hydrocarbons. Happily, effective mechanical means for removing this carbon have been developed in the large-scale commercial operation, so that in equipment for production on a commercial scale carbon deposition is not a serious factor. The percentage of carbon formed in the experiments was determined by scraping the interior of the tubes after each run or experiment and weighing the solid matter thus removed. The values thus obtained for the various oils used are given in table 12, following.

TABLE 12.—*Results of cracking four oils under various conditions of temperature and pressure showing percentage of carbon formed.*

Furnace conditions.		Percentage of carbon formed from original oil from—				Average proportion recovered.
Temperature.	Pressure.	Pennsylvania.	Oklahoma.	California.	Mexico.	
° C.	*Atmospheres.*					
850	1	7.4	.....	.....	.....	7.4
850	(a)	.....	5.8	7.1	.....	6.4
800	(a)	.....	4.1	6.9	.....	5.5
750	12	24.3	24.6	38.8	.....	29.2
750	6	15.3	20.0	36.2	.....	23.8
750	1	3.7	11.3	9.9	.....	8.3
750	(a)	16.1	4.1	8.7	10.5	13.1
650	(a)	.....	2.2	.....	.....	2.2
600	24	7.5	17.2	26.7	.....	17.1
600	18	5.3	13.2	27.5	.....	15.3
600	12	3.6	6.7	19.3	13.1	10.7
600	6	2.4	9.6	16.2	.....	9.4
600	1	0.6	3.1	12.3	16.4	8.1
600	(a)	0.0	.....	13.6	9.0	7.5
550	24	.....	9.2	21.1	.....	15.1
550	18	.....	7.0	.....	.....	7.0
500	24	1.2	4.6	11.7	.....	5.8
500	18	0.0	.....	.....	.....	0.0
500	12	0.0	1.4	14.5	16.2	8.0
500	6	0.0	1.2	10.1	.....	3.8
500	1	0.0	0.0	3.7	9.8	3.6
500	(a)	6.0	0.0	11.9	.....	5.9
450	18	.....	0.0	.....	.....	0.0
450	12	5.1	0.0	2.3	.....	2.5
400	10	.....	.....	.....	13.8	13.8

a Vacuum.

The amount of carbon formed, together with the volume of evolved fixed gases, is a valuable index of the percentage of total decomposition as contrasted with a partial alteration or cracking.

The differences among percentages of carbon formation may be attributed to variations in both the physical and the chemical properties of the oils studied. In the first place, the average size of the hydrocarbon molecules differed widely, the heavier oils containing a larger percentage of high-boiling constituents which were decomposed more rapidly by heat and formed higher percentages of carbon and fixed gases. The asphaltic-base California and Mexican oils show a consistently higher carbon percentage at the varying temperatures than the paraffin-base Pennsylvania oil. The mixed-base Oklahoma oil is intermediate. The Pennsylvania oil, which consistently deposited the least carbon, was a water-white burning oil

(kerosene), 90 per cent of which distilled over at a temperature of less than 250° C. The Oklahoma fuel oil gave a distillation cut of 22 per cent below 300° C., and the California oil gave a cut of only 17 per cent below 300° C., whereas the Mexican crude, which was "lighter" than the California oil, gave a distillation cut of 37 per cent below 300° C. This Mexican oil seemed to have the peculiar physical property of causing considerable heavy tarry material to

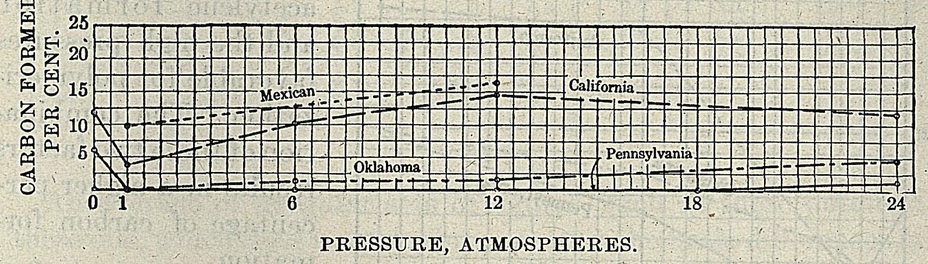

FIGURE 15.—Curves showing percentages of carbon formed from cracking four oils under varying pressures at 500° C..

be included in the carbon deposit, so that the figures for carbon formation are high, and the figures for yields of recovered oil and the specific gravities of these oils are correspondingly low. However, experience with the larger tubes has served to indicate that on a larger scale much more favorable results can be expected with this oil than were obtained with the small 1½-inch tubes of the experimental apparatus. The characteristic difference is shown by figures 15, 16, and 17.

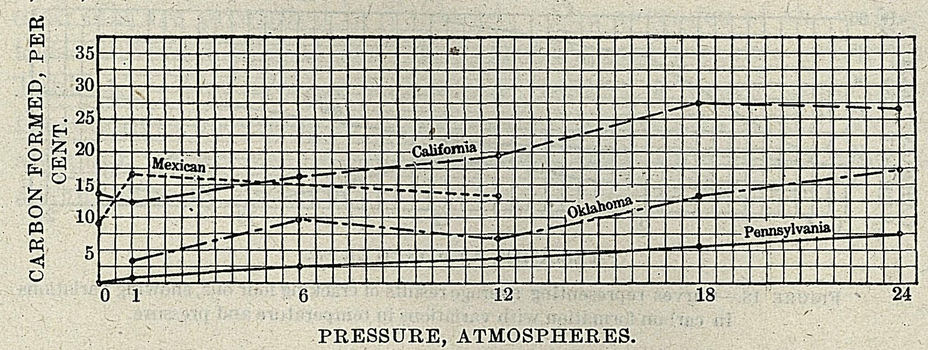

FIGURE 16.—Curves showing percentages of carbon formed from cracking four oils under varying pressures at 600° C.

The increase in the amount of carbon formation at the temperatures favorable to the manufacture of aromatic hydrocarbons as compared with the relatively lower percentages of formation under the conditions favorable for gasoline formation, is probably to be explained on the theory that production of gasoline by cracking is a simple dissociation process. In the production of aromatic hydrocarbons it is necessary in a considerable degree both to break down the larger molecules to ethylene or acetylene hydro-