h-tec Energy Technology Projects

Fact Sheet Technology	
Subject:	**Bergius 1: 1976 – 2000**
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Bergius-Pier Process (3)

1. History in brief

With the oil price crises of the seventy's of the last century, the German Government started several programs to enhance the utilization of domestic energy resources. The major project realized was the re-establishment of the Bergius-Pier technology for the liquefaction of German hard coal resources. First test runs were made in 0,5 t/day units in 1976 at the laboratories of the major German coal company.

Based on that and on the remaining available Know-how of the plants operated until 1964, the construction work for the Coal Liquefaction Plant in Bottrop (West Germany) started in late 1978. In 1981 the 200 t/d Coal Liquefaction Plant was started-up ("Kohleoel- Anlage Bottrop" or "KAB"). During the first 7 years the Kohleoel Anlage Bottrop was operated in coal liquefaction mode ("DT" / "IGOR"). After revamp in 1987 the plant was operated in Heavy Oil Upgrading mode with a capacity of 24 t/hour or 3.500 bpd Vacuum Residue ("VCC").

2. Technology – 3rd development

2.1 Overall Process

Process characteristics:

- ◊ Like in the 2nd development, integrated "Liquid Phase" and "Gas Phase" in one high pressure gas loop
- ◊ Separate preheating of gas and residue / slurry
- ◊ Hydrogen residue work up by distillation

Objectives:

- ◊ Elimination of the oil recycle from Residue work Up unit
- ◊ Higher yields:
  - ⇒ For coal above 60% oil yield
  - ⇒ For residues a conversion above 90% conversion of 500^{+} °C
- ◊ Increase of the specific throughput
- ◊ High efficient preheating design
- ◊ Hydrogen partial pressure above 180bar
- ◊ Adjustment of the old design to state of the art technology

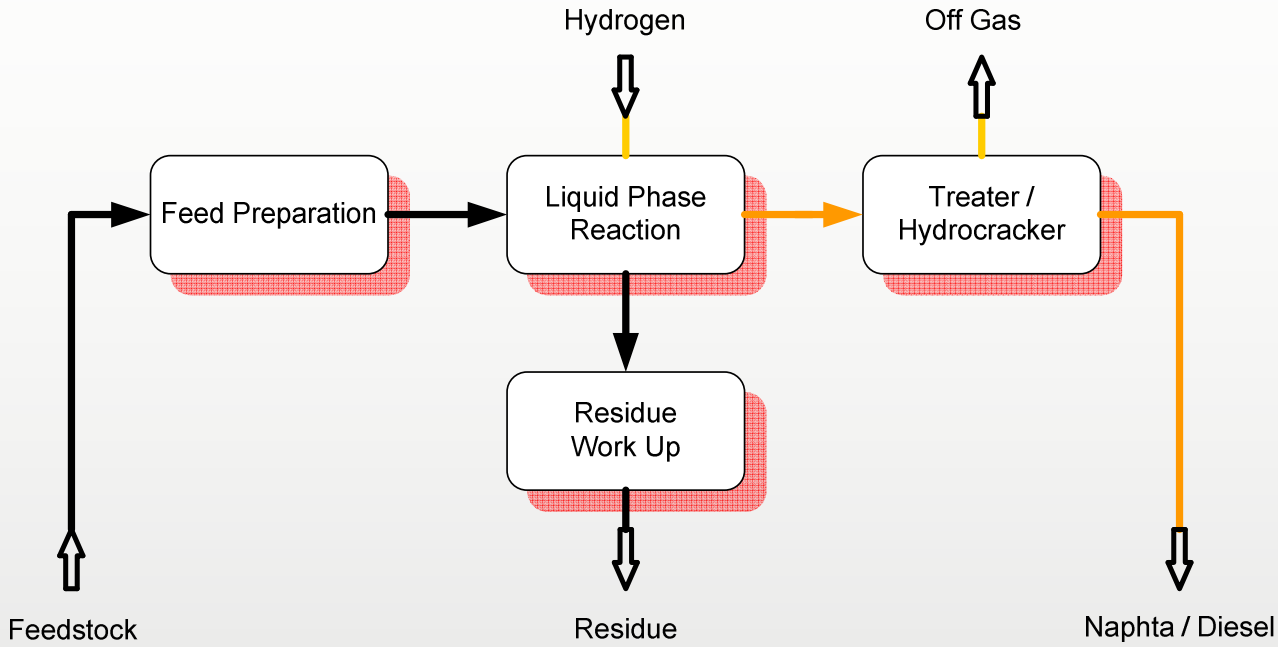

Fig. 1: Block Diagram Bergius-Pier 3rd development status

Balances:

The following tables show the performances achieved at the Bottrop Bergius-Pier plant. It is important to mention that the results in oil yield (Coal Liquefaction Mode) and conversion (Heavy Oil Upgrading mode) could be demonstrated in the 200 t/d coal / 3.500 bpd on the same level as in the smaller laboratory and pilot plant units.

In	mass %		**Out**	mass %
Hard Coal (waf)	100,0		C_1-C_4	17,8
Ash (wf)	4,7		Naphtha	18,3
Water (Coal)	0,5		Diesel	42,3
Fe-Catalyst	2,0		H_2S, NH_3, H_2O	9,8
Na_2S	0,2		Hydrogen. Residue	27,7
Hydrogen	8,5			
	115,9			**115,9**

Tab. 1: Mass Balance Coal Liquefaction Kohleoel-Anlage Bottrop
Source: Abschlussbericht Kohleöl-Anlage, Ruhrkohle AG

In	mass %		Out	mass %
Vacuum Residue	100,0		C_1-C_4	10,4
Additive	2,0		Naphtha	19,3
Hydrogen	3,5		Diesel	46,5
			VGO	14,5
			H_2S, NH_3, H_2O	5,2
			Hydrogen. Residue	9,6
	105,5			**105,5**

Tab. 2: Mass Balance Heavy Oil Upgrading Kohleoel-Anlage Bottrop
Source: Publication VEBA OEL AG, 1989

2.2 Feed preparation

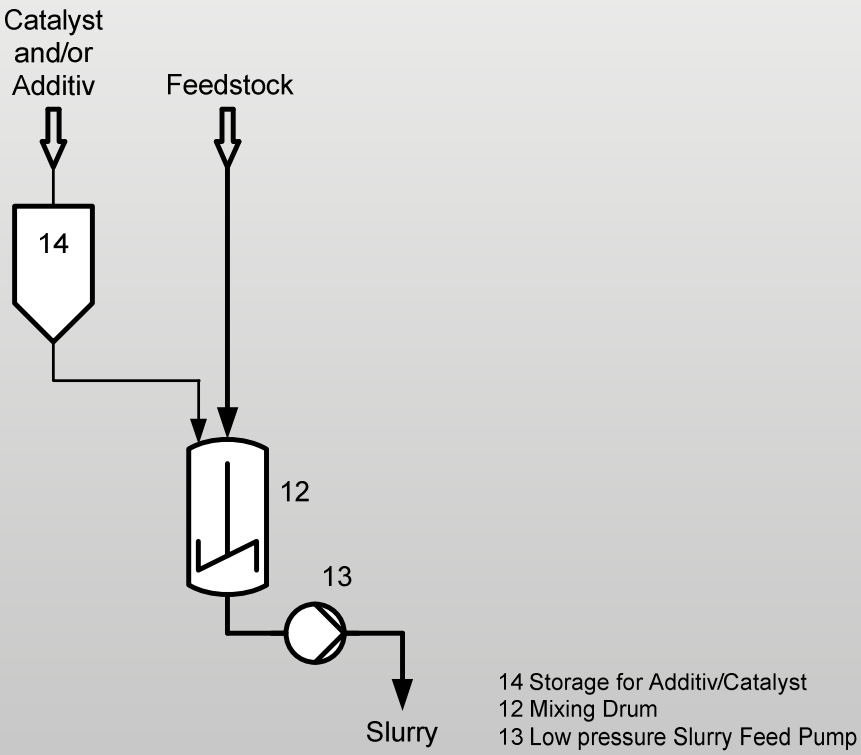

Fig.2: Feed Preparation scheme

In general the Feed Preparation section was as in the 2nd development except the elimination of the enforced internal recycle oil from the Residue Work Up Unit.

Only in case of Coal Liquefaction mode an appropriate internal oil recycle remains necessary for the preparation of the coal slurry. But by the elimination of the general oil recycle no additional solids and primarily no asphaltenes were rerouted to the feeding system. That made it possible to reduce the pressure of the plant for coal mode from 700bar to 300bar. In case of feeding Vacuum Residue the specific throughput was significantly increased.

2.3 Reaction Section

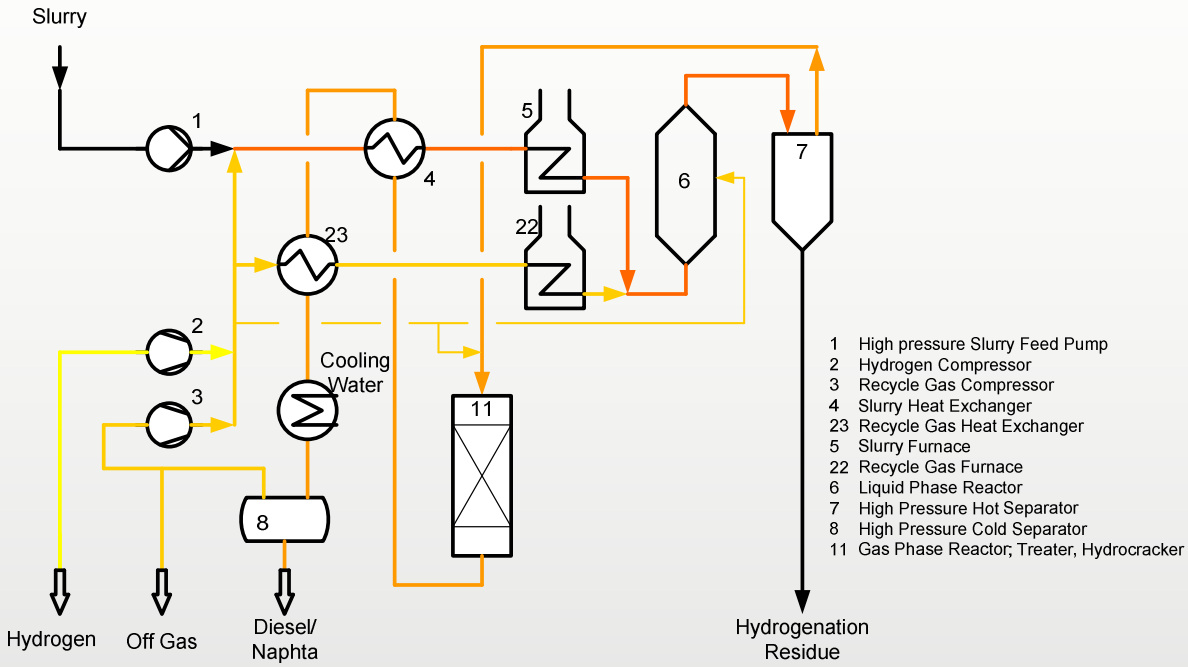

Fig.3: General Process arrangement

Start up of the plant was done in the configuration of the first development. After a short time it became evident that the preheating system of this old configuration was the bottle neck in terms of pressure drop and heat transfer. Heating up (22 & 23) most of the recycle gas separately overcame these limitations.

2.4 Residue Work Up Unit

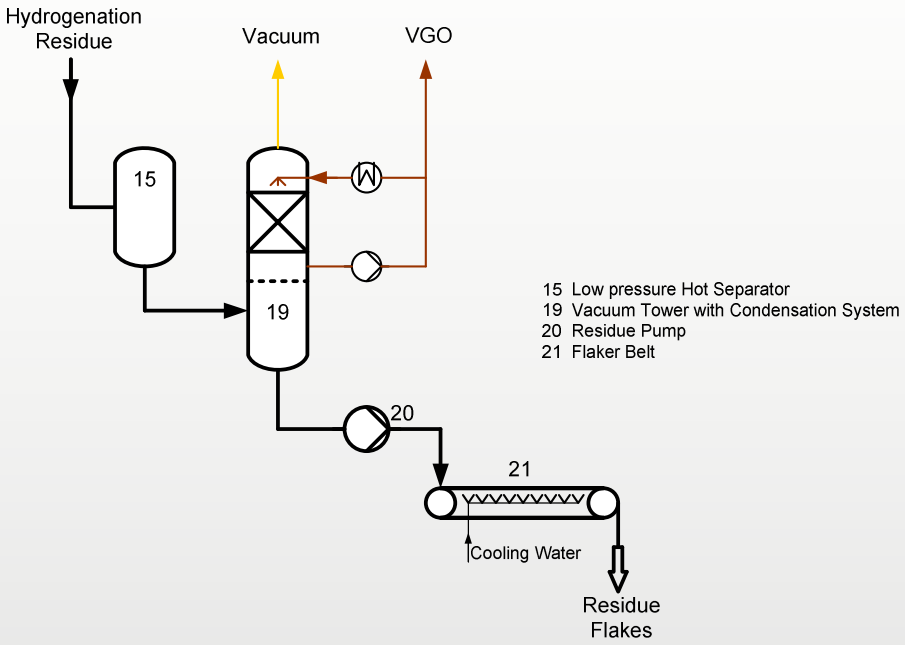

Fig.4: Residue Work Up

In this new Hydrogenation Residue Work Up concept the product coming from the high pressure hot separator was first expanded in low pressure hot separator (15) and afterwards flashed into the Vacuum Tower (19).

Solid free VGO was condensed in the top of the vacuum tower and was mainly used as internal flushing oil.

The bottom product of the vacuum tower was send (20) to a cooling belt (21) for solidification. The flakes produced can be utilized further in various applications.