MODERNIZATION OF EQUIPMENT

USE OF RISING FLOW OF FEED IN REACTORS IN L-24-5 UNITS

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Measures to increase the capacity of existing units for hydrotreating diesel fuel cuts can take the following directions: development of efficient catalysts that will enable the use of high feedstock space velocities, reduction of the hydraulic resistance of the systems, and determination of optimal heat loads.

One of the basic means for lowering the hydraulic resistance of the system is to change its operation so that the hydrotreating process takes place primarily in the liquid phase. This can be achieved by increasing the partial pressure of hydrocarbons while maintaining the same total pressure in the reactors by lowering the hydrogen-rich gas circulation ratio.

Uniform distribution of thin films of liquid in the volume of the reaction zone is ensured by the use of rising disperse-film flow of the reacting mixture in the catalyst bed. At the Ufa Petroleum Refinery, in accordance with the recommendation of VNIPIneft', the reactors in the left-hand block of the L-24-5 hydrotreating unit were reconstructed in order to organize rising flow in these reactors. In the upper part of each reactor, a sealing device was installed, and in the lower part a distributor tray with perforated wells. Also, the external connections of the reactors were rearranged (Fig. 1).

The reactors in this block were initially charged with a regenerated alumina—nickel—molybdenum catalyst, which was subsequently replaced by GKD-202 catalyst. The feed to this reactor block was a mixture of a straight-run diesel fuel cut from refinery crudes and a light catalytic gasoil. The process conditions with downflow and upflow of the feed are shown in Table 1.

TABLE 1

Index	Flow of feed	
	downflow	upflow
Feedstock space velocity, h^{-1}	1,6	2,2
Temp. in reactors, °C	360—380	360—380
Pressure, MPa	3,1	3,0
Sulfur content, wt. %		
in feed	1,2	1,2
in treated diesel fuel cut	0,18	0,18

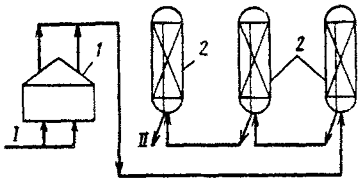

Fig. 1. Interconnection of reactors after reconstruction: 1) furnace; 2) reactor; I) gas—feed mixture; II) gas—product mixture.

No changes in the reactor construction were made after the first cycle of operation. After the second cycle, deformation was observed in two perforated baskets of the sealing de-

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vice in the last reactor encountered by the feed, and catalyst fines in the amount of 0.5 m^3 were found in the high-pressure separator.

Difficulties were encountered in cleaning the reactors, because of the close spacing of the distributor nipples and perforated wells, and also because of the lack of any possibility for regenerating the catalyst in the sealing device. In this connection, the perforated wells were removed, and the distributor tray was covered with a bed of porcelain balls. Measures were taken to strengthen the seal baskets.

The organization of rising flow in the reactors eliminated the formation of "crust" in the inlet bed of catalyst, and the hydrogen-rich gas circulation ratio was lowered from 200 to 110-130 m^3/m^3. In turn, this made it possible to take out of service one compressor with a capacity of 420 kW, to lower the resistance in the reactors and in the system as a whole from 1.5 to 0.8-1.0 MPa, and to increase the capacity of the block.

DIESEL FUEL AND NAPHTHA STABILIZER WITH CROSS-FLOW PACKING

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A distinctive feature of the operation of the stabilizer in the L-24-7 hydrotreating unit is that it operated alternately on a diesel fuel cut and a naphtha from Karachaganak condensate. The process conditions in stabilizing these two products are considerably different. For example, the stabilization of the diesel fuel cut is performed at a pressure of 0.068 MPa, the naphtha cut at 1.18 MPa. The respective vapor densities are 5.4 and 28 kg/m^3. In this connection, even with an identical volume of vapor, the vapor load factor (F-factor) [1] in stabilizing the naphtha is greater than that in stabilizing the diesel fuel by a factor of approximately 3. Also, the operation of the stabilizer is characterized by large liquid loads and small vapor loads. Because of the weak inertial properties of the vapor stream, which flows in a low velocity referred to the entire cross section of the tower (0.15 m/sec), it does not provide adequate turbulization of the liquid phase.

Under these conditions, the existing designs for tray-type contact devices do not provide the required efficiency of contact between streams over such a wide range of variation of vapor loads, particularly with a high liquid load. Therefore, it was proposed that the tray-type contact devices in the stabilizer should be replaced by regular (stacked) packing, operating in the cross-flow regime of heat and mass transfer. The cross-flow mode of interaction ensures independence of the sections for passage of vapor and liquid flow, so that with a given liquid load, the vapor flow velocity can be increased (for example, in the packed bed, to 0.7-2 m/sec or higher).

Of the various cross-flow packing blocks, two designs with helical motion of the vapor are of interest [2]. The positioning of the packs in the horizontal section of the stabilizer (Fig. 1) ensures that the vapor will come into contact three times with the downflowing liquid. On the whole, counterflow is maintained in the vessel. The vapor moves from stage to stage through sector cutouts in the horizontal distributor baffles. Owing to the increase in vapor velocity, greater turbulization is achieved in the distributed liquid film flowing along the packing surface.

Above each stage, which consists of three T-shaped packing blocks positioned in the cross section of the tower, a low-head liquid film distributor is installed; the design of this distributor is shown in Fig. 2 [3]. It consists of a distributor plate with openings, under which a bent deflector tongue is attached by means of a bayonet joint. A jet of falling liquid forms a thin film with a well-developed contact surface on the plane of the deflector; this is particularly important for cross-flow interaction. The washing of the packing surface in the film flow regime, in combination with turbulization by the vapor flow, makes it possible to increase the phase contact efficiency.

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