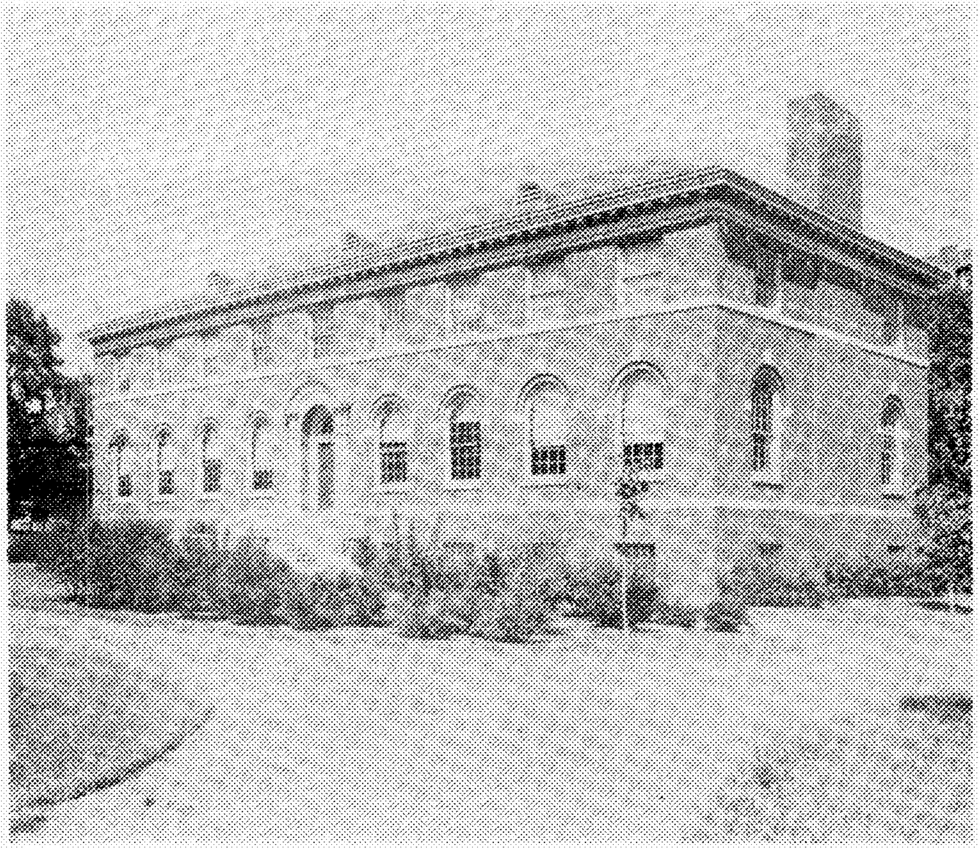
Main Building, New York State College of Ceramics, Alfred, New York.



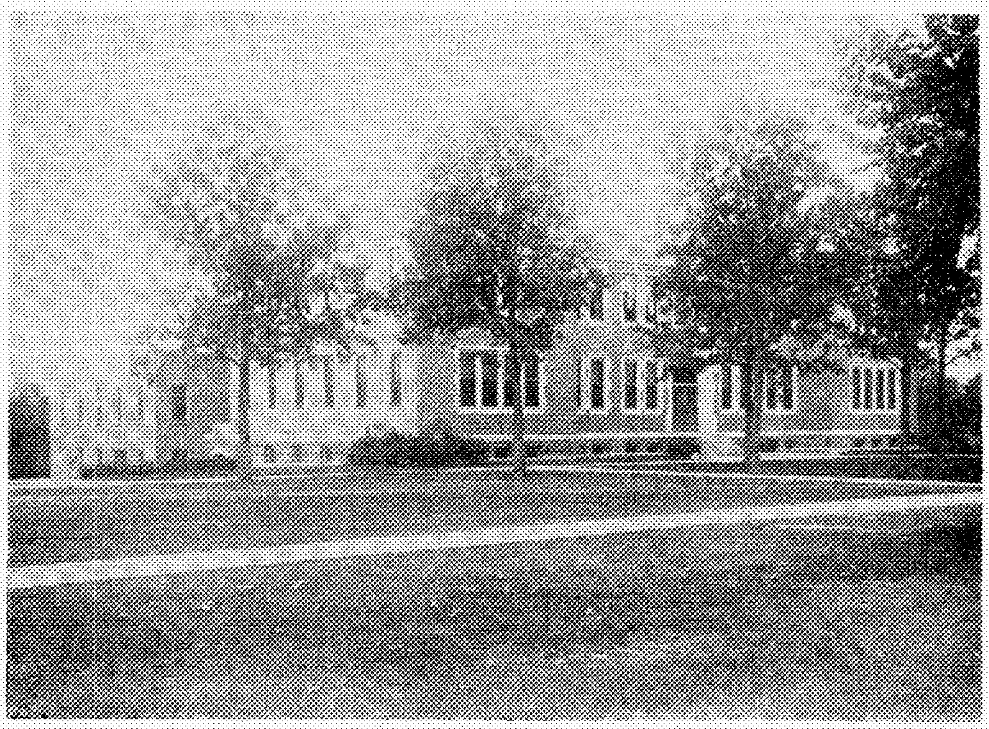
Front view of Ceramics Building, Department of Seramic Engineering, University of Illinois, Urbana, Illinois.



Kiln House, rear of Ceramics Building, Department of Ceramic Engineering, University of Illinois, Urbana, Illinois.



Ceramic Engineering Building, Rutgers University, New Brunswick, New Jersey.



Ceramics Building, Department of Ceramic Engineering, Missouri School of Mines, Rolla, Missouri.

University of Illinois, Rutgers University, New Jersey, and the Missouri School of Mines at Rolla, Missouri.

These buildings represent investments running from $200,000 up to approximately $1,000,000 in the case of New York and Ohio State. The equipment necessary to implement these buildings would represent an investment of $100,000 up to over a half a million dollars. The cost of personnel and maintenance will range from $20,000 to $200,000 annually. In the case of the higher figure which, of course, pertains to the larger institutions, a substantial portion is derived from payments by industrial organizations for privately supported research projects. It is only the recognized Ceramic Research Departments that are the recipients of such projects.

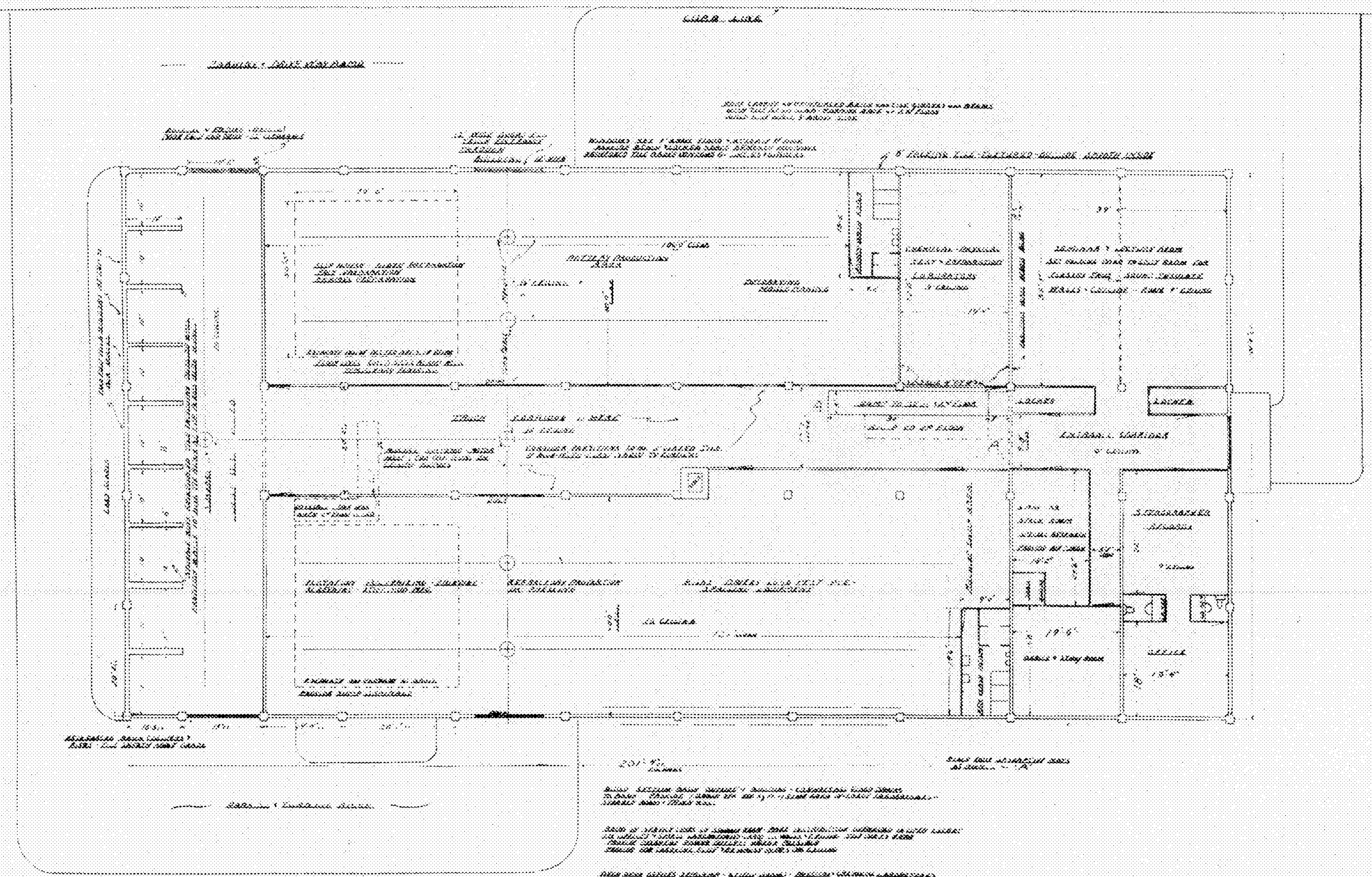
As has previously been pointed out, the outstanding undeveloped mineral resource of Texas is the non-metallic field. The proven wisdom of affording facilities for the development of this field is shown by the experiences of other states. The confirmed logic of such programs, as above listed, applies with greater force to the State of Texas. Because of advantages already pointed out, the setting up of this program in the State of Texas comes at a most favorable and opportune time. A ceramic engineering curriculum and a Bureau of Ceramic Research should be set up at the earliest date possible.

Since this demand will become critical immediately at the close of the war, the providing of a building and equipment should now be under way as an emergency measure. It is our recommendation that a one-story building, of dimensions 100 x 200 feet, be so designed that a second story can be added as the research and instructional department grow. This building can be erected at a cost of $75,000 and will house the Bureau of Ceramics and the Department of Ceramic Engineering through its earlier years.

Furthermore, an appropriation of $75,000 will be needed from the University funds in order to equip this production laboratory on a basis at all comparable to such laboratories in New York, Ohio, and Illinois. Further, it will be necessary to ask the legislature to appropriate $75,000 per year to maintain and operate this Bureau of Ceramics.

The production laboratories would not only be a proving ground for new products, but would train the student in the operative details necessary to their fabrication. Hence, a coordination of instruction and research will be set up on a practical basis.

Another feature which must be covered by the production laboratories, is the matter of raw material processing. Throughout the ceramic centers of the East we find processing plants which prepare feldspar, silica, kaolin, etc., so that the manufacturer merely places his order and receives a car-load shipment of the processed material. The prospective manufacturer is not able to do this in Texas and is timid about setting up porcelain industries



SUGGESTED FLOOR PLAN
for
CERAMICS BUILDING
UNIV. of TEXAS
BUREAU of CERAMICS

here for that reason. One of the first problems of the ceramic production laboratories will be to set up pilot plants in the processing of Texas raw materials on a scale which will remove this handicap. Such pilot plants will show that this processing can be done by individual plants until such time as the industry reaches a magnitude which will develop processing industries similar to those found in the East.

The maintenance program will also include, as an emergency measure, field investigations of raw materials, particularly with reference to their location, extent, and economic utilization. As has already been pointed out, the lack of information with reference to the extent and quality of ceramic raw materials, particularly for the porcelain industries, is one of the great handicaps to the setting up of a new industry. This information should be obtained at the earliest possible date. This type of work is admittedly expensive, but is absolutely necessary.

Almost daily, requests are being received for information necessary to the setting up of ceramic industry in the State of Texas. The proposed program outlined in the foregoing will not only safequard existing small business, but will service a field of new industry not now represented in the entire Southwest. The benefits to be derived are so varied and so fundamental, as to not only justify the program, but to place it in the emergency class of <u>must</u> legislation.

CHAPTER IV

New Uses for Cotton - And

A Research Center of National Importance

by Simon Williams°

PREFACTORY NOTE

The largest cotton research group in the United States, outside of the U. S. Department of Agriculture, is now located at the University of Texas, affiliated with the Bureau of Industrial Chemistry.

A staff of forty technicians and a wide variety of research equipment are scattered in five different buildings on the campus of the University, concentrating their entire research effort on emergency war research projects, carried on, in all but one instance, under contract to federal war agencies.

If this staff and these facilities are properly housed and maintained, the University of Texas will become the outstanding cotton research center in the South, and the State of Texas will have a research program commensurate with the magnitude of its cotton problem.

THE STORY

Five years ago there was no cotton fiber improvement research done in Texas. The work then done by the Texas Agricultural Experiment Station of the A. & M. College and the Textile Engineering Department of the Texas Technological College, concerned itself with the study of problems relating to the cotton farmer, the training of skilled textile mill operators, and the more efficient use of textile equipment of cotton as produced.

No attention was being devoted to the chemical modification of the fiber to enhance its properties and the quality of products made from it.

In considering an approach to cotton research, several avenues of approach were available, all of which had to be taken for a complete program for cotton, but any one of which was of such magnitude as to require all of the effort of some one agency in the State.

First, cotton is a plant product - a product of the farm.

°Director of Research, National Cotton Council, and Associate Director of the Bureau of Industrial Chemistry.

Therefore, the problems of yield, cultural practice, production costs, quality, etc. must be solved. In Texas, the logical research agency for this type of research is the Agricultural Experiment Station.

Second, the cotton fiber is essentially a textile fiber. Therefore, it must be processed. The training of men to supervise this processing and the study of problems relating to engineering improvements of the machines so used is obviously in the province of the Textile School at Texas Technological College.

Third, cottonseed is a valuable by-product of the fiber. Research to improve methods of cottonseed processing and to increase the value of the crop had already been initiated by the Engineering Experiment Station of A. & M. College, and logically, for efficient utilization of existing physical and mental resources, further effort in this field is best concentrated at the A. & M. College.

Finally, there remained the field of chemical modification of the fiber, employing the discoveries in the fields of plastics, organic chemistry, chemical engineering, textile chemistry, etc. to the end of improving the quality of the fiber beyond the capabilities of Nature. The Bureau of Industrial Chemistry at the University of Texas, in affiliation with the Department of Chemical Engineering seemed the agency best adapted to develop this phase of the research on cotton and a program was initiated in November 1939.

This program in the Bureau of Industrial Chemistry was started in a very small manner, with an annual budget of some $8,000.00. Yet it was started with the full realization that if at all successful, very few years would pass before a much larger expenditure would be required. Knowing this, careful study was given to justifying this added outlay to the other cotton research efforts in the State. Briefly stated, the picture developed by this study, as of 1940, was as follows:

1. Cotton has always been the major agricultural commodity of Texas. The economy of the State has its roots deep in the money value of the crop and the hundreds of gins, compresses, shipping offices, etc. which handle the crop.

2. Prior to the economic crises all over the world which took place in the early 1930's, Texas exported over 90% of its cotton crop. Hence, the domestic mills developed their technology and buying psychology around cottons grown east of the Mississippi River.

3. With the rising tides of nationalism, economic crashes, the entrance of the U. S. Government into the cotton business and supporting the price of cotton above world levels in the channels of free trade, world markets for Texas cotton steadily declined and were essentially stopped by the outbreak of World War II.

4. As world markets were lost, cotton acreage in Texas decreased at an alarming rate. As less cotton was produced; gins compresses, and oil mills went out of business at a tragic rate. Cotton economy in Texas was rocked to its foundations.

5. Even as this was happening in Texas, domestic markets for cotton were increasing and two facts were obvious:

(a) Texas, throwing its huge production onto the domestic market, was at the heart of the domestic cotton problem.

(b) The hope for Texas cotton, if its production was to be justified in terms of national economy, was to develop a domestic demand, during the period in which the world returned to normalcy, assuming that world markets could then be regained.

6. To so utilize the Texas crop, three answers suggested themselves:

(a) Regain world markets. This is probably the only method whereby the cotton problem can be completely solved, at least for the United States. This involves legislative changes, agricultural and distributional readjustments, economic changes, variation in diplomatic techniques, and in our present social philosophy, and other factors, all of which blend into one of the most complex pictures that could be conceived, and we must not be too sanguine that even with the most complete and sincere effort, world markets will be regained in the near future. The uncertainties of world events needs no emphasis here.

(b) Improve the quality of the cotton fiber and its products to the extent of widening the outlets for known products and retaining present markets against the competitive inroads of other fibers, natural and synthetic.

(c) Develop new uses for cottons.

To approach any of these suggested remedies, research and more research was called for - research that was immediate, decisive, intelligently conceived and directed, and engineered by the very best talent available. Research was demanded in laboratories completely equipped and capable of flexible expansion. Research of a new type was demanded, wherein fundamental and practical considerations were coordinated and made to cooperate.

This concept of the cotton problem facing Texas has been verified and the entire problem has become even more serious in the years since 1940, until we are currently faced with the outstanding fact that unless its technology can be improved, cotton faces the steady loss of its major markets.

In addition to the political factors hampering cotton, we are faced with a price and quality competitive fight from rayon, paper, and other synthetic fibers which has no precedent in history. Assuming an intelligent solution to the political aspects of cotton as a national and international commodity, the one solution to our problem is based on the same foundations upon which the growth and stability of any industry are based; namely, quality improvement and decreased costs. If the future of cotton is to be bright, it too, must move along this road.

RESEARCH ORGANIZATION AT THE UNIVERSITY OF TEXAS

In 1939, at the outset of the cotton program of the University of Texas, only the Bureau of Industrial Chemistry was involved. The facilities then available included but one small chemical laboratory.

By 1941, the State Legislature had passed the Moffett Cotton Research Bill, and from the funds made available for cotton research, the University of Texas added a fiber testing and spinning laboratory for the evaluation of chemically modified cottons, and expanded its chemical engineering facilities.

In 1943, the National Cotton Council of America, in recognition of the facilities available at the University of Texas and aware of a liberal, dynamic approach to its cotton problem on the part of the State, moved its research headquarters to Austin, in affiliation with the Bureau of Industrial Chemistry, and aided in adding a weaving laboratory and additional chemical processing equipment.

Some of the facilities for cotton research at the University of Texas are shown in Figures 1 - 5. These are variously located in the Chemistry, Chemical Engineering, Physics, Home Economics, and Temporary Pilot Plant Buildings.

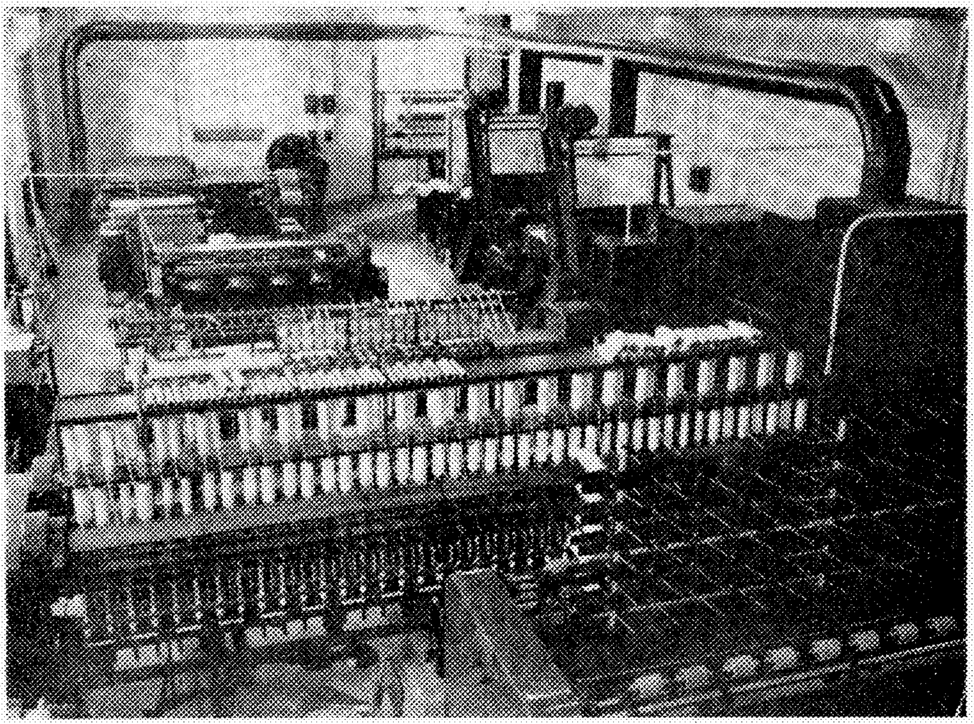
The important facts to emphasize here are:

1. The cotton research unit at the University of Texas is unique in the United States as it consists of a coordinated effort on the part of private industry and government for the solution of a mutually important problem.

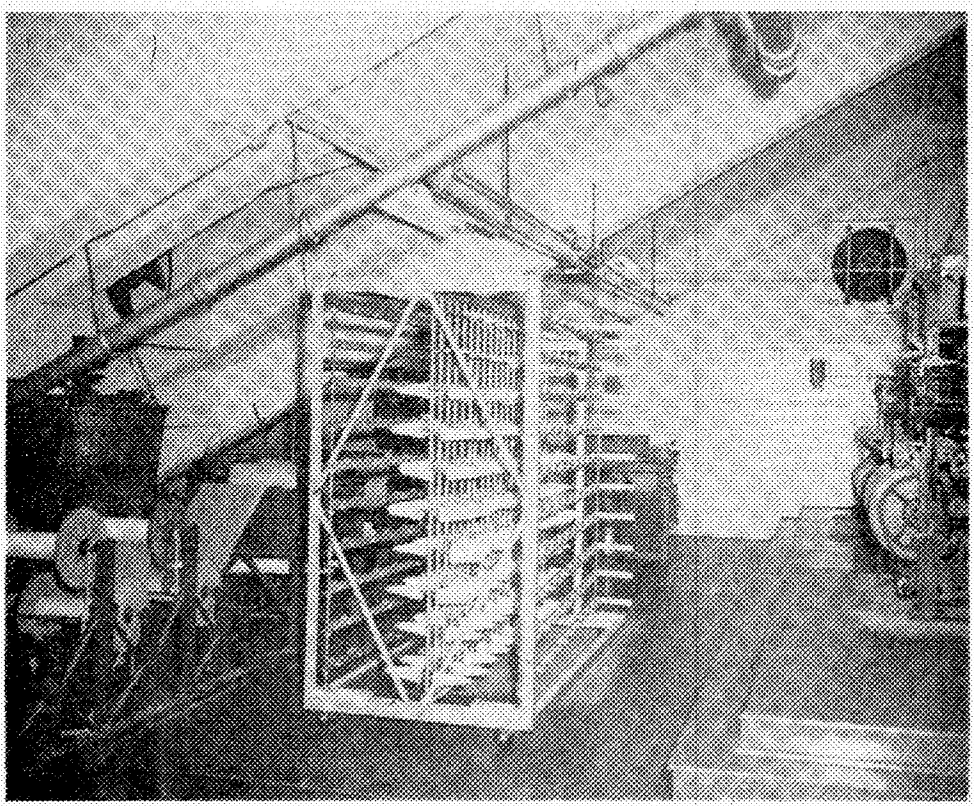
2. The equipment already available for cotton research along the lines of chemical modifications of the cotton fiber for textile and industrial applications is perhaps more complete and more versatile than any other laboratory in the United States working exclusively on cotton.

RESEARCH PROJECTS

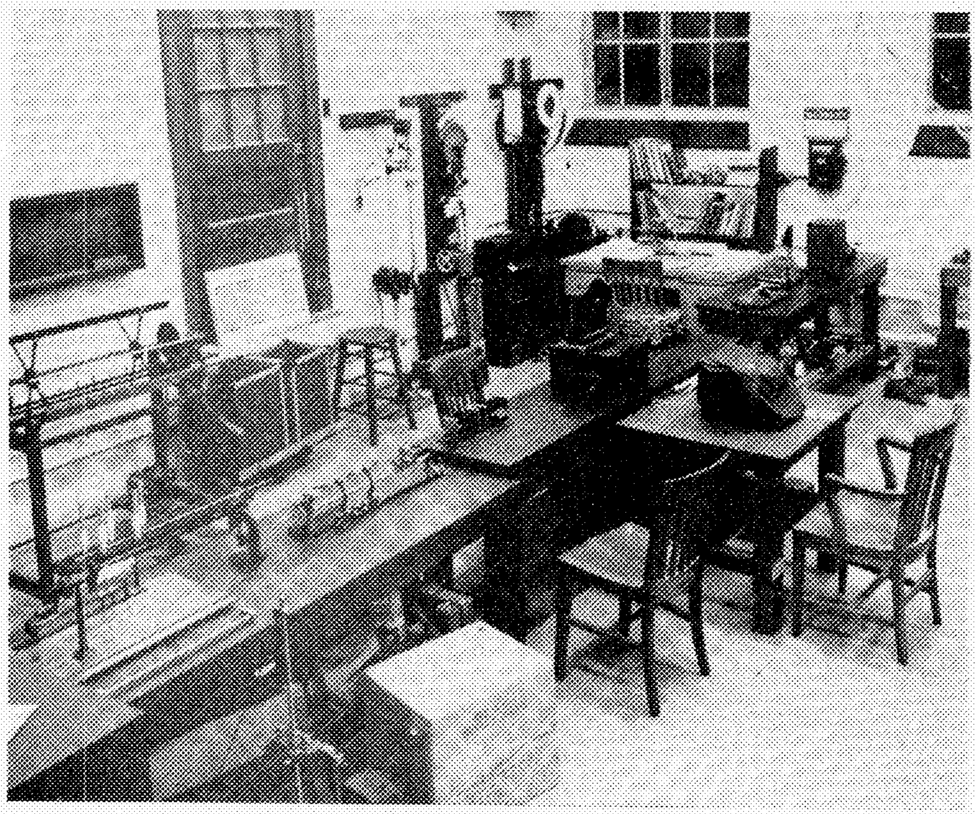
1. Studies of Dewaxed Cotton: This was the first project initiated by the Bureau of Industrial Chemistry. This project is now being financed conjointly by the University of Texas, the National Cotton Council, and the Cotton Research Committee of Texas.



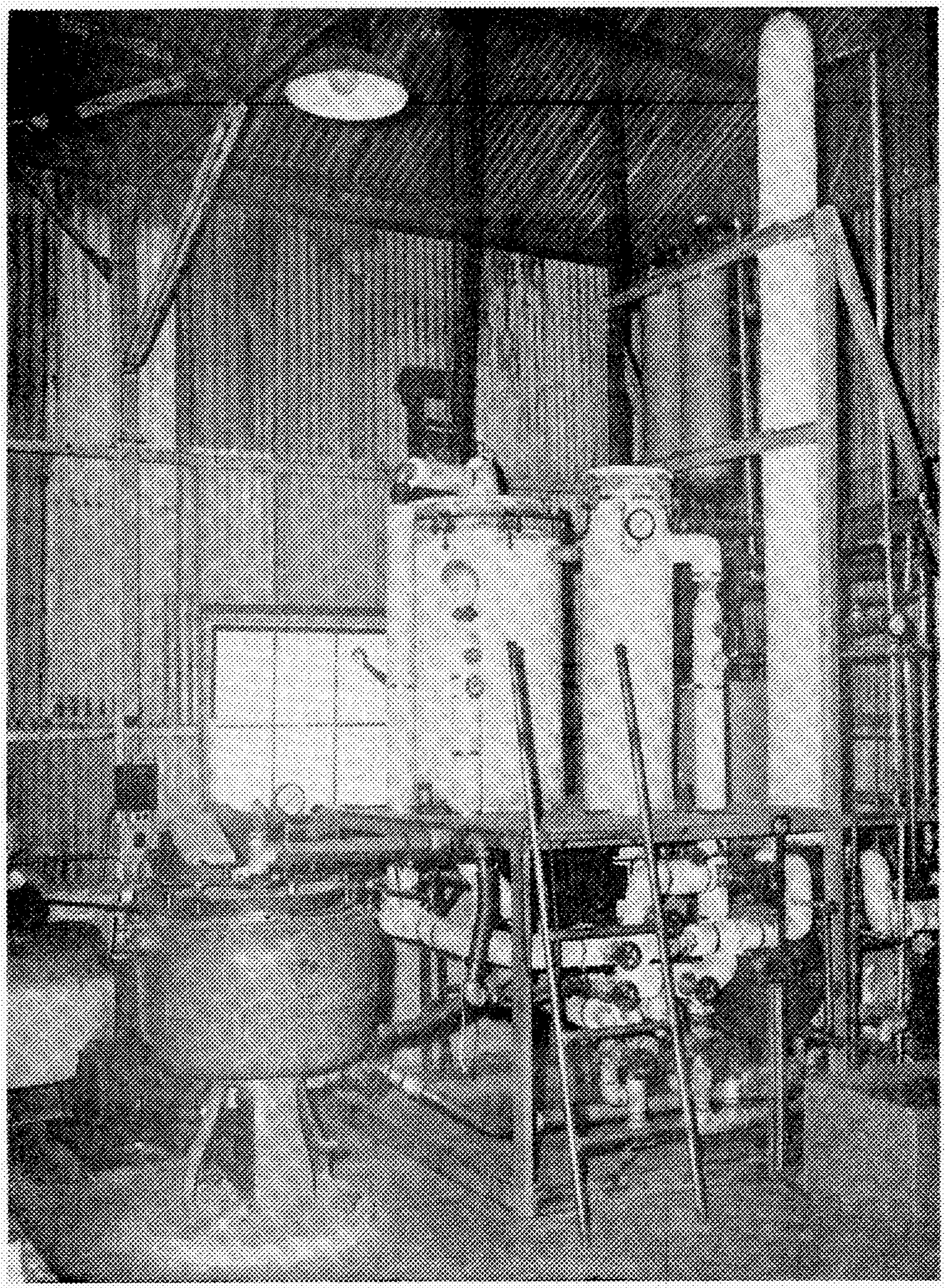
Spinning Laboratory to Test the Usability of Treated Cotton Fibers.



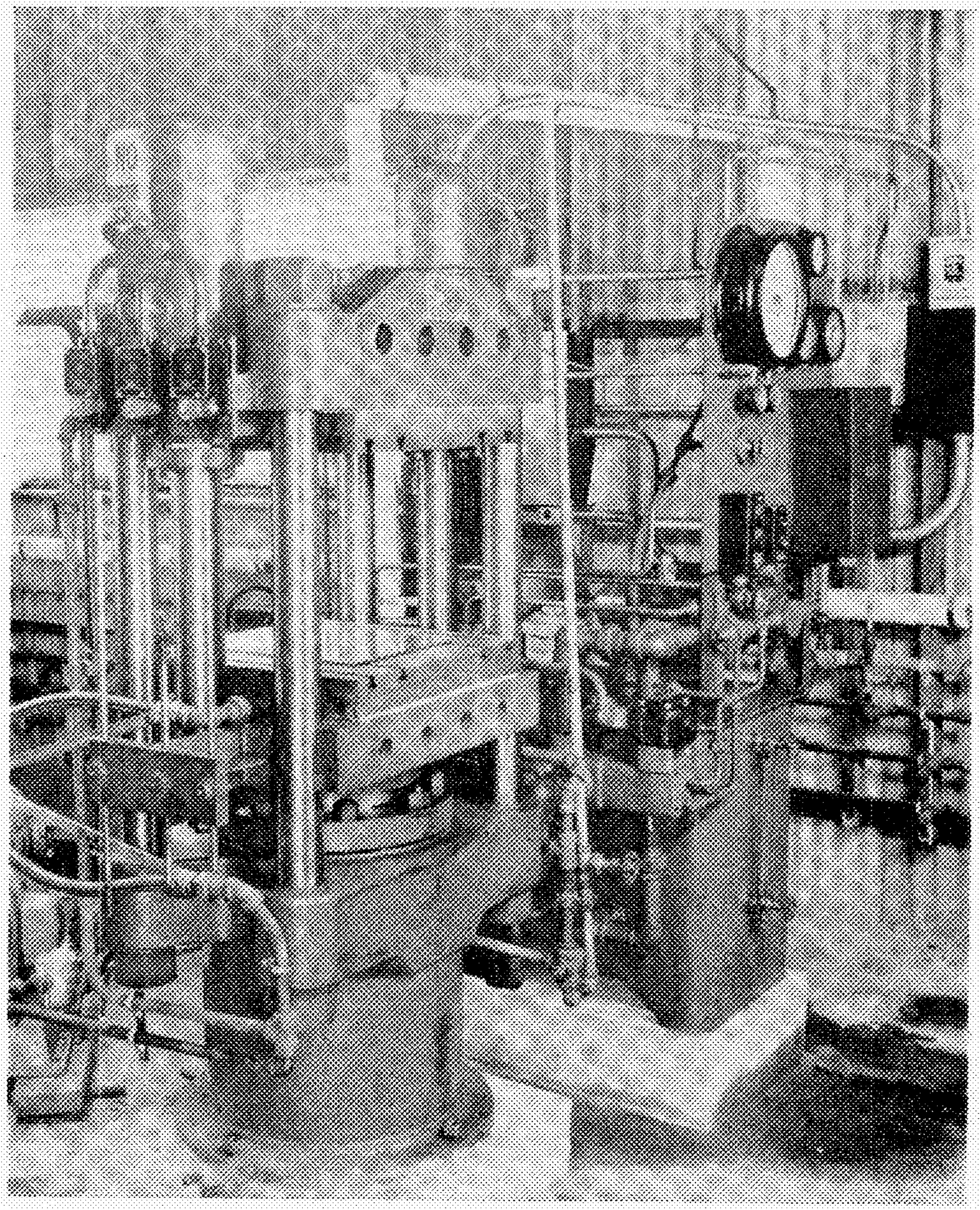
Weaving Laboratory to Test the Usability of Treated Cotton Fibers.



Cotton Fiber Testing Laboratory.



Pilot Plant for Chemical Treatment and Dewaxing of Cotton Fibers.



Hydraulic Press for Making Products from Cotton Plus Plastics.

The objective of this research is to improve the spinning quality of short-staple cotton, produced in large quantities in Texas, in order to create a more widespread market demand for this type of cotton.

It is also the purpose of this study to increase the strength of cotton yarns and fabric. This phase of the work has been recognized by the Quartermaster General as being important to the war effort.

The project has been under way for four years. Data that have been gathered indicate definite and commercially important increases in yarn strength. Methods of dewaxing cotton have been studied and a semi-commercial pilot plant has been erected. Commercial interest is high and cooperative tests are being developed with numerous manufacturers, aimed at evaluating dewaxed cotton in particular end uses, such as rope, bagging, tire cord, asbestos-cotton fabrics, felt, etc.

2. <u>The Application of Resins to Cotton Fibers Prior to Spinning and Weaving</u>: This project is being developed by the National Cotton Council under contract to the War Production Board. At present, the results obtained to date cannot be divulged.

The objective of the work is to improve the quality of cotton yarns and fabrics, in such fields as strength, flame-resistance, durability, etc.

While specific results cannot be noted in this report, it can be said that this unique approach to cotton quality is bearing considerable fruit and the lessons being learned point to the fact that in the post-war period, this type of research should be vigorously maintained. It promises the most striking results in the shortest period of time.

3. <u>The Development of Plastic Laminates Using Cotton Fabric</u>: This project is being developed by the National Cotton Council under contract to the War Production Board, for the purpose of improving the quality of metal substitutes being used as strategic construction material in airplanes, boats, etc.

The field of plastic laminates promises to be an important market for just the type of fabric that can be made of Texas cottons, <u>if</u> a technology can be developed to protect cotton from the competition of paper, glass, asbestos, etc.

This project is being worked cooperatively with the laminating industry and approximately twelve companies are involved in the testing program, insuring a quick translation of research findings into industrial practice.

4. <u>The Use of Unspun Cotton Fibers in Plastic Laminates</u>: This project is also under contract to the War Production Board by the National Cotton Council and has similar objectives to the project studying fabric in laminates.

Whether or not it is necessary to go through the expensive spinning and weaving operations to prepare cloth to be used in laminates is a moot question which is important to the military forces now and important to cotton at any time.

At the time this report is being written, negotiations are under way between the National Cotton Council and the Navy to center an additional war project in the laboratories in Austin. Further, the cotton work in Austin is actively coordinated to several Quartermaster projects in other sections of the United States.

A great effort must be made to solve the technological problems facing cotton. World War II has given the University of Texas the unique opportunity of becoming one of the nation's greatest cotton research centers. To insure the continuance and growth of this development, this work must be adequately housed and maintained. Keeping in mind that all cotton research is of benefit to Texas and that most cotton research is of greater benefit to Texas than to any other state in the cotton belt, it is only proper and fitting that the State take the lead in encouraging and stabilizing the cotton research facilities at its command.

CHAPTER V

New Manufactures from Natural Gas--

Methane as Raw Material for Plastics, Rubber and Chemicals

By E. P. Schoch

Methane is the main ingredient of gas. In weight and fuel value it amounts to seven times as much as the higher hydrocarbons or liquefiable components in natural gas, and our known gas reserves contain an amount of methane equal in weight to our known liquid petroleum reserves.

At present, the condensates abstracted from gas are the only gas ingredients used for making aviation gasoline and chemicals, but they are consumed at a greater rate than the methane. This is because six hundred billion cubic feet of dry gas are now replaced annually in the ground after abstracting fourteen million barrels of condensates from them. Since these fourteen million barrels of condensates are 30 per cent of the total natural gasoline now produced, and since the "dry" gas is saved for future use, it follows that the methane will last much longer than these valuable condensates. Hence a process of converting methane to higher hydrocarbons will be needed.

Methane is, chemically, very inert or stable. No method is now known by means of which liquid hydrocarbons can be synthesized directly from it. An indirect process for making liquid hydrocarbons from methane was devised by Franz Fischer and H. Tropsch in Germany, and consists of the action of hydrogen on carbon monoxide. In order to use methane for this purpose, it is first decomposed to carbon monoxide and hydrogen by means of either steam or carbon dioxide. But the latter can be made direct from coke and steam, and hence methane is not really needed or used for the process.

The use of methane for the production of wood alcohol and formaldehyde also involves its primary change to carbon monoxide; and the only other chemical products now made--namely the nitromethanes, and chloroform, carbon tetrachloride, etc.--are all merely substitution products of methane.

The direct coupling of two or more hydrocarbon radicals from methane requires the addition of energy. If this energy is to be added in the form of heat, then the temperature must be very high and the time of exposure very short--a small fraction of a second. This imposes difficulties which do not appear to have been overcome successfully.

In 1929 the writer undertook to use electric discharges through gases for adding the energy required to couple up hydrocarbon radicals from methane. To date this effort has resulted in a process of making acetylene from natural gas. This process is perfectly practicable and economical even though no commercial installation of it has been built so far, due to war conditions which prevented the use of the materials needed for the installations.

Theoretically, it is possible to make many valuable products from methane by means of electric discharges through gases, but it is a question whether they can be made economically. Work is now in progress to determine such possibilities.

It should be pointed out here that it is important to make valuable rather than cheap products,--that is, products which add a large manufacturing value per pound of raw material. The importance of a raw material naturally increases as more of the high-valued products are made from it. Thus clays become more important as more and more of the finer products--china ware and art ware,--rather than common bricks are made from it. With coal tar, it is the dyes and pharmaceuticals rather than tar-roofing which give it its importance. Similarly, in dealing with methane, we must seek to make plastics and rubber rather than gasoline;--because in making gasoline the value of the natural gas used is likely to be doubled only, but in making plastics or rubber the value of the gas used will be multiplied by forty.

It is with the view of devising profitable processes that this work is being carried on.

Possible Tonnage and Value of Chemical Products

To illustrate the possible tonnage and financial value of such chemical manufacturers, we present the following concerning acetylene. Other products such as ethylene would show similar pictures.

Heretofore, acetylene has been made exclusively from calcium carbide. The latter is made by smelting lime with coke in an electric furnace. Until 1910, acetylene was used solely as a fuel gas. By 1920, it was used extensively for making acetic acid: its annual production in the United States rose from 5000 tons in 1914 to 11,000 tons in 1922, and then to 183,250 tons in 1943. Its present production in Europe is probably more than three times as great. While an essential fraction of this acetylene is used for welding, yet the greater amount is used for making plastics, rubber, and chemicals. In 1942, the amounts of acetylene used for the respective products have been estimated to be as follows:

Acetylene Used	Amount
For Acetic acid	66,000 tons
For Vinyl chloride and vinyl polymers	4,000 tons
For Neoprene rubber	30,000 tons
For Chlorinated solvents	22,500 tons
For Welding	61,250 tons
Total	183,750 tons

The production of "carbide" is now taxing the established plants to the utmost, and at the end of the war there will be a large increase in demand for acetylene.

The average weight of the products made from acetylene is about twice as much as that of the acetylene itself; and the average price of the product (plastic) is about 40 cts. per pound. Hence, a production of 100,000 tons of acetylene from natural gas in Texas would produce products worth eighty million dollars, and this would be made from about twenty billion cubic feet of gas which is used partly as raw material, and partly as fuel. This gas - at 10 cts. per 1000 cu. ft. - would bring two million dollars to the gas well owners, and produce a forty-fold increase in value due to manufacturing. This is a conservative estimate of what may be obtained.

Possibilities of the Electric Discharge Process

It is risky to dwell on the possibilities of this electric discharge process. However, without some definite forecast of possibilities the impression may be gained that the writer is dubious about its possibilities:—and this is certainly not the case. Hence, the following remarks are ventured.

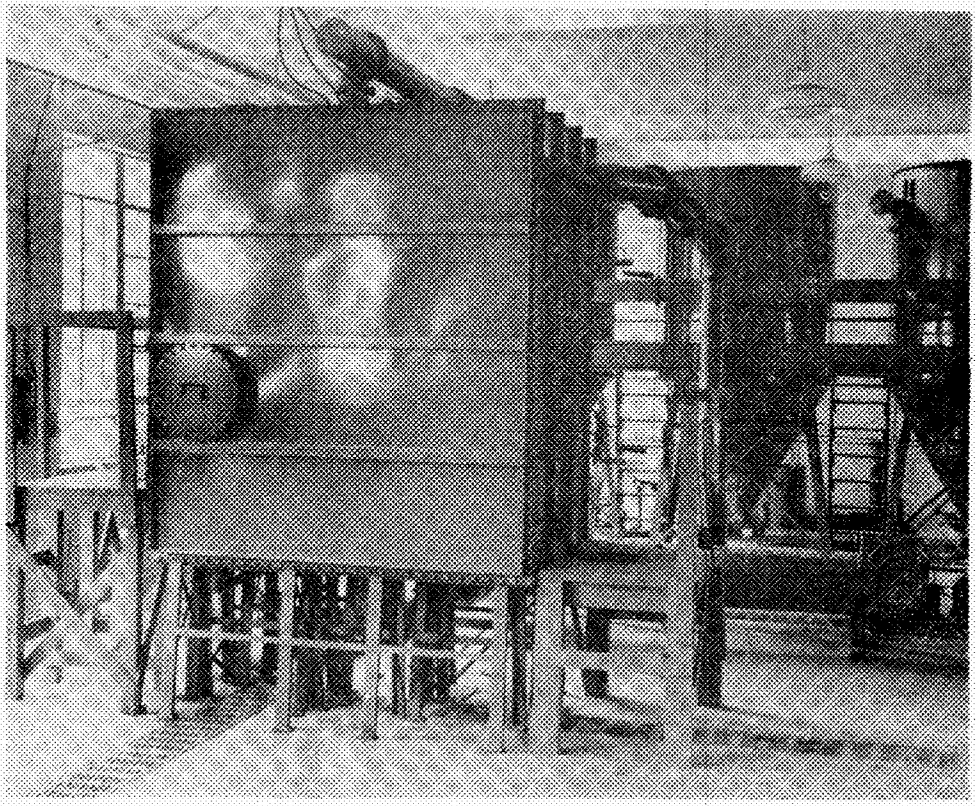
When, in 1937, the writer first asked the Legislature for funds--to support this work,—he suggested that a sum of $50,000.00 per annum be granted,—but only one-fourth of this was obtained. At that time—when asked about the possibilities of this work,— he predicted that we might obtain a process for making acetylene,—and use this for making rubber,—and that—within five years, we could be the greatest rubber manufacturing state in the Union. He was then smiled at for this prediction,— still it happened to come true,—but unfortunately we did not have this process developed far enough at the time of "Pearl Harbor" to have it included in the rubber program. To show how near we were, it should be said that Governor Stephenson gave us $35,000.00 to hurry our investigation, and the University Regents furnished another $40,000.00,—and with these sums we were able to show by February 1, 1943, that our process could make acetylene from methane and convert this to butadiene and sell this at 9 1/2 cts. per pound. The prevailing cost of this made by other processes and from other sources has been near 20 cts. a pound. Since war conditions made it impossible to obtain priorities to build a plant,—it will not be till after the war that our acetylene process can be used. Had we been given the money asked for in 1937, we could have been in production before "Pearl Harbor".

As far as acetylene is concerned, our job is nearly done. But we have other jobs to do. Many other products—ethylene, higher olefines, diolefines, aldehydes, ketones, and acids are needed and should be made from methane,—and we believe the electric discharge can be adapted to produce them.

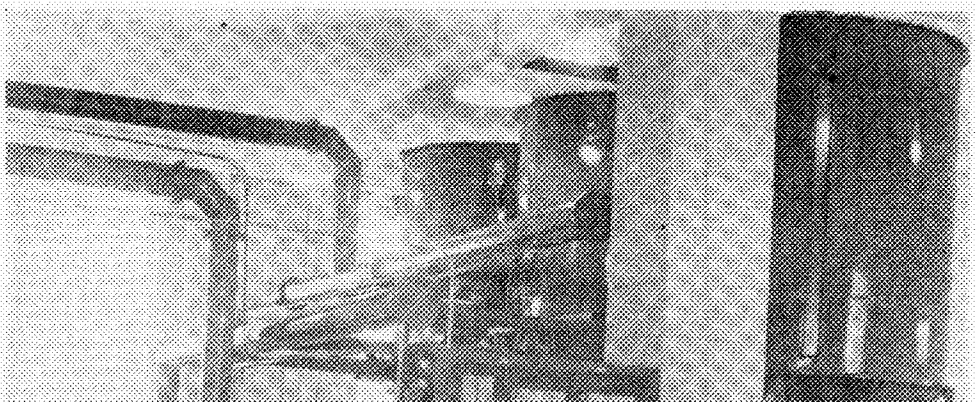
Acetylene is merely the first product to which the new electric discharge was adapted. This was because acetylene requires the highest energy intensity for its production, and the problem which had to be solved was the "taming" of the electric discharge so that it would not be excessively severe.

With further progress of our knowledge of this operation, we expect to "tame" the discharge very much more,—and thus may be able to make a whole host of products which require <u>mild</u> "activation." Our whole concept of shape, size, and operation of <u>the</u> discharge has made great progress during the last two years, and the picture of possibilities has progressed correspondingly. When, in May 1943, Dr. A. M. McAfee, Chief Chemist of the Gulf Refining Company, told Governor Stephenson, in the presence of the University Board of Regents and others,—that, in his opinion, this process would become as important to the oil and gas industry during the next decade as the oil cracking process was during the last decade—it may have been considered by some that he was taking a big chance, but the progress of this work is now such as to support his prediction more and more firmly.

But this work is expensive:—it cannot be done on a small scale because high voltage and gas both require large dimensions. Just as in heat-cracking operations,—so with electric discharge,—the experimental work must be made in substantial size to give financially reliable results. The accompanying pictures of the pilot plant for making acetylene from methane give an idea of the cost of equipment involved. Over sixty per cent of the cost goes for materials,—and with less than a hundred thousand dollars a year, we may reach decisive results just a little too late for most of the gas now pouring out of the ground. If we really want to save Texas' gas for Texas' use, let us spend the money <u>now</u> to get the information needed.



Pilot Plant for Acetylene from Methane: Discharge Chamber.



Pilot Plant for Acetylene from Methane: Carbon Filters.

CHAPTER VI

Some Comments on the State's Gas Business Based on Gas Statistics and Tax Records,- also Recommended Legislative Action

E. P. Schoch

The following table presents the amounts of gas produced and distributed in Texas during 1939 to 1943. The data are from the reports of the Texas Railroad Commission. The figures express trillions of cubic feet per annum.

Table I

Year	A Gross Prod.	B Used in Texas	C Export	D Waste to Air
1939	1.193	.821	.230	.142
1940	1.278	.915	.230	.133
1941	1.336	.977	.257	.101
1942	1.386	1.034	.270	.082
1942 In Percents of "A"		74.7%	19.5%	5.9%

DETAIL OF THE GAS USED IN TEXAS (Column B)

Year	B-1 To Pipe Lines For Fuel	B-2 For Nat.Gasoline Manufacture	B-3 For Field Development	B-4 For Carbon Black	B-5 For Oil Lift
1939	.232	.051	.171	.317	.050
1940	.264	.056	.217	.326	.052
1941	.302	.072	.213	.329	.061
1942	.413	.069	.193	.296	.063
1942 % of "A"	29.8%	5.0%	13.9%	21.4%	4.6%

This table shows that the gas used in Texas through pipe lines (Col.B-1) plus the exported gas (Col.C) amounts to only half of the total produced.

Let us look at the other half: this is usually not accurately metered,--its amount is generally underestimated in order that the operator may be on the safe side with his estimate. All of these gas quantities should be metered and their use supervised thoroughly by public officials. However, the writer was told that the Railroad Commission's budget is now too small to make such supervision possible.

The Gas used for field development (Col.B-3) is usually obtained free,--and hence is used very lavishly. Its amount as given in B-3 is already large--yet the actual amount is probably much larger. The cure here--as in the above--is supervision by public officials and actual metering.

The same is true of the gas used for lifting oil. The amount now allowed per barrel (10,000 c.f.) of oil is excessively large. Furthermore, this gas is not metered,--and since many gas companies that furnish such gas wish to get rid of as much gas as possible in order to produce the liquid condensate produced with the gas, they are frequently excessingly "liberal" with this gas.

In addition to this "lavish" use of gas introduced to lift oil, there is the gas that escapes with oil and is burned in flares. This is never reported and hence is totally absent from this report. This gas volume is unofficially estimated as amounting to 170 billion cubic feet per annum,--or one-eighth of the total gas produced.

The above gas quantities are all in need of administrative attention. The total saving that might be thus effected cannot be estimated,--but it is likely to be about one-fifth of the total gas produced.

Finally, we come to the consideration of the gas used for making carbon black (Col.B-4).

It should be noted that most of this is used in the "channel black" process in which only 1.45 lbs. of carbon are obtained per 1000 c.f. The amount of gas used for this purpose has "sky-rocketted" in 1944 and it is unofficially reported that 0.6 trillion c.f. were used for this purpose. The writer's experience with production of acetylene black leads him to venture the prediction that a process may be found for making a carbon black that can take the place of channel black,--which process will yield at least <u>five</u> times as much carbon per 1000 c.f. as the present process does,--and which will produce this carbon at nearly the same low price as that now paid for channel black. The present low price of channel black is due in part to the negligible low price paid for much of the gas used. The trade can pay--and has paid--slightly higher prices. Hence, it is within the realms of reasonable expectation that a new process secured by research could pay 5 cts. or even more for the gas, sell the carbon for nearly the same price as now, while actually saving four-fifths of the gas now used for channel black.

Hence, the total of columns D, B-3, B-4, and B-5 could be reduced through a combination of administrative measures and research which would amount to one-fourth or more of the total gas produced.

The Gas Tax Law and the Amount of Gas Taxes Collected

The tax to be collected on Texas gas is to be 5.2% of the price received for it and for all of the liquifiable constituents collected from it,--with the proviso that--for tax purposes--the minimum gas price shall be 1.41 cts. per M.c.f.

In the case of cycled gas, only the condensates are to be paid for because the gas is returned to the ground. In general the assessed value of these liquids obtained from "cycling" is placed at 60% of their sales price,--and the tax is 5.2% of 60% of the sales price.

The State Comptroller's office gave the following figure for the total tax money collected on all forms of gas and liquids condensed therefrom during the fiscal year which ended September 1, 1944--$3,246,000.00

The following table presents the total gas tax collected on gas itself,--during October, 1944, and the tax collected on the liquids produced from cycled gas, and on the "drip" gasoline and other condensates from gas.

Table II

Gas	Cts. per M.c.f. Well-price	Volume, M.c.f.	Taxable Value	Amt. of Tax
Sweet	3.05	72,454,523	$2,212,534	115,050
Sweet	Less than 1.41	9,882,184	139,340	7,246
Sour	2.7	2,392,713	64,258	3,341
Sour	Less than 1.41	16,413,460	231,439	12,034
Cas'ghead	2.25	42,293,128	952,832	49,545
Residue	1.92	2,936,522	75,359	3,919
Total Gas	Less than 2.45	146,372,530	3,675,762	191,135
Recycling Liquid		49,912,661	1,386,741	72,110
Other Condensates Bbls.		362,824	489,899	20,208
Tax on Liquids				92,318
Total Tax on Gas plus Liquids				283,453

This table shows that the amount of $191,135. was collected on 146 billion c.f. of gas in one month. This figures out to be a rate of 1.3 mill per M.c.f. Hence, the total tax receipts for gas produced in twelve months would be $2,295,000.

In order to present a picture of the gas business as a whole, the writer has prepared Table III. This presents an estimate of the amounts of gas used by the different users, the kinds of gas they use, the totals they pay at the wells, and the total commercial receipts this gas brings to Texas as a whole.

The estimates of gas volumes are based upon the unofficial information that the volume of gas used for carbon production in 1944 is nearly 600 billion cu.ft., but otherwise the estimates are merely extensions of the "trends" of the figures in Table I above. That is, the trends between 1940 and 1942 are extrapolated to 1944, together with a "cross check" with the figures in Table II. The figures given in the U. S. Mineral Year Book for the 1941 gas in Texas have also been used.

Note on Table III,--Column headed, "Commercial Collections in Texas":-The prices for Domestic, Commercial and Industrial gas are taken from Table II of Chapter I. The commercial receipts obtained from the other items in this column were calculated on the following basis:-

All gases are stripped of their condensibles before being used.

Casinghead gas yields one gallon of liquid per M.c.f., and this is worth 4 cents. Residue gas is already stripped.

All other gases yield 0.3 gallon per M.c.f., worth 1.2 cents.

The carbon obtained in making carbon black is 1½ lbs. per M.c.f., worth 4.5 cents.

The average "transportation" expense "paid by" exported gas to the border is 4 cents per M.c.f.

Notable Facts Shown by Table III

(a) The total production in 1944 was nearly two trillion cubic feet. This is probably two-thirds of the whole United States production, and does not include the unreported gas lost through oil well flares.

(b) The total amount paid for the gas "at the Wells" is forty-four million dollars, an amount which cannot be said to rank among the major incomes from Texas products, and which is strikingly little for the large volume produced and the significance of gas in our ecomonic life.

(c) Domestic and Commercial gas brings to Texas, as commercial receipts,--seventy-four million dollars for 6.3% of the total gas--or nearly twelve million dollars for one per cent.

(d) Industrial gas brings to Texas--as commercial receipts-forty-four million dollars for 22% of the gas,--or two million dollars for one per cent.

TABLE III

TEXAS GAS PRODUCTION AND DISTRIBUTION IN 1944, - ESTIMATED

Gas Volumes in "billion cu. ft." - Cash sums in "Million Dollars"

Column Number in Table I	Kind of Use	1944 Volumes Billion cu. ft.	Kind of Gas	Well Price Cts./M.c.f.	Total Paid At Wells Million Dollars	Commercial Collection in Texas Cts./M.c.f.	Commercial Collection in Texas Million Dollars	Gas Volumes in per cent of Whole	Desired change Factor	Volume of Desired Use
B-1	Domestic and Commercial	83.6 35.6	Sweet	3.05	3.633	61.8	73.7	6.30	x 3	360
B-1	Industrial	421.6	Sweet	3.05	12.83	10.2	43.8	22.2	x 1/2	210
B-2	Natural Gasoline	82.0	C'saghead	2.25	1.85	?	?	4.35	x 1	82
B-3	Lease Operation	169.0	Sweet	0(½) 3.05(½)	2.575	?	?	8.90	x 3/5	110
D	Waste	54.0	———	0	0	0	0	2.85	x 0	0
B-6	Oil Lift	118.0	"Cheap" Sweet	1.41(-)	1.66(-)	0	0	6.23	x 0	0
C	Export	342.0	C'sghd 60.0 Resid. 35.0 Sweet 247.0	2.63	8.99	8.19	28.1	18.00	x 1	342
B-4	Carbon Black	592.0	Sour 225.7 C'sghd 368.3	2.16(-)	12.80(-)	7.44	44.1	31.11	x 1/6	120
	Total Production	1098			44.358(-)		193.58	[illegible]		1224

(e) Export gas brings to Texas—as commercial receipts,—twenty-eight million dollars for 18%—or one and six-tenth million dollars for one per cent.

(f) Gas for carbon black brings to Texas—as commercial receipts,—forty-four million dollars for 31% of the gas—or one and three tenth million dollars for one per cent.

Carbon black manufacture appears as the least profitable enterprise, and at the same time it is consuming the most gas,—i.e. 31% of the whole.

Operation of Proposed Solution of the Gas Problem

In Chapter I, the writer suggested a solution of this problem which is intended to be fair to both the Texas public and to those who have investments in the gas industry,—but this solution may need restating in order to show that it is feasible.

This solution assumes that industrialization can produce the following changes shown in the last columns on the right side of Table III. These changes are:

1. Multiply the domestic and commercial gas use by three;

2. Reduce the industrial gas use to one-half;

3. Eliminate waste in the field.

4. Keep export at the present figure.

5. Reduce carbon black gas to one-fifth of its present volume.

The results will be:

1. The total income "at the wells" will be tripled— i.e. 120 million dollars vs. 44 million dollars now.

2. The commercial collections from gas in Texas will be doubled—i.e.,360 million dollars vs. 191 million dollars now.

3. The annual removal from the ground will be nearly halved—i.e., 1.2 trillion c.f.—vs. 1.9 trillion c.f. now.

A. These changes can be produced within the next five to ten years—if a real job is done to industrialize Texas with enterprises of moderate and small sizes—by means of research and investor's institutes illustrated in this publication—which will fit into the class of commercial gas users or into the class of special industrial gas users who can pay 21 cents in place of the ten cents now paid by our industries. These special industries then paying 21 cents will still be paying much less than they would in Ohio, or the whole North-East. (See Table II of Chapter I) Thus our total

Texas pipe distribution capacity will be taken up with gas users who can stand a well-price of 10 cents per M.c.f.--and it should then be the duty of the Railroad Commission to set the price at that figure.

B. This 10 cents well-price will/then also have accomplished the following:--it will have "persuaded" the large "cheap fuel" industrials back to the use of lignite, and it will have "discouraged" exportation without injuring existing lines.

Here the effect of an established 10 cent well-price upon exporting companies should be explained. It may be in the minds of the public that the exporters own enough gas reserves to supply their need,--and hence might not appear to be affected by the well-price. But the exporting lines are public carriers,--and it is the Railroad Commission's duty to pro-rate the gas which such lines must take from different parties who offer gas to them, and the exporters will not be free to use their own gas only.

C. Waste can and should be controlled by a legal requirement that all gas coming out of the ground shall be metered and reported. If the Railroad Commission is given the financial means to do the supervisory service necessary to enforce such a requirement, then waste will be at an end. This does not require money collected from taxes:--the Railroad Commission collects over a million dollars a year (3/16 cts. per barrel of oil) for operating expenses, and it needs merely to be given permission to use an adequate fraction of this fund.

D. The carbon-black industry now has no motive for changing its process because new processes require new installations,--and when a new process promises only gas conservation but no extra profit to the operators, they have nothing to impel them to make a change. They now deny that a better process can be found. The legislature or the public does not know whether or not this is true. There is only one solution:--the State should have research done to try to secure a better method, and after it has found it--the State will be in a position to compel the use of the gas conserving method.

Means For Operating the Industrialization Program

The industrialization program spoken of under paragraph A of the preceeding section requires more than talk: it requires money for experimental research. The same is true for this work on the carbon black problem.

Fortunately, the industry itself could supply the means--through its own tax yields. However, a sad error is being made with this money. This error is best illustrated by the following example familiar to many Texans.

A farmer wants to go into the dairy business,--but is poor and has only one cow and a calf to start his herd,--and this cow must live on a poor pasture. The milk yield is small--so the farmer sells all of the milk and lets the calf starve to death. Thus, he can never have a dairy herd or an adequate milk business. That is the situation with the Texas gas business. It is small, and has only a poor range to graze on. Yet we take the milk from it,--and devote none to the growth of this industry.

Can Enough Industrialization be Secured for This 5 to 10 Year Plan?

The volume of gas which must be changed from the present "cheap" industrial price to such a higher price as would allow a well-price of 10 cts. is seen from Table III--to be 22% of the total production. However,--this is a maximum figure.(See the two B-1 lines under column 9)

It is impossible to make an estimate as to whether or not this change can be achieved. It will probably not be achieved unless we operate on a constructive program such as is offered in this publication.

However, we must realize that we are up against the stern necessity to achieve this change if we are ever to industrialize Texas,--because gas is our greatest means for industrialization and unless we industrialize soon, we will have no gas to help us, and if we do not become an industrial State, then we really do not need all this gas,--and we have no gas problem.

Hence we simply must industrialize Texas in 5 to 10 years!

FAIR PLAY AND MUTUAL CONSIDERATION BETWEEN THE GENERAL PUBLIC AND THE GAS OWNERS ARE NECESSARY FOR WELL-PRICE ADJUSTMENT AND PIPE LINE PRORATION

Everybody knows that there are two parties involved in the gas business;--the owners of gas properties,--and the public.

Ordinarily they are considered as being opponents,--and it is frequently assumed that the public must resort to punitive legislation and taxation to protect its interests. When these are resorted to, then the gas owners defend themselves and we have war.

The writer is seeking to avoid such war. He believes that, in the present instance, neither side can prosper unless Texas prospers. Thus, they have a common interest and this is the ground on which he wants to secure an agreement for a constructive program. But as in all agreements,--so here--both parties will have to make concessions for the general good--and these concessions will be pointed out below.

The securing of a 10 cts. well-price within the 5 to 10 year period requires not only a vigorous industrialization program, but also a cost-accounting, market-demand adjusting, and gas-supply prorating for the pipe lines--all to be made by the Railroad Commission--in which both the pipe line owners and the general public have the right to be fairly considered,--and in which both will probably have to make concessions for the common welfare.

This procedure is not to be directed against the pipe lines: it is to be done with the spirit of seeking a fair estimate of operating costs to determine the amount which can be used to pay a higher well-price. The pipe line owners should do all they can to help this.

While the pipe line owners make this concession,--the public should make the corresponding concession not to demand rate reductions until after the 10 cents well price has been secured.

The writer cannot claim to be conversant with the legal aspects of these matters,--but as a layman they appear to him to be as follows:

(1) The Railroad Commission has control of the transportation rates of public carriers,--and hence can estimate and set the sales prices of gas from pipe lines because these follow from an addition of the gas well costs and the transportation costs. Hence, if these sales prices are known and fixed, then the Railroad Commission can--equally well--estimate and set the well-prices.

(2) If the Legislature specifies (as suggested on page 2 of this publication) that "cheap gas sold to replace lignite" shall not be figured in the "market demand" for gas,--then the present pipe line volumes of gas cannot be increased until this cheap gas volume is all taken up by higher price customers.

(3) The higher earnings due to the higher rates of the new customers must be secured to raise the well-price. To do this, the Legislature should provide that during this period of striving for a 10 cts. well-price, there shall be no lowering of the gas rates to the pipe line customers. This "setting" of the resultant well-prices by the Railroad Commission will then be merely the result of bookkeeping--and does not invade any of the individual rights of parties to do "their trading."

(4) The prorating of the total gas demand of pipe line--over the available gas supplies--should be done by the Railroad Commission as is done for oil.

It may not be amiss to mention here that in this connection gas must be defined more accurately. Thus,--its contents of higher hydrocarbons,--its heating power, its pressure,--and its unit of volume--should all be exactly specified. For example, pipe line gas might be defined as "sweet" gas containing no substantial amounts of hydrocarbons above propane--and with pressure of 750 lbs. gage at 70°F. Then the prices of sour gas, and gases with lower pressures should be given lower prices in accordance with the average cost of changing them to the "defined" pipe line gas.

It is evident that these provisions affecting the Railroad Commission should be considered by the Legislature and acted upon as necessary in order to put an effective program in action.

Suggestions for Legislative Action

A. For Industrialization

(1) The three "Research and Investor's Institutes" presented in this publication should be enabled by the Legislature to operate as effectively as possible for the solution of the gas problem--by giving them about one-fifth of the present tax receipts for gas--or four hundred thousand dollars per annum--half of which to be used for developing new products from gas, (inclusive of carbon)--one-fourth for the clay industry,--and one-fourth for new products from cotton fibers. This provision assumes that the University of Texas may start the program by furnishing the funds for the buildings and equipment necessary at an approximate cost of four hundred thousand dollars.

(2) In order to secure additional "Research and Investor's Institutes" of the same sort either now or in later years, the State Legislature should go on record as favoring the granting of financial support for such projects,--provided--

(a) each project is specific in the field it covers;

(b) each project is headed and directed by a competently trained man of the "Edison" type rather than an "executive";

(c) each project has been taken through an adequate initial developing stage with the expenditure of substantial funds to reveal the possibilities for which larger sums are asked.

B. For Stopping Gas Waste

(1) All gas coming out of the ground should be metered,--and the Railroad Commission should be allowed to use an adequate portion of their oil fee collections to perform, effectively, the engineering and administrative service necessary for observing and regulating the production of all gas.

C. To Determine Gas-Well-Prices

(1) The legislature should consider ways and means--such as are suggested just above in the last section of the last chapter--for the purpose of setting up the machinery by which the Railroad Commission may be enabled to raise the well-price of gas to a minimum of 10 cents, and to prorate the gas demands of pipe lines over their available gas sources.