UDC 504.054:665.7

TECHNOLOGICAL CALCULATION OF INNOVATIVE SCHEME FOR IRAQ OILS PROCESSING

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The research results of calculation of innovative scheme for Iraq oils processing.

Keywords: technological scheme, calculation, oil, fuels.

У статті подано результати технологічного розрахунку інноваційної схеми переробки Іракської нафти.

Ключові слова: технологічна схема, розрахунок, нафта, паливо.

Traditionally, depending on the qualities of produced oil products, they choose the most rational, economically effective ways of oil processing [1]. The choice of oil processing direction and range of produced oil products is determined by the physic-chemical properties of crude oil, technical level of oil processing and demands of certain economic region in commercial oils [2–3].

There are three main variants of oil processing: 1) fuel; 2) fuel-lubricating; 3) petrochemical (complex). To determine the most appropriate variant of processing crude oil should be classified. Today there are several kinds of classification [4]. However, during the last time technological classification became the most widespread [4]. It is based on factors, important for technology of oil processing or production of certain kind of product assortment.

The variant of oil processing is chosen according to the code of crude oil. Taking into account that fact that light oil fractions (up to 350°C) are always used for fuels production, variants of oil processing are chosen according to the group and subgroup of crude oil. The principal scheme of atmospheric-vacuum distillation (AVD) is decided after adoption of processing variant.

Deciding the scheme of processing it is necessary to study properties and characteristics of oil, and also assortment and requirements to quality of obtained products. Such characteristic of investigated oils is presented in tables (physic-chemical properties, potential content of fractions in oil, characteristics of feedstock for catalytic cracking (350–450°C), characteristics of fractions boiling up to 200°C, characteristics of kerosene fraction (180–240°C), characteristics of diesel fraction (240–350°C), potential content of basic and residual lubricants) [5].

Basing on the results of executed experiments [5–6] we prepared the table of crude oils' properties for determining their code. Thus, according to technological classification and basing on obtained results (table 1) investigated crude oils from Iraq oil field may be classified as following: Rumaila — 3.2.1.2, Nahran Omar — 2.1.1.2, Buzyrgan — 3.3.1.2, Kirkuk — 3.2.1.2, Majnun — 3.3.1.1.

Basing on the determined above codes, we may state that Iraq oils are sulfur containing, with high parrafins contents with average content of middle distillates (~ 53,0 %). Thus they may be processed according to fuel variant.

As it is known, fuel variant considers mainly crude oil processing into motor fuels and heavy oil fuels. Possessing the same crude oil capacity of OPP, fuel variant of processing is characterized by the least number of technological installations and low capital investments. Crude oil processing by fuel variant may be of high or low ratio of oil conversion. Deep conversion allows obtaining maximal possible output of high-quality aviation and motor gasolines, winter and summer diesel fuels and fuels for air-jet engines. For this there is a number of secondary processing schemes that allows producing from heavy oil fractions and vacuum residue high-quality light motor fuels. They includes catalytic processes – catalytic cracking, catalytic reforming, hydrocracking and hydrotreatment and also thermal processes, such as coking [9–15].

Processing of oil gases, in this case, is directed onto increase of high quality gasolines and liquefied gas output.

Fuel variant of investigated oils processing is considered to be economically rational as the content of lube fractions in these oils is not sufficient. According to the codes of crude oils (table 1) we have chosen three-stage scheme of AVD of crude oil for production of decided end-products. the developed scheme is based on of industrial AVDs with three-time evaporation [16–20].

Gasoline fraction (i.b.t. — 180 °C) is transferred to secondary processing. It is divided into two parts: gasoline fraction (b.t. — 85°C) that is usually transferred to isomerization. However, in our case, it wouldn't be transferred to isomerization in order to avoid additional expenses; it must be processed at the block of commercial gasoline compounding.

Table 1

Properties determining codes of Iraq crude oils

Index	Value				
	Rumaila	Nahran Omar	Buzyrgan	Kirkuk	Majnun
Sulfur content, % mass – in crude oil – fraction (i.b.t. — 180 °C) – fraction (180 — 360 °C)	 1,30 0,144 1,12	 0,73 0,029 0,64	 1,54 0,29 1,42	 1,69 0,136 1,67	 1,30 0,17 1,67
Class of crude oil:	3	2	3	3	3
Content of fractions boiling up to 350°C, % mass	50,02	59,87	43,77	46,59	44,27
Type of crude oil:	2	1	3	2	3
Content of water, % мас. Content of mechanical admixtures % mass Concentration of chlorine salts, mg/dm3	Absence Absence 14,06	Absence Absence 23,01	Absence Absence 17,52	0,02 Absence 21,16	Absence Absence 19,22
Group of crude oil:	1	1	1	1	1
Content of paraffins in crude oil, % mass	3,4	3,0	2,7	2,8	1,4
Temperature, °C – freezing point of kerosene fraction – pour point of diesel fraction	 minus 54 minus 11	 minus 59 minus 12	 minus 62 minus 14	 minus 48 minus 11	 minus 73 minus 12
Kind of crude oil:	2	2	2	2	1
Code of crude oil:	3.2.1.2	2.1.1.2	3.3.1.2	3.2.1.2	3.3.1.1

Gasoline fraction 85 – 180°C should go to catalytic reforming, where it will be processed into high-octane gasoline. Reforming gasoline comes to the block of commercial gasolines, where it is mixed with gasoline fraction with b.t. 85 °C. Hydrocarbon gas together with other gases is directed to GFP.

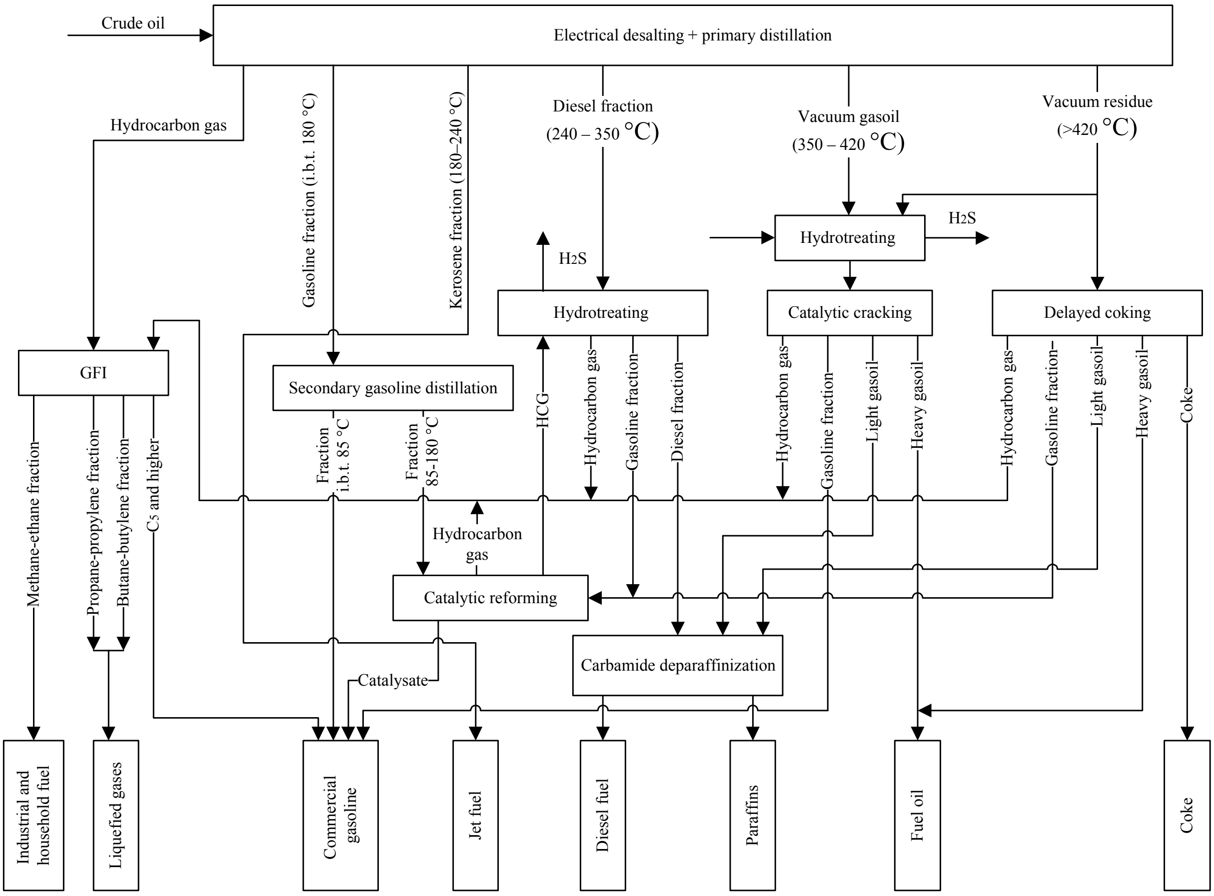
Kerosene fraction (180 – 240 °C) goes to production of aviation kerosene. For this matter installation of hydrotreating is provided.

Diesel fraction also requires hydrotreating. Hydrocarbon gas that is formed in a result comes to GFI and stripping gasoline comes to installation of catalytic reforming for increasing octane number (ON). Hydrotreated diesel fraction then comes to carbamide deparaffinization for obtaining winter diesel fuel. Vacuum gasoil (350 – 420 °C) and some part of vacuum residue (fraction > 420 °C) is a raw material for catalytic cracking that results in hydrocarbon gas, light and heavy gasoil. Light gasoil is used and a component of diesel fuel, and heavy gasoil — as boiler fuel.

Vacuum residue (> 420 °C) is transferred to delayed coking, where it is possible to obtain hydrocarbon gas, gasoline, light and heavy gasoil, and coke (see figure).

Material balance of the OPP on the example of Nahran Omar oil field with capacity of 5 mln tonn/year are presented in the table 2. Thus, results of the executed work have shown that investigated Iraq oils contain average amount of light fractions, high in sulfur and paraffin content. All these made a base for selection fuel variant of processing with maximal output of light fractions.

Deep oil processing allows obtaining maximal possible amount of high-quality aviation and motor gasolines, winter and summer diesel fuels and fuel for air-jet engines. Output of oil fuel is minimized. Thus we have foreseen such set of secondary processing operations, when heavy fractions and residue is used for production of high-quality motor fuels (gasoline, diesel fuel, fuel foe jet engines). They include catalytic processes — catalytic cracking, catalytic reforming, hydrotreating and thermal processes — catalytic cracking and coking. Processing of industrial gases, in this case, is directed into increase of output of high-quality gasolines and liquefied gases.



Principal technological scheme of the proposed oil OPP according to fuel variant

Table 2

Total material balance of proposed OPP

Product	Process	Thousand tonn/year	% mass for process raw material
Input:			
Dewatered, desalted oil		5000	100
Output:			
1. Dry gas C_1–C_2	GFP	80,39	1,55
2. Propane-propylene fraction	GFP	68,02	1,31
3. Butane-butylene fraction	GFP	85,34	1,65
4. Gas C_1–C_4	Catalytic reforming	–	
5. C_5 and higher	GFP	13,6	0,26
6. Hydrogen sulfide	Gas purification from sulfur	41,7	0,8
7. Hydrogen containing gas	Catalytic reforming	93,38	1,8
8. Fractions with i.b.t. – 85°C	Secondary processing	151,12	2,92
9. Gasoline	Catalytic cracking	486,43	9,4
10. Gasoline	Catalytic reforming	1325,03	25,6
11. Gasoline	Delayed coking	72,64	1,4
12. Kerosene	AVD	208,5	4,03
13. Light gasoil	Catalytic cracking	235,33	4,55
14. Light gasoil	Delayed coking	172,53	3,33
15. Heavy gasoil	Catalytic cracking	130,62	2,52
16. Heavy gasoil	Delayed coking	264,03	5,1
17. Liquid paraffin	Carbamide deparaffinization	120,26	2,32
18. Summer diesel fuel	Carbamide deparaffinization	832,00	16,07

End table 2

Product	Process	Thousand tonn/year	% mass for process raw material
19. Winter diesel fuel	Carbamide deparaffinization	609,57	11,78
20. Coke	Catalytic cracking	59,68	1,15
21. Coke	Delayed coking	125,73	2,43
22. Total losses		175,9	3,4
Total:		5000	100
23. Losses	AVD	31,05	0,6
	Secondary distillation	27,43	0,53
	Hydrotreating of diesel fuel	20,7	0,4
	Catalytic cracking	15,53	0,3
	Delayed coking	13,97	0,27
	Carbamide deparaffinization	20,7	0,4
	Catalytic reforming	25,88	0,5
	GFP	20,7	0,4

The main result of this work is substantiation of maximal efficient variant for processing of Iraq crude oil with selection of optimal number of installations for its processing.

Results of this work, basing on the previous investigations of physic-chemical properties of crude oils and their fractions, make a strong base for statement that fuel variant of Iraq oil processing is economically feasible. Moreover the work creates necessary and sufficient conditions for further improvement of technological schemes at Iraq OPPs.

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Article received 18.03.13.