CHAPTER VII.

CONTROL & RESEARCH LABORATORY.

PILOT PLANT CONVERTERS AND INVESTIGATIONS.

A. CONTROL & RESEARCH LABORATORY.

In the Laboratory the various starting materials for manufacturing the catalyst are very carefully analyzed and further a minute control is performed on the preparation of the catalyst in the catalyst plant, although this plant itself analyzes the liquids handled during the manufacturing processes. Although in this way an excess of impurities, etc. is easily detected, and can be corrected forthwith, it occurred that the catalyst produced proved to be unsatisfactory. Therefore, the laboratory has the task of taking samples of the purified solution and precipitating the cobalt and the oxides on Kieselguhr, whereafter the catalyst manufactured in this way is tested in specially built laboratory converters.

These consist of glass tubes of about 5/8" dia., placed in sets of 3-8, mostly 6-8, in an aluminium electrically-heated oven, with a special arrangement to keep the temperature constant. Synthesis gas is led over the catalyst and the condensed liquids are measured and analyzed periodically. In the laboratory more than 200 samples of catalyst are tried out simultaneously, part of which originate from catalyst plant solutions, part being tried out for research purposes.

The first-mentioned tests are run for some weeks only; of the latter some samples were running for more than a year.

It was stated that in this way the manufacturing process of the catalyst plant can be controlled without

unexpected failures.

The price of one oven block together with temperature control is about RM 500.-

Separate from this, similar apparatuses are used for investigating lifetime and yield of different types of catalyst under pressure.

As an example of the investigations in progress it was mentioned that catalysts are being tested having only half the amount of CO as compared with the normal catalysts. Results look promising, but no final conclusions can as yet be drawn as to their lifetime.

B. PILOT PLANT CONVERTERS AND INVESTIGATIONS.

Five pilot plant converters are housed in a building of about 12 x 16 m. These converters are of different size and construction and have different capacities. Each of these converters will be discussed briefly.

1. Same construction as the high pressure commercial converters, but 1/10th of their size.

Tubes consist of an inside and outside tube with the catalyst in between; inside diameter of outside tube 54 mm, outside diameter of inner tube 34 mm; (see Annex A, fig. 13 B).

converter diameter	1.30 m	
catalyst volume	1,000 L	
gas rate	100 m3/h	on day when visiting this plant.
pressure	3 atm.	on day when visiting this plant.

2. Converter diameter	900 mm	
height	2½ m	
catalyst volume	400 L	
gas rate	40 m3/h	on day when visiting this plant.
pressure	7 atm.	on day when visiting this plant.

Tubes of 34 mm having a thin metal sheet pressed into them and spot welded on three sides (see figure 13 A, Annex A). Catalyst filling entire space inside of tube.

3. Converter diameter	about 900 mm	
height	2½ m	
catalyst volume	300 L	
gas rate	30 m3/h	on day when visiting this plant.
pressure	5 atm.	

Tubes 10 mm diameter.

This small converter already contained 1550 tubes. It was calculated that a commercial-size converter of this type would contain 35 km tube length of this diameter. It would take the entire Mannesmann outfit 4 years to manufacture enough converters of this type for a plant like the one of Ruhrchemie.

4. Converter diameter	about 1200 mm	
height	2.4 m	
catalyst volume	805 L	
gas rate	80 m3/h	on day when visiting this plant.
pressure	5 atm.	

Tubes: same construction as those of the commercial high pressure converters and the pilot plant converter mentioned under 1.; however, the diameters in this case were 44 mm inner diameter of outside tube, 24 mm outside diameter of inner tube.

5. Converter diameter	900 mm
height	1.30 m
catalyst volume	300 L

This converter was not in operation when visiting the plant. It has a peculiar design in so far that it consists of two metal sheets welded together on the 4

sides, but leaving a small volume in between and then wound like a spring. (See fig. 13 E, Annex A).

Cooling is done by water circulating inside the two metal sheets welded together, the catalyst filling up the entire space of the spring-like wound metal sheets and the largest distance between the two sheets being 10 mm. This is, therefore, the same kind of construction as used for "Imperial" coolers.

The cooling in all these experimental converters is done by water and the temperatures are controlled in the usual way by steam pressure, the boilers being designed as vertical tubes with a diameter of 8" and a working pressure up to 50 atm.

We were told that the best cooling was obtained in those converters where catalyst had water on both sides (inside and outside as in the converters mentioned under 1, 4 and 5).

Most experiments had been made at 5, 7 and 10 atm. The higher the pressure the heavier the product produced and the less gasol and CH_4 obtained.

At higher gas rates lighter products are obtained.

When doubling the gas rate the "Leistung" is increased about 1.5 times, when leaving the temperature the same, or 1.8 times, when increasing the temperature to maintain the same CO conversion. In the latter case relatively more CO is lost as CH_4. Rough figures given in this respect:

1. 100 m3 gas/hour	185°C.	75% CO conversion	
2. 200 " " "	185°C.	say 58% "	"
3. 200 " " "	say 200°C.	75% "	"

In case 3 more CH_4 and in case 2 about the same amount of CH_4 is produced as compared with case 1.

An experiment was made with one of the pilot plant converters to see whether the reaction heat could be removed by adding tail gas to the fresh feed and circulating this tail gas back into the reactor via a cooler. It was found that about 5 times the amount of fresh feed as tail gas was sufficient to prevent any evaporation of the water left inside the cooling tubes in the reactor.