plotted in figures 31, 32, and 33, which show the percentage yields of the low-boiling aromatics at constant temperatures of 500°, 600°, and 750° C.

Figure 32, which shows the most satisfactory results for the three temperatures plotted, illustrates the close agreement when three oils of widely different characteristics were treated under favorable conditions. At a pressure of 18 atmospheres (270 pounds per square inch) there was an approximate difference of only 1 per cent among the percentages of aromatic hydrocarbon recovered from the oils.

The use of pressure favors the formation of aromatic hydrocarbons, and the general results seem to indicate that a pressure of 10 to 15 atmospheres gives the best results. The relative influences of temperature and pressure are indicated in figure 34. Here the average yields of the three oils at the three temperatures of 500°, 600°, and

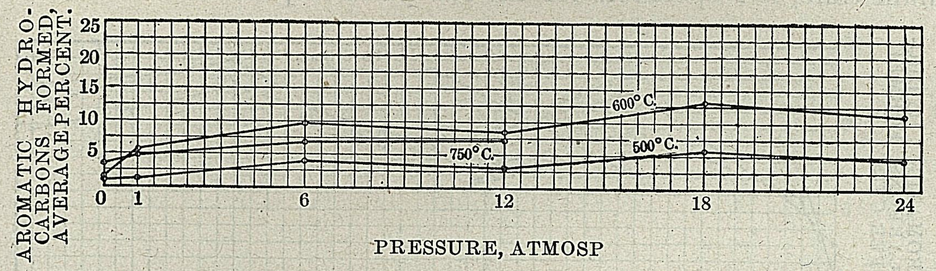

FIGURE 34.—Curves representing average results of cracking oils, showing influence of varying temperatures and pressures on formation of combined aromatic hydrocarbons (benzene, toluene, and xylene). Results for higher pressures low, owing to oil consumed in building up pressure.

750° C. and at pressures of 1 to 24 atmospheres are plotted. The progressive increase in yields with pressure is clearly evidenced.

Table 28, showing a summary of the results of cracking four different oils under varying conditions of temperature and pressure, is presented below:

TABLE 28.—*Summary of results of cracking oils under varying conditions of temperature and pressure, showing average percentages of aromatic hydrocarbons formed.*[a]

Pressure.	Average percentage of aromatic hydrocarbons formed at temperatures of—							
	450° C.	500° C.	550° C.	600° C.	650° C.	750° C.	800° C.	850° C.
Atmospheres.								
(b)	.....	0.7	.....	1.4	1.4	3.4	5.9	4.3
1	.....	1.2	.....	5.6	.....	4.9	.....	2.4
6	.....	4.0	.....	9.7	.....	6.9	.....	.....
12	1.8	3.0	.....	8.3	.....	7.1	.....	.....
18	3.3	5.6	7.3	13.1	.....	.....	.....	.....
24	.....	4.4	6.2	11.1	.....	.....	.....	.....

[a] Results for higher pressures low, owing to oil consumed in building up pressure.
[b] Vacuum.

CONCLUSIONS AS TO FORMATION OF AROMATIC HYDROCARBONS.

The data given establish that, as in gasoline formation, all types of petroleum oils, from light distillates to the heaviest residuum, including heavy asphaltic-base oils, can be made to yield aromatic hydrocarbons in commercial quantities. The residuum above the lower-boiling aromatic fraction can be rerun, and the aggregate yields from a given quantity of original oil can be proportionately increased.

The favorable conditions for aromatic formation seem to be high temperatures and moderate pressures. In commercial work a temperature ranging between 625° and 700° C. and a pressure of upward of 8 atmospheres will generally be most suitable.

GENERAL SUMMARY OF LABORATORY EXPERIMENTS.

The results of the experiments described led to the following conclusions:

In procuring the desired products of the cracking reaction, the physical and chemical properties of an original oil are of secondary importance compared with the influence of temperature, pressure, time, and concentration.

Under like conditions, practically identical results have been obtained from five different oils, and the differences reported may be attributed, in part, as much to variation in rate of reaction as to the actual production of dissimilar equilibrium products. One exception noted relates to the production of carbon, a residual product, the formation of which seems to be proportional to the quantity contained in the original oil. Viscosities and specific gravities of the oils obtained show in some measure the influence of the properties of the original oils, but the differences are only slight and can perhaps be explained by the system not having been allowed to reach complete equilibrium.

The experiments have indicated the commercial possibilities and advantages of hydrocarbon reactions carried out in a cracking chamber composed of a vertically arranged tube, when the products to be treated are in a gaseous state and are cracked in an atmosphere of decomposition products. The results obtained with large-scale equipment, subsequently described, have demonstrated the correctness of these conclusions.

AROMATIC HYDROCARBONS USED IN MAKING EXPLOSIVES.

The war in Europe has created an enormous demand for benzene and toluene as raw materials for the manufacture of explosives. Toluene, which normally sells for less than 25 cents a gallon, can not be bought in quantity at present (November, 1915) at $5 a gallon.