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Chapter 15

Petroleum and Coal Products

THE petroleum and coal products group consists of five industries: petroleum refining; lubricants, not elsewhere made; oils, not elsewhere classified; [1] coke-oven products; and fuel briquettes. The manufactured gas industry, formerly included in this group, was dropped from the Census of Manufactures in part after 1931, and entirely after 1935. We have excluded it from the data for all years.

Although the group's output increased at a rapid rate, in 1937 it surpassed only beverages, leather products, rubber products and miscellaneous products in terms of value added.

TRENDS IN THE PHYSICAL OUTPUT OF THE PETROLEUM AND COAL PRODUCTS INDUSTRIES

Petroleum Refining is an industry engaged in the refining of crude petroleum by distillation. The classification does not cover the compounding of refined petroleum products or the production of gasoline from natural gas at the wells. The output of the industry increased at an extremely rapid rate (Table 44 and Chart 17); in 1937 it was more than 20 times as great as it had been in 1899. In the first decade output came close to doubling; it tripled in each of the next two decades, and rose by a fifth even in the latest period.

[1] Oils, not elsewhere classified, is placed by the Bureau of the Census in the chemical products group. We have classified it under petroleum and coal products because prior to 1929 it included establishments producing lubricants (see Table 46, below).

The acceleration of the rate of output of the petroleum refining industry in the early part of the century, and the later retardation, reflect the influence of automobile development. The advent of the automobile contributed also to a revolu-

TABLE 44

PETROLEUM AND COAL PRODUCTS[a]
Physical Output: Indexes and Percentage Changes[b]

	Petroleum Refining	*Coke-Oven Products*	*Fuel Briquettes*	*Total*	
				Unadjusted	Adjusted
YEAR	INDEX OF PHYSICAL OUTPUT (1929:100)				
1899	5.9	18	..	7.5	8.7
1904	7.2	23	..	9.3	10.2
1909	11	38	7.9	15	16
1914	17	38	16	20	21
1919	34	61	21	38	39
1921	40	43	29	41	41
1923	56	89	54	62	64
1925	73	81	59	74	75
1927	81	84	72	82	83
1929	100	100	100	100	100
1931	91	55	50	83	84
1933	86	43	37	78	78
1935	99	58	64	91	92
1937	119	87	79	113	114
PERIOD	NET PERCENTAGE CHANGE IN PHYSICAL OUTPUT				
1899–1937	+1,920	+380	..	+1,408	+1,206
1899–1909	+86	+110	..	+97	+85
1909–1919	+209	+60	+166	+155	+143
1919–1929	+194	+63	+376	+165	+156
1929–1937	+19	−13	−21	+13	+14

[a] Industries for which there are no adequate quantity data for any of the above periods are: lubricants, not elsewhere made; and oils, not elsewhere classified. These industries are covered by the adjusted total.

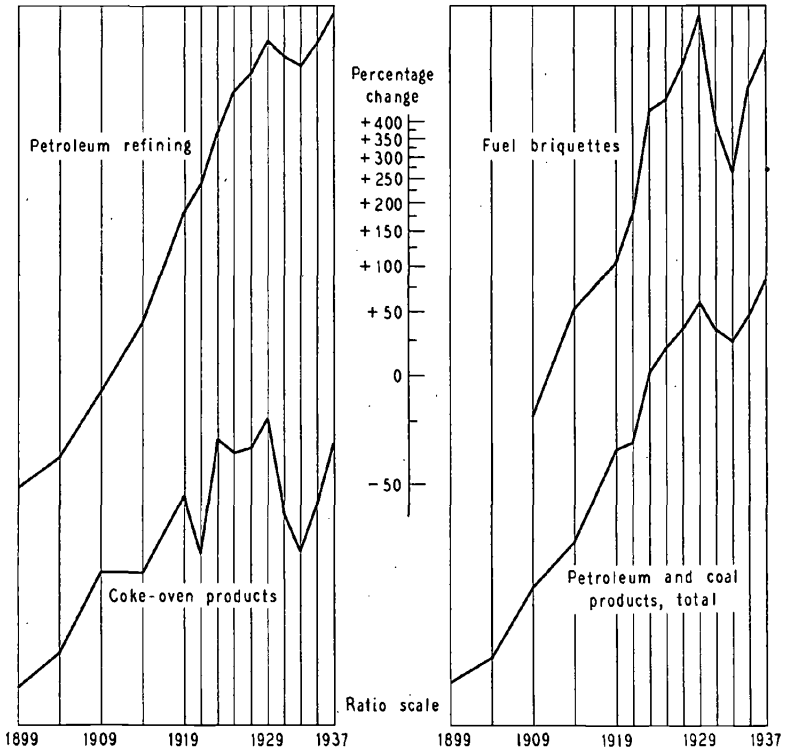
[b] The indexes have been constructed from basic data in the U.S. Census of Manufactures and in reports of the U.S. Bureau of Mines, by methods described briefly in Chapter 2 and in detail in Appendix A. Appendix B presents these data, together with the indexes derived from them. The indexes cited here for individual industries have been adjusted to take account of changes in the coverage of the respective samples.

The percentage changes are not always entirely consistent with the indexes given above because the changes were computed from the indexes in Appendix B, which are carried to one decimal place.

Chart 17

PETROLEUM AND COAL PRODUCTS

Indexes of Physical Output



tionary transformation of the composition of the industry's output. The chief products, in selected years, were:

	Quantity (billion gallons)					*Percentage Distribution*				
	1899	1909	1919	1929	1937	1899	1909	1919	1929	1937
Light products of distillation (incl. gasoline)	0.28	0.54	4.11	18.4	22.9	14	12	27	48	50
Illuminating oils (incl. kerosene)	1.26	1.67	2.31	2.34	2.51	63	38	15	6	5
Fuel oils	0.30	1.70	7.77	16.4	19.2	15	38	52	42	42
Lubricating oils	0.17	0.54	0.82	1.55	1.52	8	12	6	4	3
TOTAL	2.01	4.45	15.0	38.7	46.2	100	100	100	100	100

In 1899 the most important products were kerosene and other illuminating oils. The latter rose in output between each of the years specified; yet in 1909 and later years illuminating oils were exceeded in quantitative importance by the more rapidly growing fuel oils, and in 1919 and subsequently by light products of distillation as well. By 1929 the light products had become the most important segment of the industry's output. In 1937 the output of light products was over 80 times the 1899 output; the 1937 output of fuel oils was 64 times the 1899 output; the 1937 output of lubricating oils was nine times the 1899 output; and the 1937 output of illuminating oils was twice the 1899 output.

The radical change in the composition of the industry's products came about through successive improvements in the technical processes employed. In the very early years of the century a rather simple distilling operation, known as "topping" or "skimming," was generally employed to separate the light oil products from the heavy. This process seldom yielded more than 10 percent of gasoline from each barrel of crude oil. The skimming process was improved upon by "straight run" distillation. First introduced successfully in 1899, the new method separated some 25 percent of the gasoline at the maximum. In 1914 the "cracking" process came into commercial use. Instead of merely separating out the gasoline, this process actually creates more gasoline by breaking down the nongasoline molecules into lighter molecules (gasoline) and heavier molecules. The maximum proportion of gasoline obtainable was now raised to between 60 and 65 percent of the crude oil used, and the product itself was greatly improved in quality.[2]

[2] Zimmermann, *op. cit.*, pp. 510–13; Fraser and Doriot, *op. cit.*, pp. 425–30; B. Guthrie, Herbert Schimmel, *et al.*, "Technology, Employment, and Output per Man in Petroleum and Natural-Gas Production," *Report No. E–10* (National Research Project in cooperation with the Bureau of Mines, July, 1939), Chapter 10.

The rise of the cracking process contributed also to the industry's net output by decreasing the amount of purchased fuel consumed in its operations. By-products of the cracking process, such as refinery gas and fuel oil, replaced in large measure the outside fuels formerly purchased. The saving thus effected, plus other savings of fuel arising from the use of improved refining techniques which require less heat per barrel of oil treated, may be gauged by the decline in fuel used per barrel of oil. In 1909, 860,000 British thermal units of fuel were consumed per barrel of crude oil run to stills; in 1937 the corresponding figure was 607,000.[3]

Coke-Oven Products. In comparison with the progress made in the petroleum refining industry, the rise in the output of coke-oven products seems moderate, despite the increase of 380 percent between 1899 and 1937. Output doubled in the first decade (rising more rapidly than petroleum refining), rose 60 percent in each of the next two decades, and fell 13 percent in the period 1929–37.

Coke manufacturing affords a striking illustration of the trend toward increased utilization of by-products. In 1904 (the first year for which such data appear in the Census), "beehive" ovens produced close to 90 percent of all the coke made in the industry and thereby wasted 90 percent of the volatile constituents of all the coal distilled. Only one tenth of the coke produced in 1904 was made in ovens which retained the by-products. By 1937 the proportions were reversed, and over 90 percent of the coke was produced in by-product ovens. As a consequence of this change in the method of manufacture, the entire output of the industry, including coke and by-products, increased 380 percent from 1899 to 1937, whereas its output of coke alone rose only 150 percent. This trend toward better utilization of the fuel consumed by the industry was furthered also by more efficient operation of by-product ovens. Thus, of the total number of British ther-

[3] Guthrie, Schimmel, *et al., op. cit.,* p. 343.

mal units in the coal charged into by-product ovens in 1913, 80 percent was recovered in the form of coke and by-products; in 1936 the percentage was 86. Reflecting both this improvement and the shift from the beehive to the by-product oven are the percentages for the recovery from coal charged into all types of coke ovens: 62 in 1913 and 85 in 1936.[4] Coal is, of course, an extremely important material in the coke industry: in 1914 the cost of coal used amounted to 65 percent of the total value of products. Savings of the magnitude indicated by the above figures suggest that the index of net output of the industry rose considerably more rapidly than the index of gross output given in Table 44.[5]

Summary. The output of the petroleum and coal products group as a whole increased at an accelerating rate between 1899 and 1929, then leveled out somewhat in the last period. Since the unadjusted group index includes the output of the petroleum-refining industry, which was gaining very rapidly, adjustment of the index for the industries omitted reduces the rise shown by the index for 1899–1937 from 1,400 percent to 1,200 percent.

Both petroleum refining and coke-oven products increased their output more rapidly than total manufacturing over the period 1899–1937 taken as a whole. In the last period coke-oven products and fuel briquettes fell in relation to the total. When compared with population growth, the output of each industry rose in every period except the last.

CHANGES IN THE INDUSTRIAL PATTERN OF PETROLEUM AND COAL MANUFACTURE

Since the petroleum refining industry grew in output more rapidly than the entire group, it effected an appreciable

[4] N. Yaworski, V. Spencer, G. A. Saeger and O. E. Kiessling, "Fuel Efficiency in Cement Manufacture," *Report No. E–5* (National Research Project, April 1938), pp. 6–7, 70–71.

[5] Indeed it may be estimated roughly that from 1914–19 to 1933–35 net physical output rose some 40 percent more rapidly than gross physical output.

TABLE 45

PETROLEUM AND COAL PRODUCTS

Relative Contributions of Component Industries to the Physical Output of the Entire Group[a]

Industry	*Percentage Distribution, Comparable Pairs of Years*									
	1899	1937	1899	1909	1909	1919	1919	1929	1929	1937
Petroleum refining	47.1	80.4	46.9	47.1	56.0	71.5	71.0	81.5	77.1	80.9
Coke-oven products	34.8	14.1	35.2	39.9	30.8	20.4	21.0	13.4	17.5	13.4
Fuel briquettes	18.0	5.4	17.9	13.0	0.1	0.2	0.2	0.3	0.5	0.3
All other					13.0	8.0	7.9	4.8	4.9	5.3
TOTAL[b]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] Derived from Table 44. For an explanation of the derivation of the measurements see footnote 10, Chapter 4.

[b] The columns do not add up to 100.0 in every instance because they contain rounded percentages.

TABLE 46

PETROLEUM AND COAL PRODUCTS

Relative Contributions of Component Industries to the Value Added by the Entire Group[a]

Industry	*Percentage Distribution*				
	1899	1909	1919	1929	1937
Petroleum refining	46.8	47.1	74.2	77.5	80.5
Lubricants, n.e.m.[b]	0.9	0.9	0.8	4.7	3.1
Oils, n.e.c.[d]	17.1	12.1	7.2	1.5	2.2
Coke-oven products	35.2	39.6	17.8	15.8	13.9
Fuel briquettes	[e]	0.2	0.1	0.4	0.4
TOTAL[f]	100.0	100.0	100.0	100.0	100.0

[a] Basic data are given in Appendix C.

[b] N.e.m. denotes not elsewhere made.

[c] Between 1927 and 1929 establishments producing lubricating oils were transferred from oils to the lubricants industry.

[d] N.e.c. denotes not elsewhere classified.

[e] Not shown separately.

[f] The columns do not add up to 100.0 in every instance because they contain rounded percentages.

change in the pattern of the group's output (Table 45). In 1899 the petroleum refining industry accounted for less than half of the group's physical output. In 1937 the fraction had risen to eight tenths. The contribution of coke-oven products fell from 35 to 14 percent, and of the other industries, from 18 to 5 percent. The most marked changes in group composition occurred in the second decade.

Data on the relative contributions of the individual industries to the value added by the group, shown in Table 46, tend to reproduce the pattern outlined in Table 45.