

TEXAS BUSINESS REVIEW

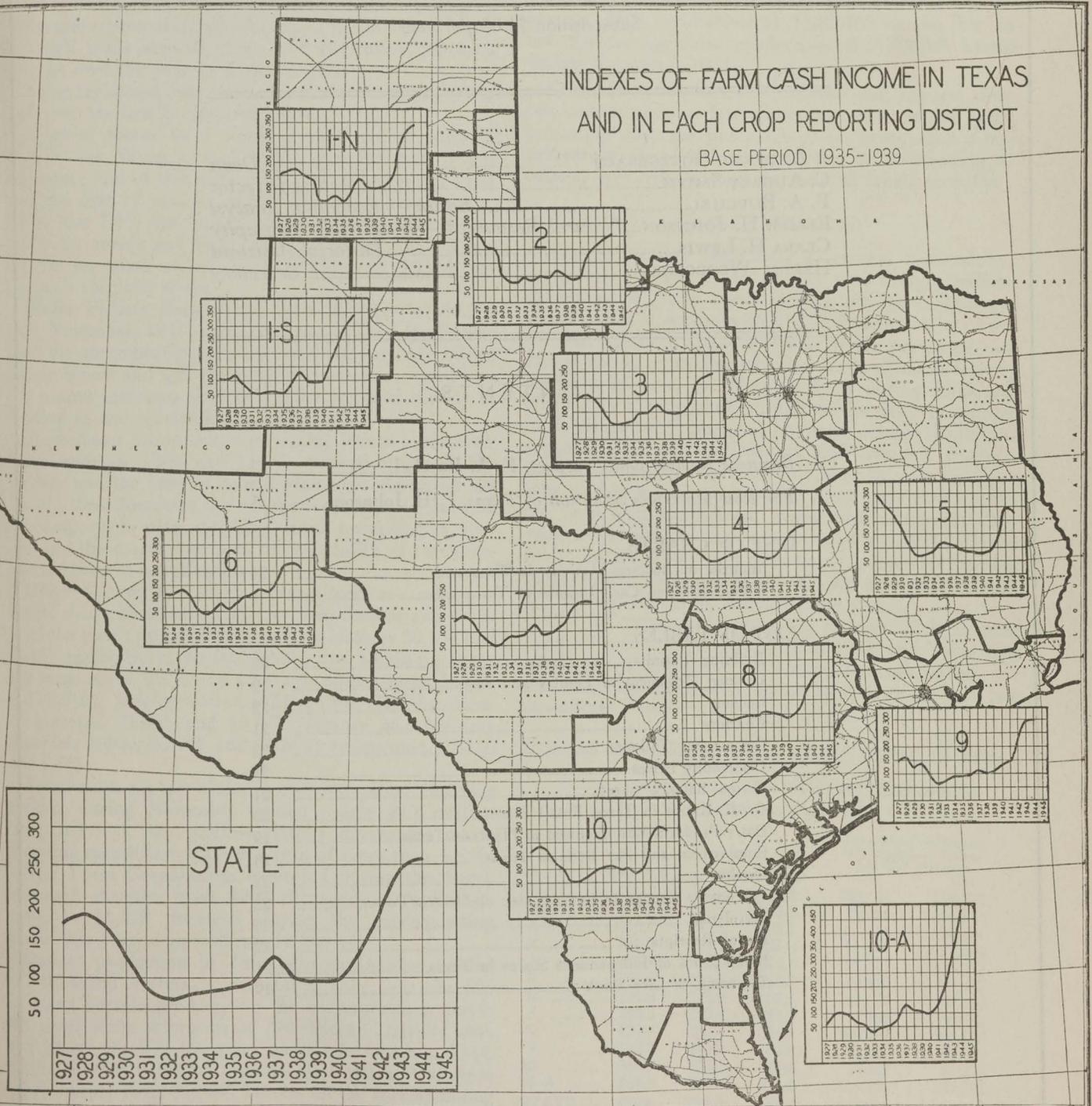
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Business Review and Prospect

CURRENT BUSINESS ACTIVITY IN TEXAS

Texas business activity during November continued on a high level in a number of important lines. Retail dollar sales averaged 15.5% higher than in November, 1944, and aggregate sales during the year to date were up 11.2% from the corresponding period last year, according to reports from approximately 1,000 retail establishments representing all sections of the State. All lines of retail trade showed gains over November, 1944, as well as over the year to date last year.

Gains registered over November and the first 11 months last year are briefly outlined below.

Apparel Stores as a whole showed dollar gains of 16.4% over November and 14.6% over the year to date last year; and of this group gains over November, 1944, and the first 11 months of that year were respectively: 2.9% and 7.9% for family clothing stores; 14.7% and 9.1% for men's and boy's clothing stores; 26.7% and 17.1% for shoe stores; and 18.4% and 18.9% for women's specialty shops.

Motor Vehicle Dealers had sales increases of 50.2% over November, 1944, and 1.1% during the year to date over the corresponding period last year. Activity in this group is now and will continue for some time (until now car output increases sharply) to be confined mainly to dealing in and servicing old cars.

Department Stores continue making new sales records. Sales were up 8.4% and 11.1% respectively from November and the year to date a year ago. As noted last month, these increases are all the more striking because of comparison with the high level prevailing a year ago and the scarcity or even unavailability of many important lines of merchandise.

Other Groups for which comparisons are made include: *drug stores*, up 15.5% from November and 6.9% from the year to date in 1944; *filling stations* 50.7% and 22.1% respectively; *florists*, 22.3% and 18.5%; *grocery and meat stores*, 6.8% and 4.5%; *furniture stores*, 16.1% and 8.9%; *jewelry stores*, 27.5% and 11.6%; *hardware stores*, 21.4% and 15.8%; *lumber and building materials stores*, 35.7% and 29.8%; *restaurants*, 21.1% and 7.7%.

Retail sales are not alone in showing gains. *Building permits* during November totaled nearly \$14 million compared with \$2.6 million dollars during the corresponding month last year or a gain of more than 400%.

New Texas Corporations chartered during the month increased sharply, from \$909 thousand in November, 1944, to \$3,428 thousand during the corresponding month this year, a gain of nearly 280%.

Cement production in Texas during October totaled 812 thousand barrels, a substantial gain over the 520 thousand barrels produced in the corresponding month last year; while shipments of 790 thousand barrels were well above the 579 thousand barrels in October, 1944. Stocks of 659 thousand barrels on October 31st were down sharply from the 848 barrels on the corresponding date last year. The Texas current cement figures paralleled the National figures quite closely.

Electric Power consumption during November was 9.6% below that of the corresponding month last year. The sharp drop of 19.6% in industrial power consumption more than offset the gain of 6.2% in commercial and 19.6% in residential consumption.

Petroleum Production in Texas averaged 1,894,000 daily during November, a sharp gain over the October average daily production of 1,482,350 barrels but below the average daily production of 2,132,000 barrels during November, 1944.

Credit Ratios in Texas department and apparel stores continue to show a low percentage of sales on credit, indicating that cash purchases predominate; and a high percentage of collections in relation to outstanding accounts, indicating prompt payment of credit accounts.

TEXAS AGRICULTURE

Adverse weather conditions at critical times during the growing season of the current year sharply reduced the output of Texas' two major cash crops—cotton and wheat—in comparison with 1944. Production of wheat in 1945 was only about half that of the preceding year and of cotton approximately two-thirds. The moderately higher price level for these products during 1945 provided only a very limited offset to the drop in marketings. Other farm products, however, notably fruits and vegetables, as well as livestock and livestock products have made moderately favorable year to year comparisons, and as a consequence total State farm cash income has been well maintained. Farm cash income for November was \$146 million as compared with \$145 million in November, 1944, and aggregate income for the first 11 months of 1945 was \$1,063,925,000 as compared with \$1,068,996,000 during the preceding year.

The following table gives the indexes of farm cash income for October and November, 1945, and November, 1944; and it also shows the cumulative cash income for the State and each crop reporting district for the last two years.

INDEXES OF AGRICULTURAL CASH INCOME IN TEXAS

(Average monthly income for period 1935-1939 adjusted for seasonal variation=100)

District	Nov., 1945	Oct., 1945	Nov., 1944	Cumulative Cash Income in Thousands of Dollars	
				Jan.-Nov. Inclusive 1945	1944
1-N	239.7	291.9	288.8	103,434	124,208
1-S	120.1	131.7	300.8	78,024	106,556
2	310.1	189.4	300.5	124,414	114,441
3	332.8	261.7	326.0	53,544	53,802
4	466.3	238.8	314.1	165,625	175,582
5	297.6	101.5	248.3	69,418	67,492
6	392.8	248.2	267.3	47,616	38,939
7	233.6	250.4	223.3	79,451	68,782
8	250.7	206.1	231.1	105,157	103,390
9	342.9	403.8	383.0	83,019	80,789
10	368.7	434.1	314.4	34,461	27,218
10-A	564.3	308.7	411.2	119,762	107,791
STATE	272.6	213.3	271.9	1,063,925	1,068,996

*Changes made in October index figures are due to rice estimates as the actual marketing figure was not available at the time the report was prepared.

The Raw Materials Situation of Texas

PART II

RAW MATERIALS FOR SYNTHETIC CHEMICALS FROM PETROLEUM

Synthetic organic chemicals have now become the outstanding group of industrial chemicals. The growth in production of these chemicals in the United States since the early 1930's is little short of amazing.

One prominent aspect of the recent trends is the growing importance of petroleum in supplying raw materials for the rapidly expanding and diversified production of synthetic organic chemicals. In fact, the petroleum industry is manufacturing organic chemicals in tremendous volumes.

In this connection, it should be noted that while coal-tar products as chemical raw materials will not decline quantitatively in the next few years, it is expected that the volume of hydrocarbons supplied from petroleum and natural gas will continue to grow even more rapidly in supplying the organic chemical industry with abundant quantities of these readily usable raw materials.

Owing to the tremendous industrial potentialities Texas possesses based upon the chemical utilization of aliphatic hydrocarbons, together with the enormous potential expansion in this phase of the chemical industry for the United States at large during the next 25 years, the following outline deals with the sources of supply of these materials somewhat more extensively than is the case for Part I of these articles. However, the oil and natural gas resources of Texas comprise so large a subject as to require special treatment, which will not be attempted in this article. The following brief summary tables are presented in order to supply a general perspective.

THE TEXAS OIL PICTURE

(as of January 1, 1945)

—thousands of barrels—

	1944 Production	Cumulative Production	Estimated Reserves
Panhandle	34,657	503,770	520,700
West Texas	161,400	1,540,063	2,958,340
North Texas	54,695	1,250,962	602,050
Eastern Texas	184,527	2,738,788	3,261,610
South-central and South Texas	35,333	531,545	354,095
Lower Gulf Coast District..	79,061	473,360	1,122,500
Upper Gulf Coast District..	192,485	1,882,342	2,700,932
Total for Texas	742,148	8,910,830	11,520,227

Source of Data: *The Oil and Gas Journal*, January 27, 1945.

An outstanding fact is that Texas' estimated oil reserves amount to 56.2 per cent of the United States total.

ESTIMATED NATURAL GAS RESERVES OF THE UNITED STATES BY STATES AND BY SOURCES

	Estimated Gas Recovery			Per Cent of Total
	—trillions of cubic feet—			
	From Oil Wells	From Gas Wells	Total	
California	6.500	4.000	10.500	6.3
The Southwest:				
Texas	17.000	82.000	99.000	59.8
Louisiana	3.500	15.000	18.500	11.2
Kansas	0.350	11.000	11.350	6.9
Oklahoma	1.750	9.250	11.000	6.6
New Mexico	2.500	1.200	3.700	2.2
Arkansas	0.500	1.500	2.000	1.2
Total Southwest	25.600	119.950	145.550	87.9
West Virginia	0.150	2.000	2.150	1.3
Other States	1.232	6.151	7.383	4.5
Total U. S.	33.482	132.101	165.583	100.0
Per Cent of total	20.2	79.8	100	

Source of Data: *The Petroleum Engineer*, September, 1945.

HYDROCARBONS PRESENT IN CRUDE OIL AND NATURAL GAS OR DERIVABLE THEREFROM

The compounds of carbon and hydrogen known as hydrocarbons constitute the raw materials for synthetic industrial chemicals from crude oil and natural gas.

Hydrocarbons can be grouped into two large classes: the aliphatics, or open-chain (acyclic) and the closed-chain or cyclic compounds, of which the aromatic group is the most common.

Aliphatic hydrocarbons in turn are divided into two larger groups: the saturated or paraffinic series, and the unsaturated group which includes the olefin series, of which ethylene is the simplest, and the acetylene series, the best known representative of which is acetylene.

Paraffin hydrocarbons, of which methane is the simplest representative, are divisible into two groups. These are the straight chains or "normal" paraffins, in which the carbon-to-carbon linkage is a continuous chain, and the branched chains, or "iso" paraffins, in which the carbon chain is branched. Typical of the paraffin hydrocarbons are methane, ethane, butanes, pentanes, and hexanes. These hydrocarbons exist as naturally occurring products.

The paraffin hydrocarbons are characterized by relative inertness generally toward most chemical reagents. Crude petroleum contains paraffin hydrocarbons and natural gas is made up largely of these compounds.

Olefin hydrocarbons do not occur in straight-run gasolines, but they are important constituents of gasolines produced by cracking operations. Typical of the olefins are ethylene, butylenes, and pentylenes.

The production of two diolefins have become industrially important in recent years; these are butadiene, synthesized by dehydrogenation of butylene and isoprene, the hydrocarbon which forms natural rubber.

Acetylene likewise is a conversion product, often appearing in products from cracking operations.

Cyclic hydrocarbons, the closed-chain compounds, comprise the aromatics proper and the alicyclic hydrocarbons, of which the cycloparaffins, such as cyclohexane and cyclopentane (naphthenes), are important examples.

Aromatic hydrocarbons include the benzene, naphthalene, and anthracene series.

Benzene, toluene, and the xylenes are typical aromatics and are ordinarily considered as products of coal-tar. Petroleum ordinarily is low in the benzene series but hydrocarbons of the naphthalene group occur in crude oil from Borneo and from some of the California crudes. As will be noted in Part III of this article, the fact that certain crude oils are fairly rich in naphthenes or cyclo-paraffins, such as cyclohexane, is of great potential importance to the production of nylon intermediates in Texas.

FUNDAMENTAL CONSIDERATIONS

What deserves particular emphasis is how modern science and industry, in mutual undertakings, are utilizing the vast storehouse of hydrocarbons readily furnished from petroleum and natural gas to produce a bewildering array of new materials, to which still newer materials are constantly being added. These new materials can be grouped under such major general headings as synthetic rubbers, aviation gasoline, and explosives; synthetic resins and plastics, synthetic textile fibers, treating and finishing agents; solvents and plasticizers; detergents and lubricants.

That the rapid development of these industries, so largely based on mass-production of synthetics provided by modern chemistry, constitute in themselves a veritable industrial revolution is putting it mildly indeed.

In brief, the fundamental factors concerned in this tremendous expansion in volume and variety of production include:

- (a) The progressive advancement of science and technology;
- (b) The insatiable appetite of modern industry for increased supplies of a never-ending variety and range of products;
- (c) The increasing availability of a constantly widening range of available substances as sources of raw materials for the manufacture of diversified groups of more valuable intermediates as well as of the finished products.

One of the outstanding aspects of the chemical industry is that it is constantly creating new products according to precise specifications; another significant feature is that as an industry it has only recently discovered the tremendous potentialities of petroleum and natural gas as vast storehouses of chemical raw materials. Furthermore the chemical industry has had an almost spectacular expansion in productive capacity owing to the necessity of meeting exigencies of World War II.

Basic features concerned in such a chemical industry involve three groups of problems:

- a) The manufacture of intermediates, in adequate quantities, which serve as raw materials for the next stage.
- b) The actual manufacture of industrial chemicals.
- c) In addition, there is the almost absolute dependence of the chemical industry upon advances realizable only through scientific research.

The chemical industry is inherently a highly competitive one. There is not only keen competition between

various industrial chemicals, but also between industrial chemicals and natural products. An example of the latter was the competition waged between synthetic dyes and the natural dye materials, in which of course the synthetic dyes won readily. Another example may well be that of synthetic rubber in competition with the natural product; in this case, however, the immediate problem is more than merely an economic one.

A chemical industry based upon petroleum or natural gas is dependent primarily upon the economics of the raw materials and the technical operations, in competition with production of the same or similar products derived from other sources.

In regard to the competition of synthetic organic chemicals with corresponding natural products, the following factors should be kept in mind:

- 1) The uniformity of the chemical products, as well as the possibilities for constant improvements of these products, through the employment of better techniques and the application of more precise technical knowledge.
- 2) The stability of price for the product; it may also be noted that, in general, chemical products have been especially marked by a progressively declining price as the volume of products grew.
- 3) The unique chemical properties and physical characteristics which these chemical products possess inherently, and which are not supplied in the natural products. In brief, the factor of their great versatility in adapting them to a wide variety of uses as well as the vast range of products industrially feasible constitute outstanding economic aspects of practically all synthetics.

MASS PRODUCTION

The economics of mass production in industry as well as the efficacy of mass production methods in particular are dependent upon a variety of factors and conditions which cannot even be outlined here.

Although mass-production methods are largely matters of economic organization, it must be kept clearly in mind that the success of mass production in modern industry is very largely dependent on precise knowledge of the scientific principles underlying not only the technical processes employed but also the resulting products.

PETROLEUM REFINING AS A SOURCE OF CHEMICALS

Potentialities of a greatly extended chemical industry based on oil and natural gas hydrocarbons as source materials for organic chemicals, during, say, the next 25 years stand out not only as one of the leading lines but also one of the most fundamental fields of industrial expansion.

In order to view important advances in fuller perspective from the vantage ground of the present and to emphasize those lines of technical development that appear destined to be important in the near future, it may be of more than passing significance to look at the record, if but briefly.

Thermal cracking of heavier petroleum fractions to gasoline gained its first great impetus in World War I, in part because of the stringent shortage of oil products due to the greatly increased demand for motor fuel which characterized that period.

Cracking operations in modern refining yield hydrocarbon gases in large amounts as by-products of these

operations. It was, in fact, the large quantities of these gases supplied from thermal cracking operations in the 1920's that provided the bases for the development of large-scale manufacture of synthetic organic chemicals using petroleum hydrocarbons as raw materials.

It was not, however, until the later 1930's that catalytic cracking entered the picture at all and the large growth of these processes came during World War II. The first commercial catalytic-cracking unit went into operation in 1936. By the end of 1941 about 20 catalytic-cracking units were in operation or under construction; at the end of 1943 the comparable figure was about 75 units, having a combined gas oil charging capacity of about 1,000,000 barrels a day.

The achievements of the United States petroleum industry in supplying the requirements of vitally needed materials for global warfare were so enormous and the undertakings of so varied a nature that neither the American public nor our educational leadership have as yet been able to assimilate even the major outlines of these accomplishments. Especially did this industry provide huge quantities of high quality aviation gasoline, large amounts of aromatic hydrocarbons—toluene—for high explosives, as well as the major share of the essential raw materials for the vast synthetic rubber program, the output of the latter rising to a level comparable with the world's prewar production of natural rubber.

Illustrative of the current trend in this industry is the statement of Gustav Egloff in an address reported in *National Petroleum News*, July 5, 1945: "Petroleum refining is becoming more and more a chemical industry. Its tendency is toward the development of specific chemical processes that yield products having precise characteristics."

With the outbreak of World War II one of the vital requirements was the immediate production of high grade aviation gasoline in large quantities.

Production of less than 10,000 barrels of aviation gasoline daily in 1938 was not so difficult a task; to raise the output to some 50 times this rate of production, and to provide a still higher quality gasoline, and, above all else, to do it immediately was, however, a stupendous task. In 1938 the production of aviation gasoline of the grade then used was limited to a small proportion of special straight-run gasoline made from only a few selected crudes. To supply the enormous quantities required in World War II meant that the bulk of the fuel—the so-called base stock—must be obtained in vast quantities by catalytic cracking and then upgraded by the addition of larger proportions of newly created blending agents—synthetic organic chemicals—such as isooctane and alkylate together with special hydrocarbons, as cumene, isopentane and the like. In brief, as Ipatieff has observed, "high-octane gasoline cannot be obtained directly from either natural crude oil or its thermal cracking . . ."

From a quantitative point of view the results were as follows: On January 1, 1942, world-wide production of 100-octane gasoline amounted to around 60,000 barrels daily, of which United States facilities accounted for 44,000 barrels. In July, 1945, world-wide production of 100-octane gasoline was 600,000 barrels daily, of which 520,000 barrels were being contributed by the United States. And, of the huge United States total, 440,000 barrels daily were being contributed by new facilities.

As summed up in data presented in the final PAW report to the War Production Board, and quoted from the *National Petroleum News*, Technical Section, December 5, 1945: "Contributing to the total production since Jan. 1, 1942, were: New Facilities 41.4%; Pre-War Facilities, 18.3%; Foreign, 13.7%; Cumene, 6.1%; Miscellaneous, 5.8%; Increasing TEL [tetraethyl lead] to 4.6 cc., 4.2% Converted Catalytic Units, 4%; Codimer, 2.9%; Ordnance and Rubber Programs, 2.5%; C-S (secret additive), 1.1%.

"Existing U.S. facilities on Jan. 1, 1942, were about 44,000 b/d, using 3 cc. TEL. Specification changes increasing lead content to 4 cc. boosted the output of these facilities to nearly 56,000 b/d. New facilities began producing in Sept., 1942, and by July, 1945, were accounting for 59.2% of the total 100-octane output."

In the wartime production of aviation fuel base stock, although superfractionation processes applied to light gasolines played an important part, the bulk was supplied by the recently constructed catalytic-cracking plants.

Catalytic cracking of a rather wide range of heavier petroleum fractions, which has come into wide use during the past five years, is a highly efficient process that not only yields vast quantities of gasoline with higher octane rating than other methods of refining, but it also supplies numerous hydrocarbon gases in large volume, available for chemical conversion and organic syntheses, and which, of course, were especially important in the government's vast synthetic rubber program as well as in the large production of high-octane blending agents for aviation fuel.

The products of catalytic cracking include large quantities of several convertible gases as well as high yields of liquid substances of improved quality. These are:

- 1) Light gases, comprising propane, propylene, and lighter gases, including hydrogen.
- 2) The so-called B-B fraction, comprising mostly isobutane and butylenes; isopentane and pentylenes are also formed.

These gases are available for alkylation. Butylene is also available for producing butadiene.

- 3) High yields of gasoline made up mainly of isoparaffins, but including also aromatics, and lesser amounts of olefins, which are admirably suited for base stocks for aviation fuel.
- 4) Recycle stock, or catalytic gas oil—that is, heavy oil not sufficiently cracked to form aviation fuel, and which may be utilized as distillate fuel oil, diesel fuel, or charge stock for further cracking operations.

The proportion of these products supplied by catalytic cracking operations varies with refinery operating conditions, which can be modified to furnish the substances desired.

Thermal cracking produces a gasoline with an octane rating of 65 to 70; catalytic cracking, of 80 octane, or higher. The high quality of catalytic cracked gasoline is due largely to the presence of isoparaffins, the absence of normal paraffins, and the character of the olefins present.

Catalytic cracked gasoline became a strategic material in World War II owing to its suitability as base stock for 100-octane gasoline.

Butylene likewise became a strategic material owing to its two important uses: (a) as a raw material for alkylate, the latter being a high-octane blending agent for aviation fuel; (b) as a raw material for butadiene, one of the basic ingredients for the manufacture of GR-S synthetic rubber. Catalytic refining provides aromatics also, but so intricately are they mixed with olefins that to separate them out with methods heretofore available would ordinarily cost more than they are worth.

Summing up, catalytic cracking affords greater flexibility in refining operations and at the same time affords larger yields of higher quality liquid products. In addition, it yields large quantities of various gases, the further utilization of which has been high-lighted by the introduction of such fundamental processes as polymerization, isomerization, alkylation, hydrogenation, to which may be added aromatization, hydroforming, reforming, and dehydrogenation. Many of these processes represent chemical syntheses and already the extent of these operations clearly exemplifies the modern trend in petroleum refining.

A NEW ERA IN CHEMICAL MANUFACTURING

What is apparent is that the petroleum refining industry has entered a new era in industrial development—an era based upon epoch-making scientific advances and technologic improvements. New process operations, greatly improved and of wider application, and particularly new developments in the chemistry of refining will be able to supply increasingly larger yields of a progressively wider range of quality, even premium products, from the constantly diminishing supplies of crude oil.

Since World War I it has been the quantitative aspects of the refining industry that have attracted most attention; henceforth, the qualitative aspects of this essential will be even more spectacular than those of volume were in the past.

The petroleum industry, as regards its conventional large-scale operations, is characterized by quick turnover and large volume of operations. The profit per unit of volume is small. In contrast with the very large requirements for conventional uses of oil and gas, the volume requirements of the chemical industry for hydrocarbons supplied by oil and gas are relatively small. From the standpoint of volume alone, petroleum refining is truly an enormous industry.

As regards a chemical industry in contrast to conventional aspects of refining operations, the following observations of G. G. Oberfell, Vice-President in charge of Research and Development, Phillips Petroleum Company in *The Oil and Gas Journal*, December 15, 1945, are indeed pertinent: "The manufacture of chemicals from oil and natural gas is certain to increase. However, the manufacture of chemicals, as compared with the manufacture of fuels and lubricants, calls for a different type of operation, characterized in particular by small quantities, higher investments, higher costs, higher research budgets, a higher degree of technical skill, and a higher obsolescence of process and products; that is, shorter life of process and product."

It may be noted, for purpose of comparison, that the basic chemical raw materials available from coal-tar number some 12 or 13 "primaries" and of these, the most important are the four aromatic hydrocarbons—

benzene, toluene, naphthalene, and anthracene—together with phenol. Coal yields only 0.5 per cent of the five chief primaries—about 11 pounds per ton—of which naphthalene comprises approximately two-thirds, benzene and toluene together about one-fifth. It was upon these primaries and the more than 200,000 different compounds derived from them that the entire synthetic organic chemical industry as it existed prior to World War I was built. Moreover, a large share of this phase of the chemical industry in its rapid expansion after World War I was built upon coal-tar raw materials. By way of contrast basic chemical raw materials derivable from petroleum are not only much more numerous, but also they are lower in cost and readily available; moreover, petroleum chemicals can be produced with a high degree of purity. Crude petroleum yields dozens of primary raw materials from which industrial chemistry can build an infinite number of useful organic chemicals. In emphasizing these contrasts, Cary R. Wagner has recently listed 38 hydrocarbons "only six of which are identical with those found in coal-tar, which may be used as raw materials in manufacturing organic chemicals from petroleum." At the same time, Wagner pointed out that isomers of many of these compounds—and the isomers are numerous indeed—constitute a source of many different chemicals, some of which will go into industrial uses when commercial methods of isolating them are developed. The utilization of compounds from petroleum and natural gas as chemical materials has grown up in the United States during the past 30 years, mostly since World War I, and more particularly since the late 1920's, with, of course, the tremendous expansion coming during World War II.

The hydrocarbons directly available from coal-tar largely belong in one group, the aromatics. Those extracted or otherwise derived from petroleum and natural gas as by conversion include large quantities of widely diversified groups such as paraffin, olefin, acetylene, cycloparaffin, cyclo-olefin, and aromatic hydrocarbons; these large groups include a bewildering array of specific compounds, all of which can be and many are now being utilized in chemical manufacturing.

To recapitulate, crude petroleum, that is the natural material, is not suitable for modern needs; it has to be separated into or broken down into its constituents, which in turn are converted or synthesized into desired products. In the course of the past few years, petroleum refining has been transformed from an industry devoted to the supplying of products obtained by fractional distillation and the further purification of such products to an industry that truly manufactures its own products from petroleum raw materials, and at the same time supplies a large number of hydrocarbon by-products in abundance.

Modern refining operations include three major groups of activities. Owing to the complex mixtures of hydrocarbons present in petroleum it usually is impossible to separate specific hydrocarbons by distillation. However, crude petroleum is first separated into a number of groups or fractions by distillation, each fraction containing constituents that boil between definite temperature limits. These fractions include gases, gasoline, kerosene, gas oil, light fuel oil, heavy fuel oil, lubricating oil, paraffin wax, and asphaltic bitumen. The respective yields of these different fractions, however, may vary

widely with crude oils from different sources. Then, by thermal or catalytic cracking, the heavier fractions are broken down (decomposed) into or converted into lighter constituents.

Finally, these gaseous products of cracking as well as naturally occurring normally gaseous hydrocarbons are synthesized by various special-process operations thereby forming a wide list of new materials.

Too much emphasis could hardly be placed upon the fact that the techniques which made possible during the war the large-scale production of such hydrocarbon products as ethylene, propylene, isobutylene, butene-1 and butane-2, isoprene, ortho-xylene as well as derivable products such as styrene and butadiene, toluene and the ingredients of aviation gasoline, are available to supply industrial demands for these and countless other organic chemicals as raw materials highly suitable for the synthesis of industrial chemicals in a post-war chemical industry expanding to unprecedented size.

Cracking operations supply enormous quantities of refinery gases—olefins, for example, sufficient for providing the bases for a greatly expanded petroleum chemistry. Most important among these gases are ethylene, propylene, and butylenes. Butane and isobutane and propane as well are also produced. So important, however, are butylenes and ethylene that special units have been installed in certain refineries in order to furnish adequate supplies of these gases.

INDIVIDUAL GASES

Emphasis must be placed on the significant fact that the industrial uses of gases under high pressures represents one of the outstanding achievements of industrial chemistry in the 20th century. These developments include scientific studies of the precise properties of the gases themselves, their chemical reactivity, on the one hand and the development of practical methods not only of large-scale production but also of precise separation (superfractionation processes) of these individual gases on the other hand. These developments also include the solving of intricate chemical engineering problems involving complex plant construction whereby these gases can be more elaborately utilized in the manufacture of diverse industrial chemicals by mass-production methods.

Of these hydrocarbon gases, such as ethylene, propylene, butylenes, and amylenes, all of which are olefins and readily reactive chemically, the English chemist, Dr. A. E. Dunstan, has written that they "are the authentic chemical bricks of our new synthetic chemistry—the chemistry of rubber, of plastics, and of polymers of various degrees of complexity. . . . Such chemical bricks are of outstanding importance and value."

Butylenes. Butylene is a basic raw material for GR-S synthetic rubber, the butylene being converted to the diolefin, butadiene. The manufacture of butyl synthetic rubber utilizes isobutylene, together with small amounts of isoprene. Isoprene, another diolefin, is now being commercially produced from petroleum.

Butylene is used as a raw material, along with isobutane, in the manufacture of aviation alkylate, which is added to aviation gasoline to increase the octane number.

Butylene is also a raw material for making butyl alcohol.

The 1944 production of butene-1 and butene-2 mixtures is given by the United States Tariff Commission as 202,380,000 pounds.

Propylene. From propylene, a gas produced in large quantities in catalytic cracking operations, such industrial chemicals as isopropyl alcohol, acetone, and many other compounds are manufactured. Propylene can also be produced, if desired, as a by-product of the production of ethylene through thermal cracking of readily available propane or ethane. Acetone originally was prepared from the destructive distillation of hardwoods. Later, Commercial Solvents Corporation made acetone in large quantities by fermentation methods. Currently acetone is made chiefly from isopropyl alcohol which in turn is made from propylene. Acetone besides being widely used as a solvent is also an intermediate for low-cost production of acetic anhydride. Most of the current production of acetic anhydride is supplied from propylene by way of a series of reactions leading from propylene through isopropyl alcohol, acetone, and ketene, the ketene being obtained through thermal decomposition (cracking) of acetone. One result of the introduction of these processes is exemplified in low-cost acetic anhydride which in turn resulted in lower-cost production of cellulose acetate; this has been an important factor in the greatly expanded production of cellulose acetate in recent years. Acetone is used also as an intermediate in the production of the polymethyl methacrylate plastics, such as "Lucite" and "Plexiglas"; these plastics belong to the acrylic group of synthetic resins.

Propylene is used in producing cumene, which is isopropyl benzene. Cumene is a "rich-mixture" ingredient used in blending stock for 100-octane aviation fuel. With the slackened demand for this powerful ingredient, a search is being made for new uses which will utilize installed production capacity. Members of the research staff of Atlantic Refining Company have announced that through dehydrogenation of cumene it is possible to produce low-cost α -methylstyrene; upon polymerization, the latter yields a product which promises to become important as a plastic material.

More recently propylene has been utilized for the production of allyl chloride and allyl alcohol.

Still another use of propylene is in the preparation of propylene glycol.

Glycerine can be made from propylene, and would be, no doubt, so produced, should such production be needed.

The production of propane and propylene in 1944 amounted to 214,555,000 pounds.

Ethylene. Ethylene, like butylenes, is present in refinery gases from cracking operations normally performed in the production of gasoline. However, because of the difficulties incident to the separation of ethylene from such mixtures, ethylene for use in the chemical industry has heretofore been commonly obtained by cracking propane (a light hydrocarbon present in large amounts in the residue gas from natural-gasoline plants) or by the thermal cracking of gas oil through special high-temperature cracking operations.

The chemical uses to which ethylene is put are not only large in number but they are highly important in our constantly expanding national economy.

Large quantities of ethylene are used in the synthesis of ethyl alcohol, from which stems numerous intermediates and chemicals. One of its derivatives is ethyl chloride used as an intermediate in the manufacture of ethyl cellulose as well as in the preparation of tetraethyl lead. Ethylene oxide is a versatile intermediate used in the synthesis of numerous substances. Another derivative is ethylene dichloride, the output of which in 1943 amounted to 115,600,000 pounds. Still another derivative is ethylene dibromide, also used in the preparation of "ethyl fluid." Ethylene is also used as a starting material in the synthesis of ethylene glycol, styrene, polyethylene, polyvinylidene chloride, vinyl chloride, polyvinyl butyral, as well as in the production of acrylic resins. These substances are not only important in themselves but may be used for further syntheses. Acetic acid, for example, may be obtained through oxidation of ethyl alcohol.

It may be noted that ethylene for the production of styrene at the Dow Chemical plant at Velasco, near Freeport, is transported by pipeline from Texas City, where it is produced from natural gas. Dow Chemical also produces large quantities of ethylene gas at Freeport.

The 1944 production of ethylene was 272,188,000 pounds. Estimates just released place the volume of ethylene consumed in 1945 at 275,000 tons and that of propylene at 50,000 tons, for the production of synthetic organic chemicals.

The availability and low cost of ethylene and propylene are fundamental factors for the large-scale production in Texas of a wide variety of organic chemicals.

MAGNITUDE OF SUPPLY OF HYDROCARBONS FROM MODERN REFINING OPERATIONS

Refinery gases from thermal cracking operations, as Dr. Robert E. Wilson pointed out in 1939, generally contain from 12 to 25 per cent of olefin hydrocarbons; the olefinic content of a typical cracked gas—the C_4 and lighter constituents—make up 18.7 per cent of the total, comprising the following individual olefins: ethylene, 5.8 per cent; propylene, 10.7, together with butene-1, 1.4 per cent, butene-2, 0.2 per cent, and isobutylene, 0.8 per cent.

Catalytic cracking plants, of which numerous huge ones were built during the war, supply even greater amounts of these olefins. For instance, according to B. H. Weil, data on once-through fluid catalytic cracking operations, yields indicate that around 9 per cent of the C_3 -and-lighter fraction comprise from 6.0 to 14.5 per cent by weight of the charge stock, there is little question as to availability of these light olefins in tremendous quantities as "building blocks" for chemical syntheses.

As to yields and general availability of the C_4 and C_5 olefins, the results of the war program of aviation gasoline as well as synthetic rubber production testify abundantly. Weil states that the data on once-through catalytic cracking indicate that the C_4 olefins make up about 32 per cent of the C_4 fraction, which in turn comprises from 5.8 to 12.8 per cent by weight of the charge. Weil also cites the case of the new large Cities Service Refinery at Lake Charles, Louisiana, to the effect that in the operation of its fluid catalytic cracking units, primarily to produce gasoline, they also produce around 75,000 pounds of ethylene and 300,000 pounds of propylene daily.

As illustrative of the constant advances being made in technology, it is worthwhile to note that a recently announced catalytic cracking process yields in substantial quantities the hydrocarbon, *isobutane*, which is a major raw material for the alkylation process.

In recapitulation:

a) Individual compounds are supplied by today's refineries through specific processes that yield substances in large quantities, having precise properties and characteristics. Among these specific hydrocarbons compounds are isooctane, isobutylene, isopentane, isobutane, isoprene, ethylene, propylene, acetylene, toluene, and in smaller amounts, cresols and xylenols.

b) From these compounds are derived through chemical processes still other compounds such as alcohols, aldehydes, ketones, organic acids, and anhydrides as well as butadiene and styrene, and so on.

c) These industrial chemicals in turn serve as a raw materials and as processing agents for such rapidly expanding groups of products as high-octane motor fuel, synthetic rubbers, synthetic resins and plastics, synthetic fibers, chlorinated hydrocarbons, various glycols, and the like. During the war period, the petroleum industry amply demonstrated its capacity to produce vast quantities of toluene for use in making high explosives. Also highly aromatic high-octane base stock is provided by the cycloversion process—a catalytic-cracking process developed by Phillips Petroleum Company.

As summarized by J. D. Westerman, Shell Development Company, in *The Journal of Commerce*, June, 1945: "The revolution in petroleum refining came during the last war with the introduction of thermal cracking to increase the proportion of gasoline produced from a unit of crude. This war has seen a secondary upheaval resulting from the extensive use of catalytic cracking to give higher yields of high-octane fuel. Along with liquid fuels, thermal cracking produces large quantities of reactive unsaturates, catalytic cracking still larger volumes, . . . The three most important of those gases are the two butylenes so greatly in demand for making aviation fuels and synthetic rubber, as well as for chemicals, propylene, the source of isopropyl alcohol, of acetone, and of the new arrivals, the allyl derivatives. In refinery cracking units these reactive unsaturates are produced as a mixture with the same paraffins, propane, butane, and so on, that are found in natural gas."

EXPANSION OF THE CHEMICAL INDUSTRY

The growth of the chemical industry, not only in the United States but also in all other industrial countries, since World War I has been little short of spectacular. That this trend not only of expansion but also in diversification in production of higher quality industrial chemicals will continue is indicated by the facts of the current situation, as exemplified, for instance, by the inclusive programs for future developments already set forth, not only by the major chemicals companies themselves, but also by most of the larger oil companies. *The astounding fact that the petroleum industry is currently producing a greater volume of synthetic organic chemicals than the chemical industry itself is clearly illustrative of the importance of these new trends that are now in operation.*

Of these trends that are currently in evidence in the production of industrial chemicals, none is more significant than the growing utilization of oil and natural gas hydrocarbons as raw materials.

Obviously, this trend is of tremendous potential significance to Texas and the Gulf Southwest, for of all major sections of the United States, this region stands to gain most from the establishing of large-scale chemical plants for converting these raw materials into industrial chemicals and consumer products.

In this connection, since the petroleum chemical industry is on the threshold of an immense expansion, the following points deserve emphasis: First of all, many of the industrial chemicals now obtained from oil and gas hydrocarbons are new developments—examples of the constantly widening base of chemicals available to post-war industrial development. Second, many of these industrial chemicals, both older and newer ones, will be consumed on a large scale by industries employing mass-production methods; consequently, large tonnages will be required. Third, most of the processes employed in producing these industrial chemicals are adaptable to the utilization of petroleum fractions, refinery gases, liquefied petroleum products, and natural gas as raw materials.

According to reports of the U. S. Tariff Commission, a total of 1,564,914,665 pounds of chemical raw materials were produced from petroleum sources in 1943—an increase of around 500,000,000 pounds over the corresponding figure for 1942. In 1944, however, the total output of chemical raw materials amounted to 3,000,000,000 pounds.

The chemical materials thus produced in 1943 included 13,915,900 pounds of cresylic acids; 17,341,192 pounds of naphthenic acids; 103,091,279 pounds of butadiene (since greatly increased); 166,224,385 pounds of ethylene; 394,620,200 pounds of C_3 hydrocarbons; 668,496,079 pounds of C_4 hydrocarbons; and 201,225,630 pounds of miscellaneous materials including benzene, xylene, etc., but not including toluene.

The 1944 total of chemical raw materials from petroleum was divided as follows, as quoted from *National Petroleum News*, December 5, 1945: "naphthenic acid, 28,462,000 lbs.; xylenes, 354,639,000 lbs.; ethylene, 272,188,000 lbs.; propane and propylene, 214,555,000 lbs.; butadiene 488,945,000 lbs.; 1-butene and 2-butene mixture, 202,380,000 lbs.; all other C_4 hydrocarbons, 569,087,000 lbs.; and 'all other' chemical raw materials from petroleum, including benzene, other 'crudes from petroleum,' and other petroleum hydrocarbons (but not toluene), 841,240,000 lbs. A large fraction of the 29,052,000 gallons of cresylic acids produced from all sources was included in the latter figure."

To sum up: The chemical industry as well as the oil industry has certainly awakened to the vast potentialities of petroleum and natural gas as a tremendously large source of raw materials from which a wide variety of industrial chemicals can be economically manufactured.

Not only will the industrial utilization of these raw materials utilize new large scale manufacturing techniques, but also the employment of efficient mass-production methods will make for progressively lower overall costs of manufacturing.

EXAMPLES OF CHEMICAL EXPANSION

With the growing importance of production of synthetic chemicals from petroleum, not only are oil companies entering this field in a large way, either through newly-created subsidiaries or in combination with established chemical companies, but also many chemical companies are actively expanding into this field which promises to be so important in the post-war period.

Shell Oil Company and Standard Oil of New Jersey are representatives of the first group; Continental Oil Company in combination with the Air Reduction Company through their subsidiary, Petroleum Chemicals, Incorporated, and Texas Company with American Cyanamid through their subsidiary, Jefferson Chemical Company, are examples of the second group. Also, it may be noted that Hycar Chemical Company, formerly owned jointly by Phillips Petroleum Company and the B. F. Goodrich Company, has only recently been taken over entirely by the latter company, and plans for its extensive expansion are already being formulated.

The California Research Corporation is a wholly owned subsidiary of the Standard Oil of California; the chemical manufacturing subsidiary of the latter, also recently organized, is the Oronite Chemical Company.

Standard Oil Company (Indiana) has recently organized a chemical products department, in recognition of "the increasing importance of manufacture of chemical products from petroleum." As stated by W. B. Plummer, manager of the new department, the new catalytic refining processes now overshadowing older methods "are making new chemical by-products available and paving the way for still further developments in the petroleum chemicals fields."

At this place may be noted the announced plans for separate plants of Jefferson Chemical Company and of American Cyanamid Company at Port Neches, Texas. Jefferson Chemical Company, as stated above, is jointly owned by American Cyanamid and the Texas Company. Jefferson Chemical will build a large chemical plant on part of a tract of 1,091 acres adjacent to the Texas Company's asphalt and roofing plant at Port Neches. The new plant will manufacture intermediates for the production of synthetic rubber, plastics, textiles and other materials from petroleum and petroleum gases. The reported estimated cost of this plant has been put at \$12 million.

Also, it was announced at the same time that American Cyanamid Company had purchased some 900 acres adjacent to the Jefferson Chemical tract, and with about 2,500 feet frontage on the Neches River, on which it will build a large chemical plant to utilize some of the intermediates produced by Jefferson Chemical.

Furthermore it is important to note that well-established chemical companies are themselves entering the petroleum chemical fields in a large way. Carbide and Carbon Chemicals Corporation is one of these, having been a pioneer in the chemical utilization of hydrocarbon gases; this company acquired a tract of 200 acres with water front at Texas City in 1940 on which it constructed a large plant for the production in bulk of synthetic organic chemicals, using as raw materials refinery gases obtained from the adjacent refinery of Pan American

Refining Corporation. This plant has since been expanded, the total estimated cost of which is \$18,681,000 and plans for a further expansion were recently announced. The Texas City plant has installed capacity for the production of acetone, ethyl ether, ethylene oxide, acetic acid, acetic anhydride, ethyl alcohol, ethylene glycol, and acetylene gas. The Dow Chemical Company and Montanto Chemical Company, as well as the Celanese Corporation of America, Tennessee Eastman Corporation, Sharples Chemical Company, and even Commercial Solvents Corporation are active participants in this field. Dow Chemical at Freeport has installed capacity for the production of ethylene gas, ethylene glycol, ethylene dichloride, carbon tetrachloride, chloroform, perchloroethylene, hexachlorethylene, triethylene glycol, methylene chloride, and ethylene dibromide, and at Velasco for the production of styrene, Thiokol, hexachlorethane, and ethylene glycol. Dow has announced plans for a \$15 million expansion in its facilities at Freeport, to be devoted largely to plastics production.

Monsanto Chemical Company has installed capacity for the production of styrene, formaldehyde, and ethylene gas at its Texas City plant. And the du Pont Company with its \$30 million nylon salts plant under construction at Orange, Texas, is certainly entering the field of synthetic chemicals from petroleum and natural gas. Incidentally, du Pont organized a Petroleum Chemicals Division in December, 1945.

In order to obtain a clearer conception as well as a better perspective of raw materials for the petroleum chemistry industry, the following brief discussion of industrial achievements in this field is presented.

HIGH-OCTANE AVIATION FUEL A VITAL PRODUCT OF WORLD WAR II

Not only did the production of high-octane aviation gasoline receive a tremendous impetus during World War II but it also clearly indicates the trends in modern refining which are destined to play not only a large part in post-war refinery operations, but also as important sources of raw materials for the large-scale manufacture of synthetic chemicals from petroleum.

Aviation gasoline consists of a mixture of several constituents, including:

a. The base stock, in part made up of specially fractionated high-octane straight-run gasoline, but mainly of gasoline from catalytic cracking plants, supplies the bulk of materials which go into aviation gasoline;

b. Blending agents, such as hydrogenated copolymers—*isooctane*, *hydrocodimer*—as well as *alkylate* and *neohexane*, are blended with high-grade base stock in order to step-up materially the octane rating of aviation gasoline;

c. Special *isoparaffin hydrocarbons*, including *isopentane*, *isohexanes*, and *isoheptanes* are added to give certain specific characteristics to aviation fuel.

d. *Tetraethyl lead*. The importance of tetraethyl lead as an anti-knock ingredient in motor fuel was discovered in 1921 by Thomas Midgley, Jr. It was soon thereafter produced commercially by a procedure involving ethyl chloride and an amalgam of sodium and lead, a process originally worked out by Dr. C. A. Kraus, then of Clark

University. This has remained the commercial process for making tetraethyl lead. Ethyl Gasoline Corporation, an affiliate of Standard Oil Company (N.J.) and General Motors Corporation, was organized in 1924, to market tetraethyl lead.

The recentness of developments in the various steps in providing blending agents or ingredients, which are outlined below, and the accelerated rate at which they were put into industrial operation thereby providing adequate aviation fuel for the war, is certainly a matter worthy of special emphasis. Although these highly important developments were put into operation within a very short period, yet each one was preceded by long-time and very intensive research programs which fortunately had been advanced to a stage in which it was possible to apply them most fruitfully to meet the exigencies of World War II.

FUNDAMENTAL PROCESSES

Hydrogenation of isobutylene polymers, to produce *isooctane*. The isomer commonly known as *isooctane*, which is 2,2,4-trimethylpentane, was arbitrarily defined as 100-octane—a definition established by Graham Edgar, in 1926. This product was a scarce substance in 1926. Standard Oil of New Jersey began its production through polymerizing isobutylene (a gas supplied in refinery cracking) to form di-isobutylene, a liquid—into the molecules of which subsequently was forced two atoms of hydrogen, thus forming so-called synthetic *isooctane*. In 1934, Standard Oil Company of Louisiana put the process into commercial utilization.

Selective catalytic copolymerization and hydrogenation of the resulting copolymers. The discovery of codimer, the copolymer formed when isobutylene is reacted with normal butylenes, which is then hydrogenated to hydrocodimer (essentially *isooctane*) for a time practically doubled the output of 100-octane gasoline. This operation is illustrative of how, by suitable catalysts, specific gases (formerly waste refinery gases) can be transformed by polymerization, thus forming valuable liquid products which in turn can be hydrogenated to gasoline ingredients of much higher octane ratings than the naturally occurring hydrocarbons. In brief, catalytic polymerization makes possible the conversion of propylenes and butylenes to high-octane polymer gasoline. This process, however, has in part at least been superseded by the discovery and the more recent development of alkylation.

Selective catalytic polymerization is a limited operation process; the yields are not large but the quality of the product is closely controlled. In contrast, much larger yields of the desired high-octane product known as *alkylate* can be produced by the alkylation process. Moreover, since the product of selective catalytic polymerization requires transformation into a saturated hydrocarbon (effected by selective catalytic hydrogenation) the process is, therefore, a two-stage operation.

Alkylation. The next important process to be developed was alkylation, which consists in chemically interacting olefins and isobutane, aided by the use of proper catalysts, to produce by a one-stage process large amounts of highly branched liquid paraffins having superior antiknock properties. This achievement was first

accomplished in the laboratory as recently as 1935. Commercial alkylation operations have been in existence only since 1938. This process, according to C. R. Wagner, had in 1944 more than tripled the rate of output of 100-octane gasoline. Wagner has called alkylation the greatest discovery in organic chemistry in our time. Certainly, alkylation supplied the key ingredient for aviation gasoline used by the United Nations in World War II.

In order to supply isobutane in sufficient quantities for alkylation with the olefins available through catalytic cracking, many refineries constructed isomerization units. By this process a straight-chain C_4 molecule, for instance, is converted into a branched-chain C_4 molecule. It is important to note in this connection that it is possible to isomerize normal pentanes and even heavier hydrocarbons. Also, normal pentanes can be converted to isobutane.

Summarizing the alkylation process as it applies to gasoline manufacture, the following items are of importance:

1. The basic reaction in the alkylation process is the combining chemically of one olefin and one paraffin hydrocarbon.

2. It is a one stage process, once the ingredients are available.

3. Isobutane is the paraffin hydrocarbon employed in this alkylation process.

4. The olefins which can be used include a wide range of light hydrocarbons, available in large quantities, such as propylene, normal butylenes, and pentylenes.

Thermal cracking units operated at higher temperatures than normally increased the yield of olefins suitable as charge stock for these alkylation units. The light hydrocarbons produced in catalytic cracking processes are rich in isobutylene.

5. All alkylation processes operate in a presence of a large excess of isobutane which is in continuous recirculation. One method of alkylation employs concentrated sulphuric acid as the catalyst; the other employs anhydrous hydrofluoric acid and operates at normal temperatures.

Isomerization. The special isoparaffin hydrocarbons, added to aviation gasoline, include isopentane, isohexanes, and isoheptanes. These can be obtained by close fractionation of natural and straight-run gasolines and this was formerly the only source. Several superfractionation plants have been built to provide these substances.

However, catalytic processes have been developed wherein normal paraffin, *i.e.*, straight-chain hydrocarbons are transformed into the corresponding iso- or branched-chain paraffin hydrocarbons. The feed stock in all these cases in either liquid or gaseous state under moderate temperature and pressure conditions is brought in contact with an aluminum chloride type of catalyst in the presence of hydrochloric acid.

Yields of these processes are high, the process is simple, and it operates at low costs.

The isomerization of normal butane to isobutane, required in alkylation operations has been noted. Other plants or units are in operation, producing isopentane from normal pentane, as well as isohexanes from normal

hexane. Several Texas refineries have large units producing isopentane. During the war Pan American Refining Corporation, for example, operated a Government-owned isopentane plant at Texas City, the rated capacity of which was 1,985 barrels a day.

Aromatization. Conversion of paraffins into aromatics has been commercially possible since 1936. Straight-chain hydrocarbons, particularly hexane and heptane, can be converted (cyclized) into cyclic compounds; *e.g.*, normal heptane can be converted to toluene, and hexane to benzene. Hydroforming is a method of bringing about aromatization catalytically. Formerly the only sources of toluene and benzene were derivatives from coal, mostly by distillation of coal-tar. Through catalytic reforming, low quality naphthas are transformed into high-octane gasoline by the conversion of straight-chain paraffinic hydrocarbons into aromatic hydrocarbons. Large-scale production of toluene by the hydroforming process utilizing special feed stocks is discussed in Part III of this article.

In summing up these outstanding achievements so vital in winning the war, it needs only be pointed out that the yield of 100-octane gasoline—which gave the United Nations air superiority, and which furthermore was a product of the United States refining industry—from a barrel of crude was more than tripled through the use of these methods of organic synthesis.

Catalytic dehydrogenation. The preceding outline does not include all the refining developments important to the further expansion of production of chemicals from petroleum. For instance, catalytic dehydrogenation processes are in operation. One phase of catalytic dehydrogenation is employed to convert paraffin hydrocarbons into olefins as well as to convert olefin hydrocarbons into diolefins. For example, butane is thus converted into butylenes, which can be employed in selective polymerization or in alkylation, or the butylenes may be dehydrogenated to yield butadiene, required in the manufacture of GR-S type of synthetic rubber.

Another application of this process is the dehydrogenation of ethyl benzene to styrene, the other basic ingredient of GR-S, the all-purpose synthetic rubber of the Government program.

Still another application is in the preparation of certain branched aromatics employed as ingredients of aviation gasoline to step up engine performance.

Catalytic dehydrogenation is used in the treatment of individual pure hydrocarbons but as yet this appears to have operating limitations. Thermal dehydrogenation, however, is used to advantage in obtaining large quantities of mixed olefin and diolefin hydrocarbons. By thermal dehydrogenation, for instance, ethylene is produced commercially from the paraffin hydrocarbons—ethane, propane, and butane.

The charge stock thus employed includes liquefied petroleum gases as well as naphtha and gas oil cuts. These are thermally cracked at low pressures but at high temperatures in the presence of steam. Although the products vary with the charging stock, this process yields large percentages of elemental hydrogen, such olefins as ethylene, propylene, butylenes, amylenes, acetylene, and the diolefins, butadiene, and isoprene. Upon subsequent segregation and purification, these chemicals are avail-

able as starting materials for a wide range of important chemical syntheses.

This process of low-pressure dehydrogenation has advanced rapidly in recent years and that it will find numerous further applications in the future is to be expected. Not only is it being used in the production of synthetic alcohols, synthetic rubber, and synthetic resins but also it will be used increasingly in the manufacture of other chemicals.

Petroleum hydrogenation. Considerable interest was manifested in hydrogenation as a petroleum refining process in the early 1930's, following the outstanding research work in Germany of Bergius on hydrogenation of coal, the results of which were announced in the middle 1920's; developments of this process have been of great importance in both Germany and England in recent years.

United States refining operations have included previously mentioned commercialized "fringe" processes, such as the hydrogenation to isooctanes from dimers—produced by catalytic polymerization of butylenes and isobutylenes to iso-octanes—and as the hydrogenation to hydrocodimer from codimers, such as produced by polymerizing isobutylene, as well as the process of hydroforming.

In addition, during the war catalytically cracked aviation base stock was selectively hydrogenated in order to improve stability and octane number by converting olefins to paraffins; also kerosene fractions—from distillate fractionation or from cracking—of predominantly aromatic character were hydrogenated to produce a high-quality base stock. "The direct manufacture of aviation base from kerosene fractions, . . . is an example of destructive hydrogenation, since it involves a combination of simple hydrogenation and other catalytic reactions such as pyrolysis and isomerization."

Large-scale commercialization of the hydrogenation process applied to petroleum has, however, not materialized as yet. An article in the *National Petroleum News*, September 5, 1945, summed up the situation as follows:

"Petroleum hydrogenation is an intriguing process. Millions have been spent on it for research. Fundamental principles are thoroughly understood, as are its economics—which show that it may some day be used on a large scale on petroleum residues and low-grade crudes and distillates if the cost of petroleum rises sharply (as is not improbable). Meanwhile, many companies continue their research in an effort to be ready."

Other developments. Difficulties in segregating and purifying the individual constituents are being solved through such more recent developments as improved superfractionation, azeotropic distillation, and solvent extraction.

Already liquefied petroleum gases and natural gas are considered the most advantageous sources for low-cost hydrogen. Hydrogen from natural gas was used in war plants as the basic raw material in the manufacture of synthetic ammonia as well as of other compounds required in the war effort.

Still another line of advancement still in the development stage is the production of synthetic liquid petroleum products, gasoline especially, from natural gas by use of a modified Fischer-Tropsch process.

CATALYTIC CRACKING—A FUNDAMENTAL INDUSTRIAL DEVELOPMENT

The key to the wartime revolution in petroleum refining is catalytic cracking. Although several catalytic cracking processes are in use, and all yield a variety of catalytically cracked products, yet the composition of these products does not vary to any considerable degree with the particular process used; it does vary, however, with the severity of the operations employed and to some extent with the charging stock.

The greater the intensity of the operations, that is, the greater the rate of conversion, the higher will be the proportion of aromatics in the cracked products and the greater also will be the yield of uncondensable gases. Also, under moderate operating conditions of conversion, the greater will be the yield of naphthenic hydrocarbons. The ratio of olefinic to isoparaffinic hydrocarbons produced in catalytic cracking apparently varies more with the boiling range of the charging stock than with the rate of conversion. What is also of fundamental importance in the production of gasoline by catalytic cracking is that the lower boiling range of the gasoline contains a large percentage of isoparaffinic hydrocarbons and in its upper boiling range a high concentration of aromatic hydrocarbons. These features account for the high quality of such gasoline.

In addition to the production of high-grade base stock for aviation fuel, it may well be reemphasized that the catalytic cracking plants are furnishing vast quantities of raw materials for chemical synthesis.

Catalytic cracking is also important in still another way. No one can question the efficacy of the process as a means of conservation with respect to our petroleum reserves. In establishing well-balanced refinery operations it is important also not only to attain maximum yields of gasoline and light fuels but to minimize the yields of heavy fuels.

Catalytic cracking facilities hastily installed during the war still serve to provide a better gasoline-fuel oil balance, as such plants give high yields of high-quality gasoline with light fuel oil as a by-product, rather than heavy fuel oil as is the case of conventional thermal cracking plants in large use prior to the war.

However, the catalytic cracking plants installed during the war were limited to charge stocks having a high boiling point; this type of plant facilitated the maximum production of the desired products—aviation gasoline base stock—with a minimum of plant equipment. Already modifications are being introduced whereby heavier charge stocks can be used for catalytic cracking. For example, the TCC (Thermoform Catalytic Cracking) process has been adapted to handle even "the heaviest type of petroleum charge stocks without restriction to boiling range, and converting them into high yields of high-quality motor gasoline and distillate fuel oils. The latter application of the TCC principle is referred to as 'TCC liquid-charge technique,' . . ."

But by no means have the possibilities for still further improvements in catalytic refining been exhausted. Even before V-J Day a modified catalytic refining process, designated as re-treating, using the same catalytic equipment and plant arrangements as catalytic cracking, but operating at lower temperature, was in large-scale use

for the treatment of gasolines in order to step them up to aviation requirements. Also, by employing other types of catalysts, such processes as desulphurization, dehydrogenation, and cyclization, as well as other chemical reactions, are being brought into other refining picture as practical procedures.

Summarizing: By the introduction of more effective techniques, the refining industry is becoming not only more and more dependent upon chemical processes but is also becoming more and more an agency of conservation. In brief, the changes in oil refining from merely a physical separation procedure to highly complex chemical processes, with more precise control of products all along the line, include: (a) more efficient methods of cracking whereby long-chain hydrocarbons are broken up into shorter, more usable ones; (b) more efficient methods of combining the extremely short-chain hydrocarbons (formerly wasted or used only for fuel) into usable and highly valuable products; (c) new processes for rearranging the composition of molecules to yield premium products; (d) new methods of manufacturing a wide group of specialty products which are in increasing demand.

What is so important is that now all these hydrocarbon constituents of 100-octane gasoline the supply of which is guaranteed by commercial cracking processes—are also available as chemical raw materials. These hydrocarbons are the smaller building blocks from which chemists can build up the desired molecules for the manufacture of a wide range of industrial chemicals for use in a greatly expanded post-war chemical industry. They are products of developments in industrial chemistry during the late 1920's and 1930's, and which have been carried forward to an even greater degree of achievement during the 1940's. A vast new field involving an ever-extending use of new and improved catalysts has been opened up, the potential limits of which are as yet nowhere in sight. As indicative of the promise of this new field in modern chemistry is the fact previously noted, that the petroleum refining industry is now producing a greater volume of synthetic organic chemicals than is the chemical industry itself.

Moreover, it is worthy of note that many of these hydrocarbons are by-products of modern refining processes. The economies of by-products in modern industry lie in the fact that as raw materials available for further manufacturing, they are low-cost materials. In addition, they are in plentiful supply in great purity and are characterized by the necessary chemical reactivity. In short, the modernized oil refining industry, through its large production of various by-products, has already become an integral part of the manufacture of synthetic organic chemicals, exemplified, for instance, in the current production of synthetic alcohols, aldehydes, organic acids, ketones, as well as synthetic rubbers, synthetic resins, and synthetic fibers.

ACETYLENE—ITS DERIVATIVES AND PRODUCTS

Acetylene as a chemical raw material is not only a hydrocarbon that is readily transformed but also it is one of the most fruitful substances as regards variety and importance of products derived therefrom.

Both acetylene and ethylene are of outstanding importance as raw materials for the synthesis of industrial

chemicals. The vinyl resins, for instance, represent one of the most promising groups of the newer synthetic materials that have achieved industrial importance both as plastics and as synthetic fibers. Vinyl chloride, a gas, is an ethylene derivative, but it can also be made by reacting acetylene with hydrogen chloride. Under the influence of proper catalysts, this gas can be converted by polymerization into solid, resinous polyvinyl chloride. Although vinyl acetate can be derived from ethylene, industrially it is made from acetylene. The other raw material required for vinyl acetate is acetic acid—which in turn can be prepared either from acetylene or from ethyl alcohol, and the latter can be made from ethylene. Vinyl acetate can be copolymerized with vinyl chloride; the resulting copolymer is a resin known under the trade name, "Vinylite," of which the synthetic fiber, "Vinyon" is a variety.

Neoprene synthetic rubber is derived from acetylene as the starting material.

Other plastics derived from acetylene include the polyvinyl acetals, such as polyvinyl butyral, as well as polyvinyl formal, and polyvinyl alcohol. Polyvinyl alcohol is prepared by the hydrolysis of polyvinyl acetate. Polyvinyl acetals are produced by reacting polyvinyl alcohol with various aldehydes, butyraldehyde, for instance, which is obtainable from acetaldehyde; the latter is derived either from acetylene or from ethyl alcohol. Acetylene is also used in large quantities for oxy-acetylene cutting and welding of metals.

Acetylene has been and still is being produced from calcium carbide, and is therefore a coal-derived product; an essential point here, however, is that the production of calcium carbide consumes large amounts of electricity, which is reflected in the high cost of acetylene made by the carbide method.

During 1939 the reported production of acetylene from some 130 plants amounted to 1,291,205,000 cubic feet. The number of plants rose to 156 in 1943, and additional capacity for acetylene production, including Defense Plant Corporation projects increased the number of plants still further during 1944 and 1945. It is reported that calcium carbide production rose from 167,592 short tons in 1939 to 620,847 tons in 1943, and 775,673 tons in 1944.

Methane, ethane, and other hydrocarbon constituents of natural gas can be cracked thermally, as in the Wulff process, to yield acetylene.

Concerning the production of acetylene from natural gas, R. L. Wakeman wrote in 1941: "Although acetylene is now produced from calcium carbide, a potential source is natural gas. Research work of recent years has shown the feasibility of making it from methane by catalytic pyrolysis, using extremely great space velocities. It is understood that this process has already been carried through to plant scale operations. The future will disclose whether engineers are able to evolve manufacturing methods that can compete with those now using carbides. If so, natural gas may also become the source of raw materials for the imposing array of chemicals and plastics manufactured on a large scale from acetylene."

Another aspect of the acetylene problem was summarized by C. R. Wagner, as follows in *The Oil and Gas Journal*, March 25, 1945:

For many years research workers have attempted to make acetylene from natural gas or liquid petroleum hydrocarbons. Small quantities always turned up in high-temperature processes to plague operators with separation problems, but no commercial units were installed. A few years ago Tennessee Eastman Corp. carried on a long series of experiments with the Wulff process, and today a plant to produce 150,000 lb. of acetylene per day is being installed by a large chemical company. . . .

The reactor is a regenerative type heater in which the refractories are spaced so as to give very high gas velocities during the "make" period. A considerable volume of steam at low pressure is used to maintain a low partial pressure of the acetylene produced. The feed employed may be anything from ethane up to kerosene. Ethylene produced in the process is recycled in order to increase the yield of acetylene, and its concentration in the exit gases.

It is difficult to predict what may be the effect of such a commercial venture as this acetylene making unit. If it has a long enough operating history before the war ends to demonstrate its ability to make cheap acetylene, future installations may well be of this type. On the other hand, unless it is able to compete with existing units in the postwar period, it may succumb to cheap electricity and the inertia of an established industry.

A more recent pronouncement regarding the acetylene problem is that of J. D. Waterman, as follows: "Economic factors explain why natural gas, which is both a cheap source of power and a cheap source of carbon and hydrogen, is at present insignificant as a source of acetylenes. Several efficient processes using natural gas have been worked out. But power from the great dams has become available in such quantities at so low a price that carbide has steadily undercut natural gas. The race is very close however, and there seems little doubt that acetylene will come from petroleum in a few years' time."

The intriguing problem of methane deserves mention in this connection, owing to the tremendous quantities available. Dr. A. E. Dunstan, Chief Chemist, Anglo-Iranian Oil Company, Ltd., stated in 1943 that he considered the conversion of methane to acetylene as the best line of attack on this most recalcitrant hydrocarbon, as acetylene is a convenient source of many valuable chemicals. Dunstan estimated the production of methane from petroleum sources alone at approximately 10,000,000 tons a year.

It is worthwhile to repeat that Dr. Schoch's electric discharge method for producing acetylene from natural gas is a promising development. This process, it should be emphasized, differs fundamentally from the cracking of gaseous hydrocarbons (methane and/or methane-ethane mixtures) in electric arc furnaces which was employed in Germany in producing acetylene. Gustav Egloff stated recently in a public address that Dr. Schoch apparently has the answer to cheap acetylene. Acetylene produced by the carbide process is regarded as relatively too expensive, owing to the high cost of the large quantities of electricity required in making calcium carbide.

In this connection it is worthwhile to call attention to the fact that the basic aliphatic hydrocarbon utilized by Germany during the war period was acetylene. It has been stated that acetylene chemistry kept Germany's war machine going and that therefore acetylene occupied a position in German chemical industry in World War II somewhat comparable to that occupied by the Haber synthetic ammonia process in Germany for the fixation of atmospheric nitrogen in World War I.

Having little or no petroleum available the Germans fell back on their coal resources to supply by indirect

methods their requirements of aliphatic hydrocarbons, through the production of acetylene. From acetylene they were able to make almost every chemical which in the United States is being made from petroleum. Acetylene, either directly as a basic starting material or through conversion, supplied the raw materials not only for Germany's wartime plastics and synthetic rubber, but also a host of miscellaneous industrial chemicals.

The Germans made most of their acetylene through the calcium carbide process which requires large amounts of electric power; one large plant at least employed the arc process successfully, using as raw materials hydrocarbon gases from coal hydrogenation or from coke-oven gas residue. Low-cost electric power was supplied from their relatively large brown coal (lignite) deposits.

These developments in Germany not only reflect the basic importance of acetylene in the newer phases of hydrocarbon chemistry but also they illustrate the wide versatility of acetylene in modern processes of chemical conversion and synthesis. From acetylene the Germans, for example, made butadiene for synthetic rubber either by way of the acetaldehyde-aldol process or by way of formaldehyde-acetylene reactions.

They also made both ethylene and ethyl alcohol from acetylene. Their large-scale conversion of acetylene to ethylene by catalytic hydrogenation is reported as one of their most surprising achievements. Ethylene was used not only in making styrene for Buna S synthetic rubber but also for the production of ethylene glycol, as well as numerous miscellaneous chemicals. By polymerizing ethylene they made a polyethylene ingredient used in the production of synthetic lubricating oil.

Through complex processes they were able to make a large number of other important compounds, using acetylene as the starting material. Among these are glycerol, allyl alcohol, acrylic acid, vinyl acetylene, adipic acid, and hexamethylene diamine. Adipic acid, it may be noted, is the basic intermediate used in the manufacture of nylon.

Another derivative starting from ethylene is acrylonitrile, or vinyl cyanide, which is interpolymerized with butadiene to yield Buna-N synthetic rubber.

LIQUEFIED PETROLEUM GASES AS SOURCES OF HYDROCARBONS

Along with hydrocarbons in refinery gases and "dry" natural gas, those of liquefied petroleum gases are also destined to play an increasingly important role in supplying raw materials readily available for chemical syntheses.

A liquefied petroleum gas is defined by W. H. Harts in the *Oil Weekly*, May 7, 1945:

. . . might be described as being any petroleum hydrocarbon that in a free state is a gas or vapor at atmospheric conditions, namely 14.4 pounds absolute and 60 deg. F., but which can be liquefied by applying pressure, reducing the temperature, or both.

Gas and oil produced from well are essentially the same from a chemical standpoint, the only difference being that oil has proportionately more carbon in ratio to the amount of hydrogen.

A large percentage of liquefied petroleum gases is produced as by-products of natural gasoline plants, although most of the

modern refineries have installed recovery plants to produce their waste or so-called "fixed" gases.

While the liquid gas produced at a refinery is slightly different in its chemical composition, the difference is so slight that it does not alter the usages to any appreciable extent. Where the natural gasoline plant produces propane the refiner produces propylene. The close relationship between these gases is such that the average domestic consumer would never know by the performance of the fuel whether he is using propane or propylene. . . .

The various gases considered as liquefied petroleum gases in a natural gasoline plant operation are (methane, ethane), propane, isobutane, and butane, although the first two mentioned are not generally considered, due to the extremely high pressure required to condense them to a liquid. These two gases comprise the major part of the natural gas burned in the home.

Propane, isobutane and butane, quickly evaporate if exposed to the atmosphere and therefore must be continually stored in closed containers under pressure. Within the experience of most men in the oil business all three of these products were largely wasted and considered of no value. . . .

The method of manufacture of liquefied petroleum gas in a natural gasoline plant most commonly used is a combination of compression absorption and, in some cases, refrigeration. The raw or green gas is gathered from the wells or traps in the field and conducted through pipelines to a central plant where it is compressed and cooled. Then it is run through an absorber where a mineral seal oil absorbs the gasoline or heavy hydrocarbons, together with a portion or nearly all of the liquefied petroleum gases, depending upon the design of the plant. From the absorber, the oil, saturated with these various hydrocarbons, is heated and stripped of the gases in a still. The vapors from the still are then cooled and condensed to what is called "raw gasoline." The raw gasoline is introduced into a series of fractionating towers varying from two to five—depending upon the number of cuts and kind of products desired. In most plants with three or more fractionators, the first tower removes all the methane and ethane that may be in the gasoline stock, the next tower removes the propane, and the third tower removes the butanes and leaves a natural gasoline of desired vapor pressure—usually from 12 pounds Reid vapor pressure to 26 pounds.

If the iso-butane is desired, a fourth tower is added and the butanes from the No. 3 column are split to form iso-butane overhead and normal butane as a bottom product. In some cases, especially since the war, isopentane has been needed as a commercially pure product. In this event, still another fractionator is required where a gasoline, that has been completely debutanized in the third tower, is fed into that tower and the iso-pentane is fractionated out of the gasoline.

Outstanding fact regarding liquefied petroleum gases is that their production and use, including the separate fractions and mixtures of propane and butanes, according to a statement issued November 1, 1945, by Ralph K. Davies of the Petroleum Administration for War, have tripled during the past two years. According to this statement the estimated production of liquefied petroleum gases for 1945 was set at 115,064,829 barrels (4,832,-

722,818 gallons); this amount is 27 per cent greater than the 1944 production of 90,940,378 barrels, and more than three times that of the 1943 output of 37,800,000 barrels.

The consumption data for liquefied petroleum gases during 1944 reveal their importance in the war program, particularly in the manufacture of high-octane aviation gasoline, synthetic rubber and industrial chemicals in general. For instance, in 1944 a total of 9,683,345 barrels of these products was consumed in the production of synthetic rubber and chemicals. The estimated consumption of liquefied petroleum gases in this field for 1945 was put at 12,883,127 barrels, which represents a gain of 33 per cent over the 1944 figure and an increase of 225 per cent over the 1943 figure of 3,950,000 barrels consumed in these fields.

In this connection the following statement from the Bureau of Mines, August 14, 1945, may be noted: "Petroleum refineries, gasoline plants, and cycle plants coöperating in the 1944 survey reported 156,209,000 gallons of liquefied petroleum gases delivered for synthetic rubber components. Most of this material—144,370,000 gallons or 92 per cent—was indicated as butane or related gases, and all of it was reported for areas east of California."

Liquefied petroleum gases are widely used for domestic purposes as in rural areas as fuel for cooking, heating and refrigeration. The estimated consumption of these products in this field during 1945 is put at 18,089,146 barrels—an increase of 17 per cent over the 1944 figure.

These gases also are used in a wide variety of industrial heating operations. Quoting from the previously mentioned article by Harts: "Because of economy, high purity, efficiency of combustion, ease of control and adaptability, butane and propanes are now used by hundreds of industrial concerns throughout the country for such important operations as metal cutting, paint drying, electric generation, glass annealing, hardening, die-casting, air conditioning, forging, galvanizing, water pumping, and many others."

The large use of liquefied petroleum gases, however, continues to be for refinery operations. The estimated use in this field for 1945 is put at 82,587,841 barrels—an increase of 25 per cent over the 1944 total and a rise of nearly 125 per cent over the 1943 figure.

The following data were released by the Bureau of Mines, August 14, 1945:

SALES OF LIQUEFIED PETROLEUM GASES IN THE UNITED STATES, 1938-44

—Thousands of gallons—

Year	Butane	Propane	Butane-Propane Mixtures	Pentane	Total Quantity	Percentage Increase Over Previous Year
1938	52,768	54,130	56,050	2,253	166,201	16.8
1939	71,351	79,323	69,020	3,886	223,580	35.3
1940	77,566	109,216	123,348	3,836	313,456	40.2
1941	112,244	126,969	219,252	4,387	462,852	47.7
1942	128,500	150,511	301,917	4,452	585,440	26.5
1943	140,124	218,273	312,683	4,155	675,233	15.3
1944*,†	277,240	335,377	449,192	§	1,061,809	57.3
1944*,‡	132,870	323,848	448,882	§	905,600	34.1

*Subject to revision.

†Includes material delivered for synthetic rubber components.

‡Material delivered for synthetic rubber components omitted to compare with 1943 totals.

§Figures not available.

High-pressure recovery plants. The production of hydrocarbons from high pressure recovery plants is becoming increasingly important in the Gulf Coast region of Texas and Louisiana; there are also a few high pressure recovery plants in California. The most recent of the Texas plants of this sort is that of J. S. Abercrombie Company and the Magnolia Petroleum Company processing wet gas from the Old Ocean field, near Sweeny, Texas.

In the earlier years of the development of high-pressure distillate fields, the gas was taken into high-pressure separators, in which the light oil or distillate was separated from the wet gas; the processed gas was either burned or forced back under pressure into the producing formation.

In the operation of these earlier plants, considerable amounts of pentane and heavier hydrocarbons were not removed from the gas.

In recent years, in order to recover the maximum amount of hydrocarbons in these operations, owing to the increasing demands particularly for *normal butane*, *isobutane*, and *isopentane* recovery plants operating at high pressures have been built. Currently, there are plants which recover practically all the hexane and heavier hydrocarbons, 90 per cent or more of the pentanes and as high as 90 per cent of the normal butane. Liquid propane is also produced in these plants. It may be recalled that both ethylene and propylene are derivable from propane.

IN CONCLUSION

Summarizing in broad perspective this phase of the new era of chemical industry, built on hydrocarbons

so readily available in large quantities from petroleum and natural gas, and which will serve as bases for a long range development for the manufacture of industrial chemicals built thereon, is the following statement by J. D. Westerman: "The ramifications of organic chemistry are so numerous and fruitful that no one can predict where they lead or end. Practically all of the bulk chemicals are not only useful in themselves but are also intermediates in producing useful new products or cheaper old ones. Twenty-five years ago all methyl (wood) alcohol in this country came from wood distillation. Ten times that much is now made synthetically at half the price. Important itself as a bulk solvent, it yields methyl chloride, a refrigerant and chemical intermediate, and a great variety of methyl esters useful in the most diverse fields. Its most important derivatives are, however formaldehyde, disinfectant, preservative, pharmaceutical, and in its turn starting material for still another series of products and essential components of phenolic, urea, and casein resins. Any chemical sufficiently abundant and low in price is set upon by a crowd of chemists seeking to transform it into rarer products."

Part III of this article will deal more extensively with industrial chemicals now being synthesized in large volume from petroleum and natural gas hydrocarbons, as illustrative of the broad vista that is opening out to the petroleum-chemistry industry. The field is of such magnitude and sweep as to stagger the imagination.

ELMER H. JOHNSON.

PETROLEUM

Daily Average Production (In Barrels)

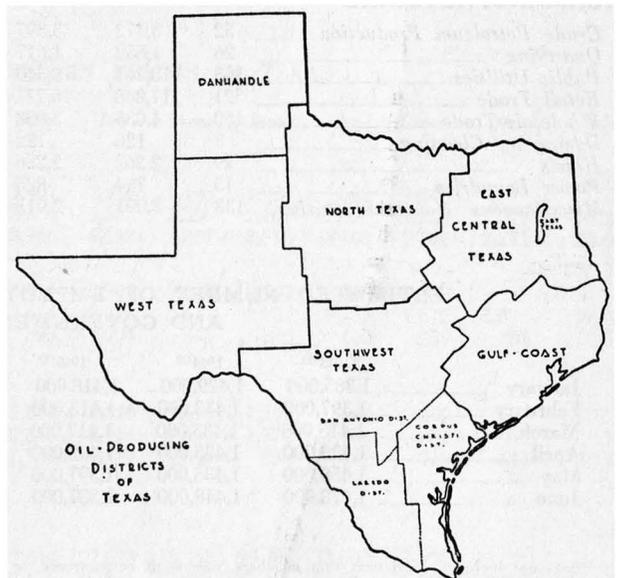
	Nov., 1945	Nov., 1944	Oct., 1945
Coastal Texas*	464,250	551,700	341,550
East Central Texas	128,000	145,150	103,400
East Texas	316,000	368,250	249,000
North Texas	147,100	150,950	125,350
Panhandle	81,000	94,650	88,000
Southwest Texas	300,100	345,750	237,400
West Texas	457,750	476,000	337,650
STATE	1,894,200	2,132,450	1,482,350
UNITED STATES	4,460,800	4,730,500	3,977,800

Gasoline sales as indicated by taxes collected by the State Comptroller were: October, 1945, 122,087,965 gallons; October, 1944, 109,452,159 gallons; September, 1945, 140,683,306 gallons.

October sales to the United States government as recorded by motor fuel distributors in Texas were 97,998,610 gallons.

*Includes Conroe.

NOTE: From American Petroleum Institute. See accompanying map showing the oil producing districts of Texas.



SAMPLE INFORMATION ON EMPLOYMENT AND PAY ROLLS IN TEXAS

November, 1945

(Collected from representative establishments reporting each month to the Bureau of Business Research in coöperation with the U. S. Bureau of Labor Statistics.)

	Number of Establishments Reporting	Number of Wage-Earners Employed*		Percentage Change		Amount of Weekly Pay Roll		Percentage Change	
		Nov., 1945	Oct., 1945	Oct., 1945 to Nov., 1945	Nov., 1944 to Nov., 1945	Nov., 1945	Oct., 1945	Oct., 1945 to Nov., 1945	Nov., 1944 to Nov., 1945
MANUFACTURING									
All Manufacturing Industries	622	85,584	82,976	+ 3.1	- 42.7	3,794,402	3,347,719	+ 13.3	- 48.9
<i>Food Products</i>									
Baking	14	471	451	+ 4.4	+ 7.7	20,750	18,508	+ 12.1	+ 24.0
Carbonated Beverages	48	565	587	- 3.7	- 11.0	17,066	17,991	- 5.1	- 5.5
Confectionery	8	186	167	+ 11.4	- 21.3	3,784	3,623	+ 4.4	- 3.4
Flour Milling	16	1,796	1,769	+ 1.5	+ 28.0	73,551	74,714	- 1.6	+ 22.5
Ice Cream	13	451	463	- 2.6	- 1.6	14,195	13,615	+ 4.3	+ 6.1
Meat Packing	10	2,668	2,639	+ 1.1	- 16.4	113,383	108,015	+ 5.0	- 13.7
<i>Textiles</i>									
Cotton Textile Mills	14	4,090	4,020	+ 1.7	+ 12.7	123,926	119,341	+ 3.8	+ 28.3
Men's Work Clothing	9	998	1,173	- 14.9	- 22.6	20,580	24,773	- 16.9	- 28.6
<i>Forest Products</i>									
Furniture	6	284	276	+ 2.9	- 21.7	8,227	8,366	- 1.7	+ 0.9
Planing Mills	16	847	868	- 2.4	+ 2.1	27,549	30,279	- 9.0	- 0.3
Saw Mills	7	1,690	1,637	+ 3.2	- 1.3	45,690	41,339	+ 10.5	+ 3.4
Paper Boxes	5	603	588	+ 2.6	+ 11.5	21,309	19,534	+ 9.1	+ 26.4
<i>Printing and Publishing</i>									
Commercial Printing	20	216	201	+ 7.5	+ 11.7	8,656	9,191	- 5.8	+ 11.7
Newspaper Publishing	13	942	870	+ 8.3	+ 14.7	50,012	44,970	+ 11.2	+ 27.9
<i>Chemical Products</i>									
Cotton Oil Mills	37	1,329	1,201	+ 10.7	- 5.3	44,587	38,901	+ 14.6	+ 6.5
Petroleum Refining	51	25,885	22,544	+ 14.8	- 13.2	1,458,379	931,063†	+ 56.6	- 17.4
<i>Stone and Clay Products</i>									
Brick and Tile	12	581	531	+ 9.4	+ 23.4	17,058	14,889	+ 14.6	+ 61.4
Cement	7	884	845	+ 4.6	+ 18.8	35,666	33,282	+ 7.2	+ 31.4
<i>Iron and Steel Products</i>									
Structural and Ornamental Iron	10	1,151	1,100	+ 4.6	- 16.2	53,055	49,581	+ 7.0	- 16.7
<i>Unclassified Miscellaneous Manufacturing</i>	306	39,947	41,046	- 2.7	†	1,636,979	1,745,744	- 6.2	†
NONMANUFACTURING									
Crude Petroleum Production	52	3,472	3,397	+ 2.2	+ 5.1	182,910	178,854	+ 2.3	- 2.4
Quarrying	26	1,652	1,617	+ 2.2	+ 7.4	76,113	73,764	+ 3.2	+ 7.1
Public Utilities	163	18,761	18,349	+ 2.2	+ 9.2	726,758	660,768	+ 10.0	+ 32.8
Retail Trade	521	17,848	16,771	+ 6.4	+ 4.2	483,005	457,403	+ 5.6	+ 11.8
Wholesale Trade	160	4,035	3,958	+ 1.9	+ 3.1	159,078	144,062	+ 10.4	+ 19.4
Dyeing and Cleaning	8	126	122	+ 3.3	+ 10.4	3,911	3,725	+ 5.0	+ 19.1
Hotels	19	2,262	2,256	+ 0.3	- 0.9	47,808	46,943	+ 1.8	+ 6.8
Power Laundries	15	794	825	- 3.8	- 5.5	16,622	16,327	+ 1.8	+ 7.4
Miscellaneous Nonmanufacturing	133	3,091	2,913	+ 6.1	†	115,465	113,834	+ 1.4	†

ESTIMATED NUMBER OF EMPLOYEES IN NONAGRICULTURAL BUSINESS AND GOVERNMENT ESTABLISHMENTS⁽³⁾

	1943 ⁽²⁾	1944 ⁽²⁾	1945 ⁽²⁾		1943	1944	1945
January	1,385,000	1,429,000	1,418,000	July	1,450,000 ⁽¹⁾	1,448,000 ⁽²⁾	1,381,000 ⁽²⁾
February	1,397,000	1,433,000	1,413,000	August	1,441,000 ⁽²⁾	1,446,000 ⁽²⁾	1,371,000 ⁽²⁾
March	1,415,000	1,433,000	1,417,000	September	1,448,000 ⁽²⁾	1,432,000 ⁽¹⁾	1,319,000 ⁽²⁾
April	1,433,000	1,435,000	1,402,000	October	1,455,000 ⁽²⁾	1,420,000 ⁽²⁾	
May	1,458,000	1,435,000	1,397,000	November	1,461,000 ⁽²⁾	1,434,000 ⁽²⁾	
June	1,478,000	1,448,000	1,387,000	December	1,470,000 ⁽²⁾	1,467,000 ⁽²⁾	

*Does not include proprietors, firm members, officers of corporations, or other principal executives. Factory employment excludes also office, sales, technical and professional personnel.

⁽¹⁾Revised.⁽²⁾Subject to revision.⁽³⁾Not including self-employed persons, casual workers, or domestic servants, and exclusive of military and maritime personnel. These figures are furnished by the Bureau of Labor Statistics, U. S. Department of Labor.

†Not available.

‡Employees on strike were still carried on pay roll even though they received no pay, thus accounting for the drop in average weekly wage.

NOVEMBER SHIPMENTS OF LIVE STOCK CONVERTED TO A RAIL-CAR BASIS*

	Cattle		Calves		Hogs		Sheep		Total	
	1945	1944	1945	1944	1945	1944	1945	1944	1945	1944
Total Interstate Plus Fort Worth	6,318	7,013	1,936	2,416	128	479	677	775	9,059	10,683
Total Intrastate Omitting Fort Worth	1,600	1,543	295	264	14	18	292	334	2,201	2,159
TOTAL SHIPMENTS	7,918	8,556	2,231	2,680	142	497	969	1,109	11,260	12,842

TEXAS CAR-LOT* SHIPMENTS OF LIVE STOCK FOR YEAR 1945

	Cattle		Calves		Hogs		Sheep		Total	
	1945	1944	1945	1944	1945	1944	1945	1944	1945	1944
Total Interstate Plus Fort Worth	64,507	59,249	13,004	13,022	4,558	13,283	15,526	13,430	97,595	98,984
Total Intrastate Omitting Fort Worth	9,130	8,183	1,754	1,633	276	819	1,922	2,494	13,082	13,129
TOTAL SHIPMENTS	73,637	67,432	14,758	14,655	4,834	14,102	17,448	15,924	110,677	112,113

*Rail-car Basis: Cattle, 30 head per car; calves, 60; swine, 80; and sheep, 250.

Fort Worth shipments are combined with interstate forwardings in order that the bulk of market disappearance for the month may be shown.

NOTE: These data are furnished the United States Bureau of Agricultural Economics by railway officials through more than 1,500 station agents, representing every livestock shipping point in the State. The data are compiled by the Bureau of Business Research.

NOVEMBER CARLOAD MOVEMENT OF POULTRY AND EGGS

Shipments from Texas Stations

*Destination	Cars of Poultry						Cars of Eggs					
	Chickens		Turkeys		Shell		Frozen		Dried		Shell Equivalent†	
	1945	1944	1945	1944	1945	1944	1945	1944	1945	1944	1945	1944
TOTAL	16	19	355	257	2	15	21	70	4	108	74	1,019
Intrastate	3	3	6	42	2	9	2	26	---	14	6	173
Interstate	13	16	349	215	---	6	19	44	4	94	70	846
Receipts at Texas Stations												
TOTAL	12	19	17	18	26	44	44	82	0	7	114	264
Intrastate	2	13	10	14	2	8	1	25	0	7	4	114
Interstate	10	6	7	4	24	36	43	57	0	0	110	150

*The destination above is the first destination as shown by the original waybill. Changes in destination brought about by diversion factors are not shown.

†Dried eggs and frozen eggs are converted to a shell-egg equivalent on the following basis: 1 rail carload of dried eggs=8 carloads of shell eggs, and 1 carload of frozen eggs=2 carloads of shell eggs.

NOTE: These data furnished to the Division of Agricultural Statistics, B.A.E., by railroad officials through agents at all stations which originate and receive carload shipments of poultry and eggs. The data are compiled by the Bureau of Business Research.

DAIRY PRODUCTS MANUFACTURED IN PLANTS IN TEXAS

Product and Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
CREAMERY BUTTER (1000 lb.)													
1945*	1,546	1,786	2,492	3,612	3,934	3,407	2,910	2,495	1,974	1,502	1,246		
1944*	1,827	1,984	2,548	3,634	3,998	3,594	3,388	2,556	2,407	2,027	1,509	1,717	32,304
1930-39 average	2,074	2,109	2,392	3,138	3,556	3,166	4,113	2,867	2,513	2,608	2,301	2,211	33,048
ICE CREAM (1000 gal.) ‡													
1945*	1,209	1,250	1,627	1,663	2,276	2,914	2,901	2,852	2,967	2,040	1,938		
1944*	991	1,075	1,332	1,516	2,090	2,674	2,825	2,517	2,127	1,759	1,672	1,076	24,011
1930-39 average	215	262	434	570	752	893	904	845	686	460	259	205	6,485
AMERICAN CHEESE (1000 lbs.)													
1945*	779	893	1,433	1,871	2,183	2,074	2,020	1,694	1,147	688	490		
1944*	762	919	1,306	1,886	2,255	2,312	2,114	1,684	1,372	1,128	881	708	17,197
1930-39 average	554	590	737	1,050	1,215	1,129	1,119	1,025	866	852	718	641	10,496
MILK EQUIVALENT OF DAIRY PRODUCTS† (1000 lbs.)													
1945*	57,308	63,892	90,817	124,559	143,240	137,514	127,623	113,952	99,478	71,003	61,405		
1944*	59,584	65,589	86,493	121,197	140,768	140,176	136,854	110,497	100,545	85,557	70,887	57,455	1,190,864
1930-39 average	54,675	57,139	67,456	89,641	104,323	97,562	97,075	89,185	76,165	73,444	60,119	55,872	922,656

*Estimates of production made by the Bureau of Business Research.

†Milk Equivalent of Dairy products was calculated from production data by the Bureau of Business Research.

NOTE: 10-year average production on creamery butter, ice cream and American cheese based on data from the Division of Agricultural Statistics, B. A. E.

‡Includes ice cream, sherbets, ices, etc.

NOVEMBER CREDIT RATIOS IN TEXAS DEPARTMENT AND APPAREL STORES

(Expressed in Per Cent)

	Number of Stores Reporting	Ratio of Credit Sales to Net Sales		Ratio of Collections to Outstanding		Ratio of Credit Salaries to Credit Sales	
		1945	1944	1945	1944	1945	1944
All Stores	62	44.6	46.1	69.1	69.8	1.0	0.9
Stores Grouped by Cities:							
Austin	7	36.8	39.6	73.6	74.1	1.4	1.1
Beaumont	3	46.7	47.6	69.1	72.9	0.9	0.8
Bryan	3	35.2	41.4	57.1	55.1	2.2	1.7
Corpus Christi	4	38.6	40.3	77.9	79.9	1.6	1.9
Dallas	7	57.4	62.1	67.8	67.5	0.6	0.6
Fort Worth	5	42.8	42.6	74.1	80.4	1.0	1.0
Houston	8	41.8	41.6	66.0	65.7	1.2	1.2
San Antonio	5	37.6	37.2	71.0	67.6	1.1	1.1
Waco	5	42.1	44.6	66.5	68.7	1.2	1.0
All Others	15	35.7	37.8	67.9	69.8	1.3	1.1
Stores Grouped According to Type of Store:							
Department Stores (Annual Volume Over \$500,000)	18	43.7	43.9	71.0	73.2	1.0	1.0
Department Stores (Annual Volume under \$500,000)	9	35.4	37.6	68.7	63.1	1.3	1.2
Dry-Goods-Apparel Stores	4	31.4	36.5	75.4	71.2	2.1	1.6
Women's Specialty Shops	18	52.4	55.1	65.0	63.7	0.6	0.7
Men's Clothing Stores	13	34.2	41.5	72.3	71.6	1.4	1.3
Stores Grouped According to Volume of Net Sales During 1945:							
Over \$2,500,000	18	47.9	49.0	68.8	70.1	0.9	0.9
\$2,500,000 down to \$1,000,000	13	35.1	36.8	72.4	71.7	0.7	0.6
\$1,000,000 down to \$500,000	13	33.0	35.3	69.9	65.7	0.9	0.9
Less than \$500,000	18	26.1	34.1	63.9	61.0	2.0	1.8

NOTE: The ratios shown for each year, in the order in which they appear from left to right are obtained by the following computations: (1) Credit Sales divided by Net Sales. (2) Collections during the month divided by the total accounts unpaid on the first of the month. (3) Salaries of the credit department divided by credit sales. The data are reported to the Bureau of Business Research by Texas retail stores.

NOVEMBER RETAIL SALES OF INDEPENDENT STORES IN TEXAS

	Number of Establishments Reporting	Percentage Changes in Dollar Sales		
		Nov., 1945 from Nov., 1944	Nov., 1945 from Oct., 1945	Year 1945 from Year 1944
TOTAL TEXAS	914	+ 15.5	- 0.5	+ 11.2
STORES GROUPED BY LINE OF GOODS CARRIED:				
APPAREL	115	+ 16.4	- 4.9	+ 14.6
Family Clothing Stores	25	+ 2.9	- 3.9	+ 7.9
Men's and Boys' Clothing Stores	39	+ 14.7	- 6.4	+ 9.1
Shoe Stores	17	+ 26.7	+ 3.5	+ 17.1
Women's Specialty Shops	34	+ 18.4	- 4.9	+ 18.9
AUTOMOTIVE*	75	+ 51.7	+ 7.3	+ 3.6
Motor Vehicle Dealers	67	+ 50.2	+ 7.9	+ 1.1
COUNTRY GENERAL	83	+ 10.9	- 0.8	+ 5.0
DEPARTMENT STORES	54	+ 8.4	+ 0.9	+ 11.1
DRUG STORES	79	+ 15.5	- 2.9	+ 6.9
DRY GOODS AND GENERAL MERCHANDISE	26	+ 9.2	+ 2.3	+ 11.3
FILLING STATIONS	23	+ 50.7	- 11.7	+ 22.1
FLORISTS	24	+ 22.3	+ 3.4	+ 18.5
FOOD*	129	+ 6.3	- 0.5	+ 3.8
Grocery Stores	39	+ 6.8	+ 1.0	+ 0.8
Grocery and Meat Stores	84	+ 6.8	- 0.5	+ 4.5
FURNITURE AND HOUSEHOLD*	60	+ 15.0	+ 4.0	+ 8.7
Furniture Stores	56	+ 16.1	+ 4.3	+ 8.9
JEWELRY	24	+ 27.5	+ 34.5	+ 11.6
LUMBER, BUILDING, AND HARDWARE*	158	+ 29.6	- 3.9	+ 23.7
Farm Implement Dealers	18	+ 3.9	- 16.7	+ 8.8
Hardware Stores	43	+ 21.4	+ 0.6	+ 15.8
Lumber and Building Material Dealers	95	+ 35.7	- 3.2	+ 29.8
RESTAURANTS	27	+ 21.1	+ 0.4	+ 7.7
ALL OTHER STORES	12	+ 23.6	- 3.1	+ 9.5
TEXAS STORES GROUPED ACCORDING TO POPULATION OF CITY:				
All Stores in Cities of—				
Over 100,000 Population	130	+ 17.3	+ 0.2	+ 13.9
50,000-100,000 Population	117	+ 10.3	- 0.9	+ 8.7
2,500-50,000 Population	71	+ 10.5	- 0.6	+ 5.5
Less than 2,500 Population	596	+ 18.5	- 1.6	+ 9.6

*Group total includes kinds of business other than the classification listed.

Prepared from reports of independent retail stores to the Bureau of Business Research, cooperating with the U.S. Bureau of the Census.

RETAIL SALES OF INDEPENDENT STORES IN TEXAS

(By Districts)

	Number of Estab- lishments Reporting	Percentage Changes		
		Nov., 1945 from Nov., 1944	Nov., 1945 from Oct., 1945	Year 1945 from Year 1944
TOTAL TEXAS	914	+ 15.5	- 0.5	+ 11.2
TEXAS STORES GROUPED BY PRODUCING AREAS				
District 1-N	61	+ 12.6	- 1.3	- 0.2
Amarillo		+ 10.4	- 1.4	
Plainview	12	- 4.3	- 9.6	
All Others	27	+ 19.3	+ 0.7	
District 1-S	22	+ 11.3	+ 0.7	+ 10.8
Lubbock	12	+ 12.9	+ 1.3	
All Others	10	+ 7.7	- 0.7	
District 2	78	+ 13.6	- 2.3	+ 4.8
Abilene	19	+ 9.0	+ 7.4	
All Others	59	+ 15.7	- 5.9	
District 3	32	+ 18.7	- 1.5	+ 18.7
District 4	208	+ 14.7	- 0.8	- 1.6
Dallas	27	+ 22.2	+ 1.0	
Fort Worth	26	+ 4.1	- 0.5	
Waco	21	+ 10.0	- 4.2	
All Others	134	+ 15.8	- 4.2	
District 5	112	+ 16.9	- 2.2	+ 10.6
District 6	28	+ 11.7	- 0.1	+ 10.4
District 7	51	+ 21.8	+ 0.6	+ 5.8
District 8	153	+ 20.9	- 0.8	+ 15.0
Austin	14	+ 14.7	+ 0.4	
Corpus Christi	24	+ 13.3	+ 0.6	
San Antonio	39	+ 23.5	- 0.7	
All Others	76	+ 28.5	- 4.7	
District 9	102	+ 11.6	+ 0.2	+ 7.8
Beaumont	16	- 0.8	- 3.9	
Houston	38	+ 15.1	+ 0.7	
All Others	48	+ 11.7	+ 2.9	
District 10	25	+ 6.9	+ 3.3	+ 1.5
District 10-A	42	+ 27.3	+ 6.6	+ 5.4

*Change of less than .5%

NOTE: Prepared from reports of independent retail stores to the Bureau of Business Research, cooperating with the U.S. Bureau of the Census.

TEXAS CHARTERS

	Nov., 1945	Nov., 1944	Oct., 1945
Domestic Corporations:			
Capitalization*	\$3,428	\$909	\$2,942
Number	122	59	137
Classification of new corporations:			
Banking-Finance	2	0	4
Manufacturing	13	6	19
Merchandising	48	26	41
Oil	8	6	4
Public Service	0	0	2
Real Estate Building	16	7	19
Transportation	3	4	5
All Others	32	10	43
Number capitalized at less than \$5,000	31	24	27
Number capitalized at \$100,000 or more	10	1	6
Foreign Corporations			
(Number)	20	2	15

*In thousands.

NOTE: Compiled from records of the Secretary of State.

COMMODITY PRICES

	Nov., 1945	Nov., 1944	Oct., 1945
Wholesale Prices:			
U. S. Bureau of Labor Statistics (1926=100)			
All Commodities	106.8	104.4	105.9
Farm Products	131.1	124.4	127.3
Retail Prices:			
Food (U. S. Bureau of Labor Statistics (1935-1939=100))			
	*	136.5	139.3
Consumer's Price Index (1935-1939=100)			
	*	126.5	128.9
Department Stores (Fairchild's Publications (Jan. 1931=100))			
	113.5	113.4	113.5

*Not available.

COTTON BALANCE SHEET FOR THE UNITED STATES AS OF NOVEMBER 1, 1945

(In Thousands of Running Bales Except as Noted)

Year	Carryover Aug. 1	Imports to Dec. 1*	Gov. Est. as of Dec. 1	Total	Cons. to Dec. 1	Exports to Dec. 1	Total	Balance Dec. 1
1935-1936	7,138	30	10,734	17,902	1,924	2,575	4,499	13,403
1936-1937	5,397	41	12,407	17,845	2,482	2,303	4,785	13,060
1937-1938	4,498	31	18,746	23,275	2,212	2,434	4,646	18,629
1938-1939	11,533	54	12,008	23,595	2,236	1,535	3,771	19,824
1939-1940	13,033	48	11,792	24,873	2,660	2,328	4,988	19,885
1940-1941	10,596	42	12,686	23,324	2,801	495	3,296	20,028
1941-1942	12,367	†	10,976	23,343	3,553	†	3,553	19,790
1942-1943	10,590	†	12,982	23,572	3,777	†	3,777	19,795
1943-1944	10,687	†	11,478	22,165	3,472	†	3,472	18,693
1944-1945	10,727	65	12,359	23,151	3,266	650	3,916	19,235
1945-1946	11,164	84‡	9,195	20,443	2,944	867	3,811	16,632

The Cotton Year begins August 1.

*Figures are in 500-lb. bales.

†Figures on imports and exports to November 1 not available.

‡Imports to Nov. 1, 1945.

BUILDING PERMITS

	Nov., 1945	Nov., 1944	Oct., 1945
Abilene	\$ 166,340	\$ 4,015	\$ 44,950
Amarillo	723,720	147,200	482,752
Austin	1,258,333	61,844	678,640
Beaumont	176,145	48,048	197,272
Big Spring	65,595	31,190	68,235
Brownsville	48,556	19,540	107,236
Brownwood	27,050	2,400	18,200
Bryan	80,120	14,900	56,185
Childress	14,579	4,230	12,280
Cleburne	33,925	3,825	11,835
Corpus Christi	806,717	152,370	437,176
Corsicana	21,475	12,890	12,225
Dallas	2,412,173	386,032	1,740,729
Denison	39,730	25,044	44,496
Denton	125,320	1,300	13,750
Edinburg	36,930	2,065	70,550
El Paso	242,870	48,167	269,140
Fort Worth	1,139,135	276,192	1,007,609
Galveston	76,465	24,542	81,060
Gladewater	3,600	5,100	29,610
Graham	7,800	4,380	9,753
Harlingen	48,405	6,450	43,275
Houston	2,411,953	459,310	1,673,913
Jacksonville	45,150	100	48,800
Kenedy	2,500	0	9,150
Kerrville	42,250	8,125	66,011
Longview	37,358	4,090	29,302
Lubbock	474,706	78,741	408,465
McAllen	140,725	17,850	89,640
Marshall	40,154	12,529	97,125
Midland	402,000	58,150	57,550
New Braunfels	29,239	7,465	53,594
Palestine	35,516	1,305	34,986
Pampa	26,000	3,900	38,425
Paris	55,450	3,725	29,975
Plainview	34,500	8,200	40,175
Port Arthur	165,414	20,360	85,543
San Antonio	1,628,090	408,768	1,377,514
Seguin	28,583	1,088	14,130
Sherman	49,700	10,365	24,927
Snyder	22,300	0	4,500
Sweetwater	44,010	110,610	19,880
Texarkana	61,662	41,150	69,775
Tyler	132,911	21,900	136,605
Waco	137,892	48,200	136,880
Wichita Falls	122,639	24,404	94,289
TOTAL	\$13,725,685	\$ 2,632,059	\$10,078,112

NOTE: Compiled from reports from Texas chambers of commerce to the Bureau of Business Research.

CEMENT

(In Thousands of Barrels)

	Oct., 1945	Oct., 1944	Sept., 1945
Texas Plants			
Production	812	520	685
Shipments	790	579	744
Stocks	659	848	638
United States			
Production	11,104	9,194	9,826
Shipments	13,303	10,263	11,211
Stocks	12,396	16,075	14,581
Capacity Operated	35.0%	45.0%	50.0%

NOTE: From U.S. Department of Interior, Bureau of Mines.

LUMBER

(In Board Feet)

	Nov., 1945	Nov., 1944	Oct., 1945
Southern Pine Mills:			
Average Weekly Production per unit	176,013	186,196	178,432
Average Weekly Shipments per unit	172,246	193,555	181,782
Average Unfilled Orders per unit, end of month	1,056,854	1,214,233	1,107,108

NOTE: From Southern Pine Association.

POSTAL RECEIPTS

	Nov., 1945	Nov., 1944	Oct., 1945
Abilene	\$ 28,334	\$ 48,293	\$ 32,017
Amarillo	55,133	59,942	64,836
Austin	92,083	111,646	105,705
Beaumont	48,925	52,931	50,797
Big Spring	9,400	11,518	14,894
Brownsville	11,118	11,736	13,219
Brownwood	18,230	27,270	18,717
Bryan	8,253	8,095	10,530
Childress	4,687	7,813	6,285
Cleburne	5,136	6,005	6,258
Corpus Christi	62,473	69,823	78,623
Corsicana	10,975	10,620	11,378
Dallas	630,427	622,341	659,605
Del Rio	4,411	6,329	5,672
Denison	9,197	11,003	10,711
Denton	12,026	11,685	15,083
Edinburg	5,120	4,683	5,984
El Paso	90,185	95,035	101,290
Fort Worth	278,647	287,619	321,445
Galveston	49,033	50,330	55,654
Gladewater	3,645	4,631	4,875
Graham	3,233	3,488	4,225
Harlingen	13,735	14,206	16,276
Houston	404,392	414,558	435,517
Jacksonville	4,878	4,718	5,991
Kenedy	1,996	1,857	2,271
Kerrville	4,059	4,168	5,403
Longview	13,076	15,052	15,665
Lubbock	29,509	40,127	43,518
McAllen	10,320	8,245	10,253
Marshall	10,351	10,758	12,361
Midland	12,109	13,016	19,747
Palestine	6,981	7,577	10,410
Pampa	8,799	10,710	12,027
Paris	10,827	23,481	14,640
Plainview	5,915	7,005	7,299
Port Arthur	23,465	26,846	26,982
San Angelo	23,525	22,938	30,192
San Antonio	254,081	260,668	290,797
San Benito	3,731	4,223	4,837
Sherman	13,841	13,015	16,940
Snyder	1,989	2,638	2,773
Sweetwater	8,249	7,336	7,816
Temple	14,761	16,106	17,296
Texarkana	22,552	28,261	33,038
Tyler	27,086	31,200	31,812
Victoria	9,449	11,559	13,230
Waco	55,242	53,243	64,492
Wichita Falls	45,544	44,666	56,340
TOTAL	\$ 2,481,133	\$ 2,621,013	\$ 2,805,726

NOTE: Compiled from reports from Texas chambers of commerce to the Bureau of Business Research.

NOVEMBER PERCENTAGE CHANGES IN CONSUMPTION OF ELECTRIC POWER

	Nov., 1945 from Nov., 1944	Nov., 1945 from Oct., 1945
Commercial	+ 6.2	- 6.0
Industrial	- 19.4	- 1.7
Residential	+ 19.6	+ 2.2
All Others	- 11.6	- 4.7
TOTAL	- 9.6	- 2.4

Prepared from reports of 9 electric power companies to the Bureau of Business Research.

TEXAS COMMERCIAL FAILURES

	Nov., 1945	Nov., 1944	Oct., 1945
Number	1	0	1
Liabilities*	\$2.3	0	\$1.7
Assets*	\$13.9	0	\$1.3
Average Liabilities per failure*	\$2.3	0	\$1.7

*In thousands.

Note: From Dun and Bradstreet, Inc.

Agricultural Census Tabulations

The Bureau of Business Research of The University of Texas several years ago sponsored a W.P.A. projects for the tabulation of Texas Agricultural Census data by counties for each of the census years 1900, 1910, 1920, 1925, 1930, and 1935; but work on the project was interrupted before the compilations could be put in form for publication. In the summer of 1945 provision was made for the completion of the project and the material will be ready for distribution in January, 1946.

The census year 1930, which was the most complete up to that time, was used as the basis for the chronological comparisons. The census had not been taken when this project was set up, but it has since been possible to add summary data from the 1940 census reports for a few of the tables as indicated in the titles included in the following list of tabulations:

- I. Farm Acreage by Types of Farms.
- II. Value of Farm Property by Types.
- III. Value of Farm Products Sold, Traded or Used.
- IV. Quantity of Specified Livestock by Types of Farms.
- V. Tenure of Farm Operator for Specified Types of Farms.
- VI. Expenditure for Feed, Fertilizer and Labor by Specified Types of Farms.
- VII. Units of Specified Farm Products Harvested.
- VIII. Acres Planted in Specified Farm Products.
- IX. Value of Vegetables Harvested for Sale.
- X. Acreage Planted in Vegetables Harvested for Sale.
- XI. Quantity of Specified Livestock Products.
- XII. Value of Specified Livestock Products (Includes 1940 data).
- XIII. Irrigated Farms.
- XIV. Crops Grown on Irrigated Land—1930.
- XV. Farm Mortgage Debt and Farm Taxes (Includes 1940 data).
- XVI. Farm Machinery, Facilities, and Loans (Includes 1940 data).
- XVII. Types of Farms by Size.
- XVIII. All Farms Classified by Size—Comparative (Includes 1940 data) Acreage Groups.
- XIX. Types of Farms by Value of Products Sold, Traded, or Used by Operator's Family.
- XX. Manufactures and Agriculture (Includes 1940 data).

The foregoing tabulations may be secured for the nominal cost of materials and processing in either of three options:

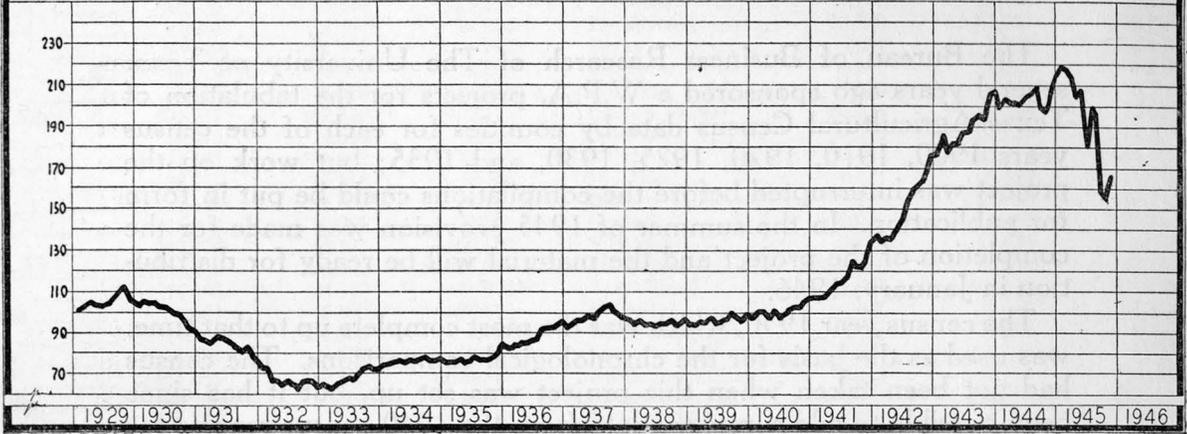
- Option (1) \$1 for all 20 tables of figures for a given county.
- Option (2) \$2 for a single table of figures for each of the counties of the State; or 254 tables.
- Option (3) \$15 for all 20 tables for all of the 254 counties; or a total of more than 5,000 tabulations.

INDEXES OF BUSINESS ACTIVITY IN TEXAS

AVERAGE MONTH OF 1930 = 100

WEIGHT IN COMPOSITE INDEX			
EMPLOYMENT	25	MISCL FREIGHT CARLOADINGS	20
PAYROLLS	25	CRUDE OIL RUNS	5
DEPARTMENT STORE SALES	10	ELECTRIC POWER CONSUMPTION	15

• COMPOSITE INDEX OF BUSINESS ACTIVITY IN TEXAS •



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