

nected with the vapor line, in which the more readily condensable liquids are collected. The gases which remain uncondensed at this point pass upward through a 3-inch U-shaped iron pipe into a twin water-cooled condenser consisting of 3-inch copper pipes incased in iron pipes through which water is continually circulated. The liquids which are condensed pass by gravity into what is called the secondary separator. The fixed and uncondensed gases are discharged into a gas header on the upper floor of the furnace building by means of a 1½-inch pipe whenever the pressure on the system exceeds the predetermined pressure. The primary separator is 8½ inches in diameter by 3 feet 4 inches in height. The secondary separator is 10¼ inches in diameter by 5 feet 6¼ inches in height. These separators hold as much liquid as will be condensed during a run of the duration permitted by the capacity of the carbon receptacle. The twin water-cooled condensers are approximately 7 feet 10 inches in height and have an internal-wall area of approximately 10 square feet.

#### FATAL ACCIDENT DUE TO TAPPING CONDENSERS WHILE UNDER PRESSURE.

In the operation of the plant it has been the practice to keep the liquid products from the various tubes separate until after suitable laboratory tests and determinations were made, after which the combined products were discharged into a header and pumped to the storage tank to await distillation. In order to tap the condensers with safety, in view of the pressure on the system, ranging from 150 pounds to 250 pounds per square inch, it has been the custom to release the pressure before opening the cadmium valves for the discharge of the liquid. Explicit instructions were given from the beginning of operations for the observance of this precaution. The one time when orders were not followed and the separators tapped while the system was under pressure resulted in an accident fatal to five of the company's employees. The uncondensed gases were expelled under high pressure from the condenser, and immediately caught fire, thus igniting the oil-spattered clothing of the men. While this accident was most deplorable, such accidents may happen in any industrial establishment when prescribed safety precautions are not followed, and is in no wise to be attributed to any inherent danger in the use of the process itself.

#### INADEQUACY OF CONDENSER INSTALLATION.

The inefficiency of the condensers, which led to the installation of a large-size condenser and gas scrubber, is shown by the amount of aromatic hydrocarbons in the oil immediately on leaving the condenser and the amount in the same oil after it had been exposed to

the air in open barrels, in which it was customary to store it temporarily. It was found that between 30 and 50 per cent of the low-boiling aromatic hydrocarbons formed in the tube had evaporated while the oil was allowed to stand in contact with the air. The significance of this loss has been shown in the discussion of the data contained in Table 57. Some liquid was mechanically carried over by the gases and did not condense in the individual condensers.

The volume of gas formed in the cracking process is so great that a very considerable percentage of both light and heavy oils is mechanically carried over and does not yield readily to condensation. Traps were placed in the gas line, into which the uncondensed gases were discharged, and analyses have been made for a number of different runs. It was found on distillation from the traps that 50 to 60 per cent boiled over below 175° C., in which cut the benzene content ranged from 5 to 21 per cent and the toluene content from 8 to 25 per cent.

In the effort to further determine the amount of products which had been lost in this manner, the gas issuing from the header was passed through a scrubber with the result that large percentages of benzene and toluene were recovered. These losses, it will be observed, are in addition to the losses by evaporation from the recovered oil taken from the separators.

A table showing the percentages of benzene and toluene in the so-called header oil is inserted for the purpose of showing the extent of the losses which resulted during the time covered by this publication and of indicating clearly the need of adequate condensing and scrubbing apparatus.

*Benzene and toluene in header oil.*

Percentage of oil distilling up to 175° C.	Specific gravity of distillation cut.	Percentage of benzene in header oil cut to 175° C.	Percentage of toluene in header oil cut to 175° C.
72	0.844	8.9	12.0
63	.860	21.0	25.0
66	.890	8.9	13.2
58	.838	11.0	16.0
49	.842	5.4	8.8
49	.868	7.8	10.8
60	.865	10.8	14.4
53	.870	9.0	12.2

It will hardly be credited, perhaps, that operations were permitted to continue for such a length of time without making suitable provision for the complete condensation and separation of the liquid products from the permanent gases. The chief factor in this situation was the continued desire to study the results accomplished by the individual tubes, which would not have been possible had the