Module 2. Industrial Implementation of Thermal Processes

Lecture №5 Thermal cracking at high pressures and moderate temperature. Visbreaking.

The **objective** of thermal cracking at high pressure is the production of liquid fractions that should be lighter or have a lower viscosity than the feedstock.

In the past, the main purpose of these processes was the production of gasoline.

The cracking at high pressures was the first process that produced supplementary gasoline, after that from straight-run distillation.

The first plant of this type was put into operation in 1919.

Beginning in 1928, when the pumps were first developed that allowed feeding the furnace with hot raw material, the process underwent rapid development, amplified by the introduction in 1932 of the "selective" cracking plants equipped with two furnaces.

The appearance in 1940 of catalytic cracking produced a fundamental change in the petroleum processing industry. The construction of thermal cracking units gradually ceased and the existent plants were transformed or liquidated.

In parallel with the expansion of catalytic cracking, the preferred feedstock became the overhead product from the vacuum distillation of the atmospheric residue. A vacuum residue was a result of this operation. Its use as fuel presented difficulties due to its high viscosity.

This fact determined the appearance and the expansion of the visbreaking process, by means of which the vacuum residue is converted to fuel oil, gas-oil fractions, and small amounts of gasoline and gases. Visbreaking represents today the last important process of thermal cracking that produces a liquid residue. A thermal cracking process which has limited extension but is of great importance for the preparation of the strongly aromatic residue necessary for the fabrication of needle coke for electrodes used in electrochemical industries and especially in the production of aluminum.

Visbreaking

The main purpose of the visbreaking process is to produce a fuel with lower viscosity than that of the feed, a vacuum residue.

The amount of cracked lighter material left in the residue controlled the viscosity and stability of the fuel oil.

In addition to fuel oil, the visbreaking unit produces one or two distillates fractions (light and heavy gas oil or only light gas oil) and small amounts of gasoline and gases.

Visbreaking basically breaks the long paraffinic side chains attached to aromatic structures. Due to this the residue pour point and viscosities are considerably reduced.

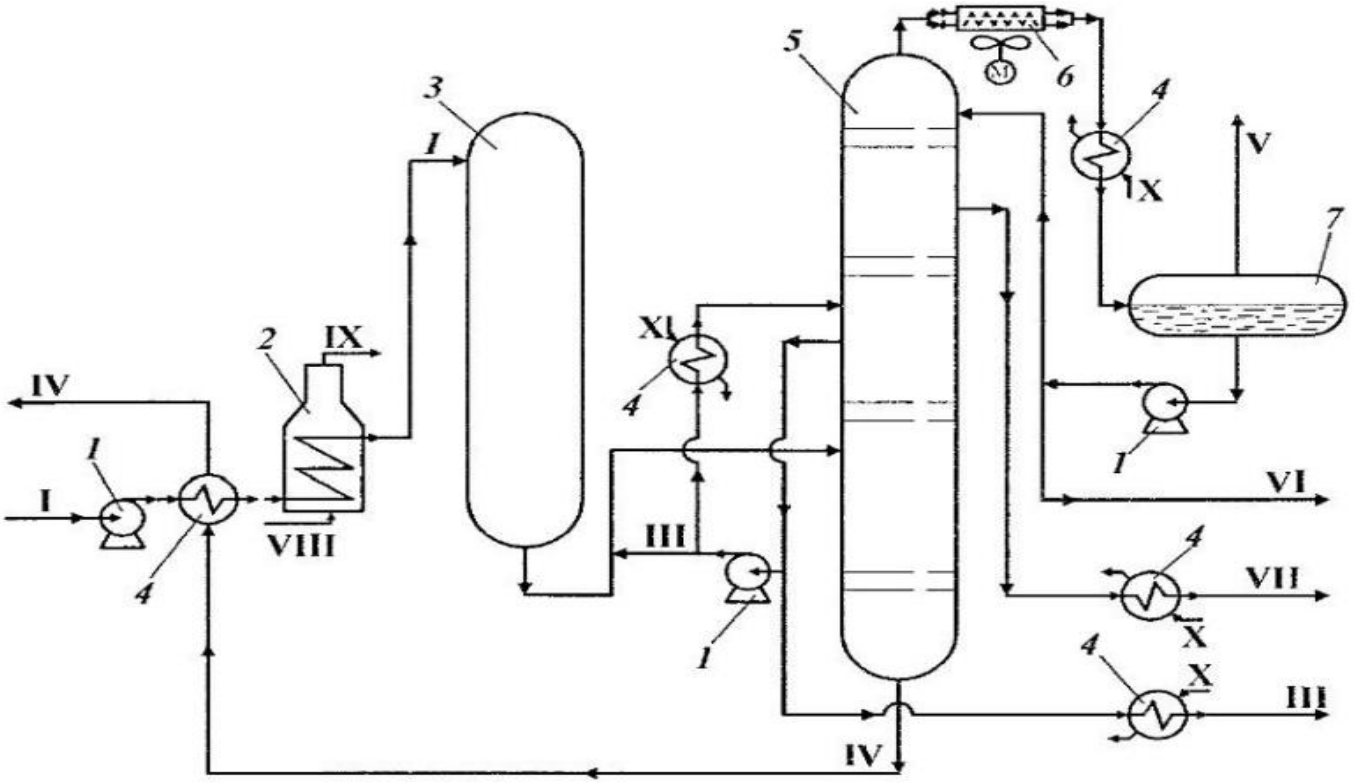
Two classes of reactions occur during visbreaking:

- Cracking of side chained aromatic compounds to produce short chained aromatics and paraffins
- Cracking of large molecules to form light hydrocarbons.

- Visbreaking is carried out either in a ***coil*** or in a ***soaker***.
- When coil technology is used, the mild thermal cracking is carried out in the furnace coils
- When soaker technology is adopted, the cracking is carried out in a soaker unit that is kept immediately after the furnace.
- After cracking, the products are at high temperatures (480 **°C** for coiled furnace case or 430 **°C** for the soaker)

Visbreaking Conditions:

- Inlet Temperature: 305-325 **°C** (15-40 bar)
- Exit: 480-500 **°C** (2-10 bar)
- With soaking 440-460 **°C** (5-15 bar)



1 – pumps, 2 – furnace, 3 – soaker, 4 – heat exchanger, 5 – fractionating column, 6 – air cooler unit, 7 – separator.

I – feedstock, II – water, III – gas oil fraction, IV – cracking-residue, V – hydrocarbon gas, VI – gasoline fraction, VII – kerosene fraction, VIII – fuel gas, IX – flue gases, X – water.

Description of the scheme

Feedstock I is heated in the furnace 2 and directs to soaker 3, where visbreking proceeds. The react column works at pressure 1,7 MPa. After that mixture of products is diluted and cooled by part of gas oil III going out from fractionating column 5. Obtained mixture of products is directed to fractionating column 5, where it is separated on gasoline VI, kerosene VII, gas oil fractions III, hydrocarbon gas V and cracking-residue. In separator of low pressure separation of hydrocarbon gas V from gasoline VI occurs.

Advantages

- 15% reduction in fuel oil
- Larger running time between two decoking operations. coke deposit rate 3-4 times slower than in conventional units.
- Better selectivity towards gas and gasoline productivity.

Products

The cracked product contains gas, naphtha, gas oil and furnace oil, the composition of which will depend upon the type of feedstock processed. A typical yield pattern may be gas 1-2%, naphtha 2-3%, gas oil 5-7%, furnace oil 90-92%.