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DEVELOPMENT OF THE PETROCHEMICAL INDUSTRY IN CZECHOSLOVAKIA[1]

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The petrochemical industry in Czechoslovakia began to develop after the large scale import of crude oil started. The first petrochemical units based on crude oil products were brought on stream in 1961. At the present time, crude oil and natural gas create the very important raw material basis of the modern chemical industry and have a considerable effect on the industrial development and living standard of our country. The petrochemical industry can be split into the following basic groups:

1. the production of olefins and the ensuing processing of ethylene, propylene and C_4-fractions;
2. the production of aromatics and the ensuing treatment of benzene, toluene and xylenes;
3. the production of synthesis gas and the ensuing production of ammonia, urea, methanol, with eventually a parallel production of acetylene, or even ethylene and their further treatment.

1. The production of olefins and the ensuing technologies

The first olefin unit in Czechoslovakia was started in 1961 in Most, based on own technological data obtained from the laboratory and the pilot plant research, engineered and executed by Czechoslovak companies.

The raw material is refinery gas and straight run naphtha 40 - 180°C. The original capacity of 50,000 tons/year was increased to 60,000 tons/year ethylene. The gas separation is based on the absorption method using a butane-butylene fraction as the absorption medium. The ethylene has a purity of not more than 99 per cent by weight and is used for the production of synthetic ethanol by the direct hydration process and for the production of ethylbenzene which is used to manufacture styrene.

The ethylene unit is operated under mild conditions and therefore a considerable quantity of propylene is produced. The propylene is used for the production of 24,000 tons/year oxoalcohols, i.e. n- and i-butanols and 2-ethyl-hexanol.

The butadiene-butylene fraction containing about 22 per cent butadiene which is isolated by extraction with cupro-ammonium acetate solution.

Two years later, a new unit for the production of olefins with a capacity of 75,000 tons/year ethylene started production at Bratislava in connexion with the new refinery being erected. This unit is more advanced than the first one, both in pyrolysis technique and in the separation of gases. The pyrolysis

section was erected by Czechoslovak firms. The separation of the pyrolysis gases is based on the principle of low temperature demethanation by distillation and was carried out by Humphreys & Glasgow Ltd. The raw material for this plant is straight run naphtha 40 – 180 °C and refinery gases. Olefins of polymerization grade purity are produced and used for the production of 32,000 tons/year polyethylene, 24,000 tons/year ethylene-oxide and ethylene glycols and the propylene obtained is used for the production of 30,000 tons/year of phenol by the cumene route.

Butadiene from the butadiene-butylene fraction is similarly isolated and used for the rubber production in a synthetic rubber factory.

To cover raw materials for the production of plastic materials and other chemicals in the future, it will be necessary to erect a big olefin unit, having a capacity of 300,000 tons/year ethylene by 1975 and later a further unit with a similar capacity. One of the problems will be the question of raw materials. The raw material for these units cannot be covered by the straight run naphtha only. It will be necessary to utilize higher distillates in the range of gas oil for the production of olefins. The new ethylene units have therefore to be designed with a higher raw material flexibility.

Another problem connected with the erection of a petrochemical complex based on a large capacity ethylene unit are the high investment costs for the separation units following the olefin production: in agreement with these facts the erection of both new ethylene complexes in Czecholsovakia is considered splitting the units between various factories interconnected by ethylene pipelines and means of propylene and C_4 transportation.

The new ethylene plant will be based on refinery gases, straight run naphtha and gas oil. The pyrolysis will be carried out under severe conditions with high ethylene yields for straight run naphtha in the order of 33 per cent wt. and for gas oil in the order of 24 per cent wt. At the same time, maximum yields of butadiene are required for the production of synthetic rubber.

The ethylene and propylene production will be oriduced in the ratio of 2 :1 with a certain amount of flexibility to cover the market requirements. The olefin plants will be designed to generate their own steam and will be equipped with steam driver turbocompressors.

To use the ethylene existing units will be expanded and new processes introduced:

(a) high density polyethylene 40–60,000 tons/year

(b) vinylchloride 100–150,000 tons/year

(c) vinylacetate 30–50,000 tons/year

(d) acetaldehyde 50–100,000 tons/year

(e) ethylene–propylene ter polymers 30,000 tons/year.

(a) High density polyethylene is expected to be produced on the basis of Ziegler catalysts, enabling a variety of grades of polyethylene to be produced.

(b) Vinylchloride will be produced only from ethylene and chlorine, using thermal cracking of dichlorethylene, produced by direct chlorination as well as oxichlorination of ethylene.

(c) The present vinylacetate plant has to be replaced by a process based on ethylene.

(d) Acetaldehyde production has to be carried out in order to create the raw material basis for the production of higher alcohols, acetic acid and other chemicals.

(e) The actual capacity and development of ethylene–propylene ter-polymers will depend on the future technical development of the process, as well as on the solution of some application problems.

Expansion of existing units:

With regard to existing processes, the main increase in capacity is expected to be in the production of low density polyethylene in the order 60,000 tons/year in approximately two units. Also the production of ethylbenzene is to be increased. The amount of the increase will be related to the process finally selected for making propylene oxide.

The production of ethyleneoxide is to be expanded by 40–50,000 tons/year.

Propylene will be utilized in the following chemical processes:

(a) Expansion of the production of oxo alcohols by 60,000 tons/year. An advanced process is required giving a maximum ratio of n-butyraldehyde to isobutyraldehyde. The alcohols produced will cover the required production of plasticisers for PVC compounding.

(b) Expansion of the production of polypropylene by 60,000 tons/year in two units.

(c) The production of propylene oxide and propylene glycols with a capacity of about 30,000 tons/year propylene oxide, based on a non chlorine process.

(d) The production of acrylonitrile with a capacity of about 30,000 tons/year, using amooxidation of propylene. This unit will be erected at a relatively later date.

(e) Other chemicals like polypropylene oil, epichlorhydrin, acrylic acid etc.

The butadiene-butylene fraction coming from both of the new ethylene units will be separated in one unit to obtain 35-45,000 tons/year butadiene depending on the type of the raw material used for the original pyrolysis.

2. Aromatics production and the ensuing processes

At present, most of the aromatic hydrocarbons are obtained from coal.

Another part are produced from an aromatized gasoline fraction by extraction with diethylene glycol solution. This unit has been built by Czechoslovak firms.

To meet the high requirements of benzene in the near future, a further big unit is being engineered and erected, having a capacity of 150-170,000 tons/year aromatics. To increase the yields of benzene, the de-alkylation of toluene is introduced. The unit also contains the complex processing of the xylene mixture which will produce 40,000 tons/year p-xylene for the production of DMT, 12,000 tons/year o-xylene for the production of phthalic anhydride and 12,000 tons/year of ethylbenzene. This unit is based on reform te fractions and pyrolysis gasoline.

Another aromatics complex unit will be erected in future in agreement with increasing requirements.

Caprolactam

A considerable quantity of the benzene produced is used for the production of caprolactam. Caprolactam is produced from phenol by a technology which was developed shortly after World War II. The original raw materials - phenol from brown coal tars - is being replaced by synthetic phenol, produced from benzene of a petrochemical origin. The original units of 1,500 tons/year have been expanded to 6,000 tons/year and in the past few years, a new unit producing 20,000 tons/year caprolactam has started production. Future units will use

cyclohexane as raw material and existing plants will be reconstructed for the use of cyclohexane.

3. Synthesis gas production for ammonia and methanol with eventual co-production of acetylene and ethylene.

(a) PVC

In addition to the PVC units based on 100 per cent ethylene mentioned earlier, a unit using the combined acetylene - ethylene HTP process for making vinylchloride monomers is now under erection.

The combined process has been chosen for the following reasons:

- it was necessary to increase very quickly the PVC capacity from an existing 40,000 tons/year to 90,000 tons/year;
- no ethylene was available at such short notice;
- the old VCM and PVC units had to be used but carbide based acetylene must be replaced.

As pointed out below, the next expansion of PVC production will be based on the ethylene route and the units will be erected as a part of the new petrochemical complexes.

(b) Acetylene

Most of the plants using acetylene are based on acetylene produced from calcium carbide.

A new petrochemical acetylene process based on the Montecatini partial oxidation of natural gas was started this year. Acetylene from this new unit is destinated for the production of chloroprene rubber and also partly for acetaldehyde.

(c) Ammonia and methanol

Ammonia is produced at four factories on many units of different ages, capacities as well as by different processes.

Today's production in the order of 450,000 tons/year will increase to 1,000,000 tons/year in the near future.

The first units use coke-oven gas or coke for making synthesis gas. But plants are now mainly based on petrochemical raw materials, mainly natural gas with steam reforming and partial oxidation with or without co-production of acetylene.

A major part of synthesis gas productior based on coke will shortly be replaced by the partial oxidation of fuel oils. By this change, the existing methanol plants with a total caracity of 50,000 tons/year will operate on a petrochemical raw material basis.


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