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Research paper

Development of the Petroleum Refining in the Republic of Côte D'ivoire- Primary Processing of Refining

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Abstract

The article is considering the technology of primary processing of S. I. R (Societe Ivoirienne de Raffinage). General modern technology of petroleum refining
The problems with primary processing technologies of refining and ability development of the petroleum refining in the Republic of Côte d'Ivoire. Comparison of the two types of technologies (primary of refining) between SIR for Cote d'ivoire and general technology in Russia.
S. I. R (Societe Ivoirienne de Raffinage) is the only petroleum refinery in the Republic of ivory coast
The Republic of Côte d'ivoire is located in West Africa with a population of 22.8 million (data for 2014 b is the second economic power in sub-region (West Africa) after Nigeria, with an average of 8% of GDP over the last five years, Economic development of the country and its economic development is related to petroleum production and refining in the Republic of Côte d'ivoire.
Refining is the obvious economic rate for a more diversified and more competitive economy

Keywords: *Output, petroleum refining technology, primary processing of refining, economy, Cote d'Ivoire, Russia.*

1. Introduction

The essence of petroleum refining production, the process of petroleum refining can be divided into 3 main stages [11]:
1. Separation of petroleum raw materials into fractions, differing in intervals of temperatures (primary processing);
2. Processing of the obtained fractions by chemical transformations, hydrocarbons contained in them and development of components of commercial petroleum products (secondary processing);
3. Mixing of components with the involvement, if necessary, of various additives, with the production of commercial petroleum products with specified quality indicators (commodity production).
Refinery products are motor and boiler fuel, liquefied gases, various types of raw materials for petrochemical industries, and also, depending on the technological scheme of the enterprise, lubricating, hydraulic and other oils, bitumen, petroleum coke, paraffins. Based on a set of technological processes, the refinery can receive from 5 to more than 40 commercial types of petroleum products.
Petroleum refining - continuous production, the period of production between capital repairs in modern factories is up to 3 years. The functional unit of the refinery is a process unit - a production facility with a set of equipment that allows the full cycle of a particular process. This article describes the main technological processes of fuel production - the production of motor and boiler fuels, as well as coke used in metallurgy.
In this approach, we should have a general idea about the object of our research:
geographical location of the country;
the main development of the Republic of Côte d'Ivoire;
The importance of petroleum and the impact of the volatility of international petroleum prices in the economy of Côte d'Ivoire.
The Republic of Cote d'Ivoire is a country located in West Africa, with a population of 22.8 million people (data for 2014) and having a territory of 322,462 km2. Yamoussoukro is a political capital with 400,000 inhabitants, and Abidjan is an economic capital with 5 million inhabitants. [11] The official language is French with more than 60 local dialects.
The Republic of Côte d'Ivoire is the second economic power in West Africa after Nigeria, with an average GDP of 8% over the past five years and is a member of the Economic Community of West African States (ECOWAS), which comprises 15 countries with a population of 308 million people. [2] In the region, the average growth is 4% of GDP. The Republic of Cote d'Ivoire is a member of the AGOA (African Growth and Opportunity Act), an American federal program that provides benefits and exemption from customs duties for the accession of exporting countries. [1]
Modern petroleum refining production is presented in figure-1 [10, p. 5].

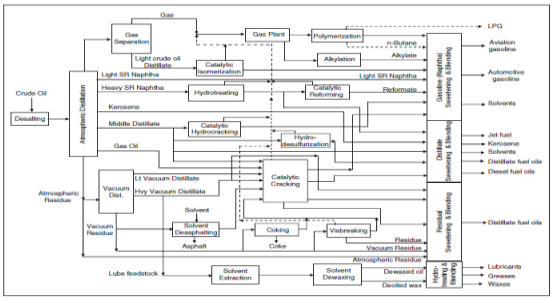

Figure 1: Flow chart of a modern refinery

2. Methods

Methods of research. The method is to study and solve the problems of development of petroleum refining with an economic effect in the Republic of Cote d'Ivoire. The article considers and compares the general technology of petroleum refining in the Republic of Cote d'Ivoire and in Russia, which is one of the world leaders in the petroleum and gas industry.

3. Results

Côte d'Ivoire is Africa's largest exporter of palm petroleum and natural rubber. In addition to coffee and cocoa, the main export crops include bananas, cotton, sugar cane, tobacco. Also cultivated coconut palm, peanuts. Currently, Côte d'Ivoire is one of the main exporters of pineapples to Russia. In the forests, harvesting of valuable species of wood (including black (ebony) wood, collection of hevea juice (for the production of rubber) is conducted. For the agricultural needs, sheep and goats are bred, commercial fishing is conducted, petroleum and gas are produced mainly on the continental shelf. nickel, manganese and iron ore deposits, as well as bauxite, diamonds and gold are being developed, it is obvious that a significant part of the country's resources comes from agriculture.
In agriculture, about 70% of the country's active population is employed; The output of this sector of the economy provides more than 60% of export earnings to the budget. Because the country has made significant progress in this sector, Côte d'Ivoire can become the world leader in the processing of cocoa beans [1] [2] [3].
The growth dynamics of the nominal GDP of the Ivory Coast by interest is shown in Figure 2.

Year	Value (%)
2005	1.9
2006	0.7
2007	1.6
2008	2.3
2009	3.8
2010	2.4
2011	-4.7
2012	10.7
2013	8.7
2014	8.5
2015	9,5
2016	8,8

Figure 2: Size of the nominal GDP of Côte d'Ivoire

Petroleum production in the Republic of Côte d'Ivoire actually began in the 1980s, but exploration was already carried out in the 1950s. The development of petroleum production in the country is divided into two periods:
• from 1980 to 1992
• from 1994 to the present.
Indeed, after the discovery of the first petroleum fields, production began in 1980 with the exploitation of the BELIER field, then in 1982, the exploitation of the ESPOIR field. However, in 1992, petroleum production in the Republic of Cote d'Ivoire faced difficulties before the development of LION, PANTHERE, BAOBAB in 2005 and the resumption of ESPOIR activities in 1994 2002 year.
To date, petroleum production averages 50,000 barrels per day in 2006. However, many petroleum fields have stopped production due to many technical and environmental problems, such as the BAOBAB fields. Thus, petroleum production fell from an average of 50,000 barrels per day to 20,000 barrels and even less [4].
After the discovery and commissioning of the Marlin field, Côte d'Ivoire will raise the average of 18,954 barrels per day in 2014 to an average of 30,000 barrels per day in 2016. In terms of reserves, there is an interesting pool potential, especially in deep waters. The recoverable reserves are estimated at 232 million barrels of crude petroleum and 1,407 billion cubic meters of natural gas.
For comparison, these crude petroleum reserves are less than six [5] months for a country such as Nigeria, which produces between 2 and 2.5 million barrels per day [6, p. 1].
It is connected with the fact that the Republic of Cote d'Ivoire is considered a small petroleum producer in Africa, compared with Angola, which produces 1.5 million barrels per day and Nigeria - 2.12 million barrels per day [4], Equatorial Guinea also produces 300,000 barrels / day [5].
SIR, Cote d'Ivoire's petroleum refinery, is the only petroleum refinery in the country, so SIR has a monopoly on 95% of the national market. SIR was established on October 3, 1962 with the help of multinational companies, including Total. Currently, SIR processes over 3.8 million tons of crude petroleum a year against 700,000 tons per year of creation (1962). SIR petroleum products meet the Afri3 (Euro3) standard. Although SIR processes crude petroleum from Nigeria, Cameroon, Angola and other African countries. As you can see, the first field in Cote d'Ivoire began to be developed in 1980, practically 20 years after the creation of the SIR [6]. SIR was created taking into account the processing of heavy petroleum, which can be seen from the principle technological scheme P & ID of primary processing of petroleum emulsion.
The characteristics of the feedstock in SIR (petroleum emulsion) are presented in Table 1.

Table 1: Characteristics of the raw feedstock-forkados (Nigeria) of the petroleum refining company SIR (Cote d'Ivoire)

Components	Methods	Units of measure	Results
Density	NF EN 12185	kg/ m3	865,5
Water content	NF EN 9029	% v/v	0,050
Acidity	ASTMD 664	mg KOH/g	0,39
Sulfur content	NF EN 8754	% m/m	0,16
API	ASTMD 1298	-	32,0
Freezing point	NF EN ISO 3016	°C	-30

SIR processing technology does not allow the processing of petroleum (gas condensate) from Côte d'Ivoire. The technology allows processing only heavy petroleum. Therefore, raw materials for refining are purchased in other countries. The country is not in a position to dictate its market price for fuel. Thus, local market fuel prices in Côte d'Ivoire are highly dependent on global fluctuations, which affects the overall economic performance of the country. As an example, the current price of the petroleum market is low, which is beneficial for customers. However, higher costs (the price of purchasing raw materials) may not be justified, which will have serious consequences for the national economy, for example, inflation [6]. The flow diagram of SIR and [7] the principle flow diagram of P & ID for the primary processing of petroleum emulsion on ELOU + AT. are shown in Figures 3 and 4.
Nevertheless, petroleum from Côte d'Ivoire is of a rather high quality (gas condensate). In addition, Côte d'Ivoire is a gas producer with great potential, which allows the country to export petroleum products to 20% of the total export volume. Historically, the economic development of Côte d'Ivoire is based on the agrarian industry. Indeed, Côte d'Ivoire is the first producer of cocoa and cashew nuts and the fifth world producer of coffee beans, etc. Côte d'Ivoire exports its petroleum products mainly in the ECOWAS region, as well as in the United States of America.

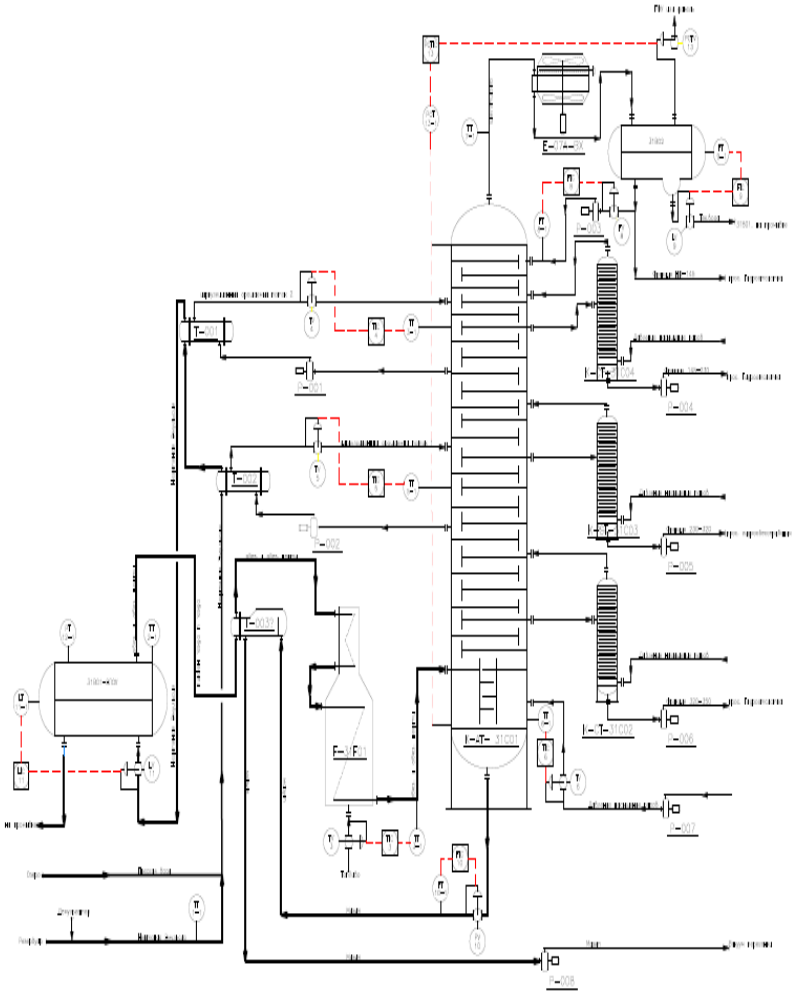

Figure 3: SIR Flow Diagram.

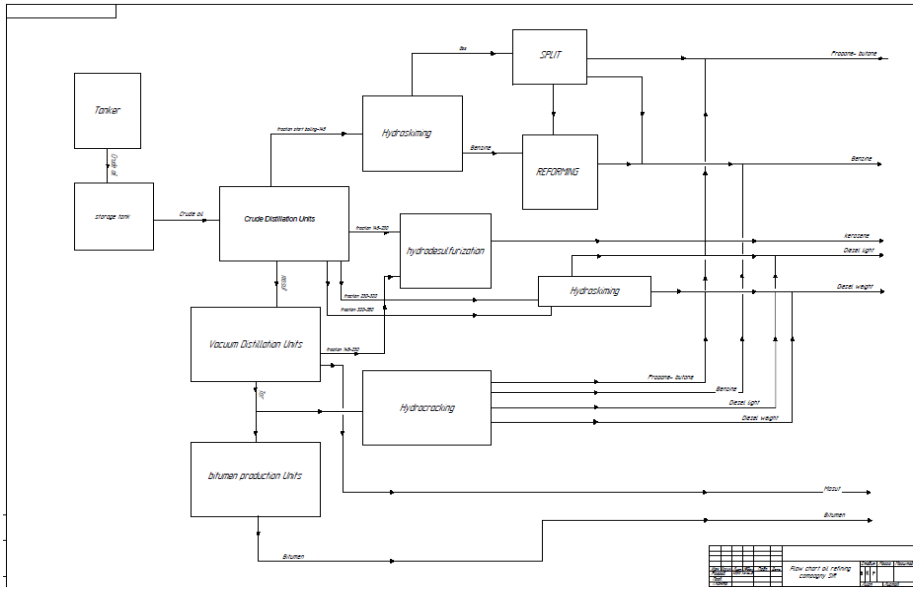

Figure 4- Principal flow chart of P & ID of petroleum emulsion primary processing on ELOU + AT (SIR).

4. Discussion

It is common knowledge that the technology of primary processing of raw materials depends on the quality and type of raw materials. That is why we tried to study the refining process in the refinery (SIR) above. Let's compare it with the processing technology in Russia. For a better understanding of this technology, a description and a basic flow diagram of the primary processing of the petroleum emulsion is presented.

Description of the technological process and technological scheme of the production facility in Russia [9]. A general approach to the primary petroleum refining process can be described as follows.

The process of petroleum processing in an atmospheric-vacuum tube installation consists of successive stages:
- preliminary heating of crude petroleum in heat exchangers due to the heat of waste products;
- fractionation of petroleum heated in heat exchangers in the first distillation column K-1 with the aim of its stripping;
- heating of semi-refined petroleum in P-1, P-2 tubular furnaces;
- fractionation of the heated semi-aerosolized petroleum in the second distillation column K-2 to produce the top product - straight-run gasoline, side-ends - straight-run fractions for the production of RT, diesel fuel and diesel petroleum;
- fractionation of fuel petroleum in the vacuum column K-5 to obtain vacuum distillates and tar;
- alkalinisation of gasolines of the first and second distillation columns K-1 and K-2, from which we obtain different fractions.

To protect the equipment from corrosion, ammonia water is fed into the helmet of the K-2 column and 1-2% of the alkaline solution into the petroleum. Alkaline solution and ammonia water are supplied depending on the pH in the drainage waters of the tanks E-1a, E-2.

Rectification column K-1

• Top temperature, °C - no higher than 150;
• Lower temperature, °C - not higher than 245;
• Pressure, kgf / cm2 - no more than 3.0.

The rectifying column K-1 has 28 spongy cone plates. In the column K-1, the gasoline fraction HC-175 °C and gas are separated from the petroleum. The steam-gas mixture from K-1 is delivered through the helmet by two parallel flows to the air cooling units 1XB-1, 1XB-2, 1АВГ-1-8, where it is condensed, cooled and enters the gas separator E-1a. The temperature of the top of column K-1 is adjusted pos. TIRCA 1013 with flow compensation pos. FIRC 3018, the control valve is installed on the irrigation supply line to the K-1 column. The pressure in the column K-1 is recorded by the device pos. PIRA 2006.

The temperature of the bottom of the column is maintained by feeding a hot stream of stripped petroleum from P-2 or P-1, heated to a temperature of no higher than 365 °C. The fatty gas from E-1a is discharged to the dripper A-7, and then it is removed from the unit. The condensate from the dropper A-7 is pumped to the sediment tanks A-1, A-4 by the H-34 pump. The consumption of fatty gas is recorded in pos. FIR 3012. If there is not enough fuel gas, the fatty gas can be sent to the K-4 fuel gas separator, from where it comes through the heat exchanger T-19 / 1,2 to the P-1,2 furnace nozzles. The pressure of the fuel gas is regulated by the valve pos. PRCA 2004 installed on the gas supply line in the P-1 furnace, 2. Excess gasoline from E-1a passes through a block of alkalization or is removed from the unit. The level of gasoline in E-1a is regulated by the valve pos. LIRCA 4005, the valve is installed on the line of pumping gasoline to the block of alkalization. The consumption of gasoline from E-1a is recorded in pos. FIR 3042. The level of water-gas phase separation in the tank E-1a is regulated pos. LIRCA 4006, the control valve is installed on the water discharge line in the E-4 tank. Overheated water vapour is supplied to the bottom of K-1 for the most complete topping of petroleum. The steam flow rate is regulated by the valve pos. FIRC 3027, the control valve is installed on the supply line of superheated steam from P-1. The topped off petroleum from the bottom of the K-1 column to the H-2,3 pumps is pumped by four streams through the P-1 furnace and two streams through the P-2 furnace.

At the exit from the P-1 streams are combined and two transfer lines are fed to the 6th plate of the rectifying column K-2. The flow rate of each flow at the inlet to the furnace P-1 is regulated pos. FIRCA 3020L, 3020P, 3021L, 3021P, the valves are installed on the lines of entry of semi-aerated petroleum into the furnace. The pressure in the coils of the furnace is recorded in pos. PIRA 2007L, 2007P. The temperature of petroleum heating through P-1 flows is recorded in pos. TIRA 1027, 1028, adjustable pos.

TIRSA 1029L, 1029P, control valves are installed on the lines of gaseous fuel to the injectors. The temperature at the furnace passes is recorded in pos. TIRA 1021, 1022, 1023, 1024, 1025, 1026. In the convection chamber of the furnace P-1 s the superheater consisting of 4 pipes 159x10 is installed in which the water vapour is heated to the temperature of 360-420 °C and fed to the K-1, K-2, K-3 / 1,2 columns.

Rectification column K-2

• Top temperature, °C - no higher than 150;
• Lower temperature, °C - not higher than 350;
• Pressure, kgf / cm2 - no more than 1.4.

In the atmospheric Column K-2, 11 grooved trays and 23 valve plates from Sulzer were installed: - 19 single-flow type BDH (trays 14 to 22, 25 to 34), 4 double-flow MVG types (trays 12, 13, 23, 24). Pair of gasoline through the helmet pipe from K-2 goes to the air-cooling units 2XB-1.2; 2ABB-1-4; AB3-2; AB3-2a, where they condense, cool and enter the water separator E-2. The pressure in the column K-2 is recorded by the device pos. PIRA 2009. Ammonia water is supplied to the helmet line. The flow rate is adjusted pos. FIRC 3022, the control valve is installed on the ammonia water supply line. Petrol from E-2 pumps N-6,7,8 is fed for irrigation in K-2, and the excess is pumped to alkalization in A-1, 4 or is removed from the unit. The scheme provides for separate withdrawal of I and II gasoline from the installation. The temperature of the top of column K-2 is adjusted pos. FIRC 3023 with flow compensation pos. TIRCA 1031, the control valve is installed on the irrigation supply line to the K-2 column. The level of gasoline E-2 is regulated pos. LIRCA 4011, the valve is installed on the gasoline pumping line. The level of the water-gas phase in E-2 is regulated pos. LIRCA 4012, the control valve is installed on the line of acidic water in E-4. For the purpose of the most complete extraction of light petroleum products, superheated steam from the superheater P-1 is supplied to the bottom of the column under the first plate. The flow rate of superheated steam is regulated by the valve pos. FIRC 3026, the control valve is located on the superheated steam line from P-1 to K-2. Based on the assessment of the principle technological scheme for the primary processing of petroleum emulsion at refineries in Russia, it can be concluded that this technology is more flexible and versatile that, on the whole, allows processing almost any raw material. By comparing two types of technologies, we find that the technology used by the petroleum refinery plant (SIR), and used in Russia are significantly different. The basic technological scheme of primary petroleum refining in Côte d'Ivoire is simpler, but it has drawbacks. These shortcomings are expressed in the fact that SIR can process only a certain type of petroleum (only heavy), whereas the technology used in Russia is more complicated, but more interesting in its organization, especially with regard to column K1, which separates gas from liquid . Accordingly, this technology using K1 is more flexible. This flexibility opens up a broad perspective in terms of raw materials for refineries. The basic technological scheme of primary processing of petroleum emulsion at refineries in Russia is presented in Figure 5 [9].

5. Summary

Petroleum is a complex hydrocarbon mixture of dark color, fluid. Crude petroleum consists of a large number of organic compounds. It contains all kinds of saturated hydrocarbons (paraffin, naphthenic, aromatic, asphaltene). The petroleum also contain a variety of heteroorganic compounds, including oxygen, sulfur and nitrogen atoms [11].

Due to the complexity of the chemical composition of petroleum, for processing petroleum is first divided into relatively narrow fractions, the chemical composition of which is more uniform. The criterion for separation is the temperature limits for the boiling-off of these fractions-the onset of boiling and the end of boiling. Primary petroleum processing at the plant begins with the separation of petroleum into fractions according to the temperature boiling range. Then these fractions are sent to other facilities in order to obtain commercial petroleum products or their

components. Separation of petroleum into fractions is carried out on combined installations of atmospheric-vacuum tubes (abbreviated AVT). These facilities usually include an ELOU unit, on which water and salts are separated from petroleum. The combination of AVT units and ELOU units significantly reduces fuel, electricity, steam and capital costs, that is, it is economically viable.

Also, the combined unit ELOU-AVT includes an atmospheric distillation unit (one or two columns for distillation of fractions boiling up to 350 °C), a stabilization unit designed to separate hydrocarbon gases and hydrogen sulphide dissolved in them from gasoline fractions, a vacuum unit on which there is a division into fuel petroleum fractions - a heavy part of the petroleum boiling at a temperature above 350 °C, and a unit for secondary rectification of gasoline fractions.

The choice of the scheme of the installation ELOU-AVT or ELOU-AT is determined by the characteristics of the petroleum, which will be processed on it, the capacity of the facility for raw materials and the assortment of petroleum products obtained on it.

As can be noted on the basis of the analysis of the principle technological scheme of primary processing of petroleum emulsion at refineries in Russia, this technology is more flexible and versatile, which on the whole allows processing almost any kind of raw materials. In principle, it is possible to make similar changes to the technological scheme of SIR. However, such a decision would lead to the closure of the company for a long time and would have serious consequences for the economy of Côte d'Ivoire, which would affect the economy of Côte d'Ivoire with external factors that threatened its further development. A decision that has a medium and long-term perspective, which will ensure national demand and increase exports of petroleum products, could be the introduction of a new refinery, designed with more flexible technologies in mind.

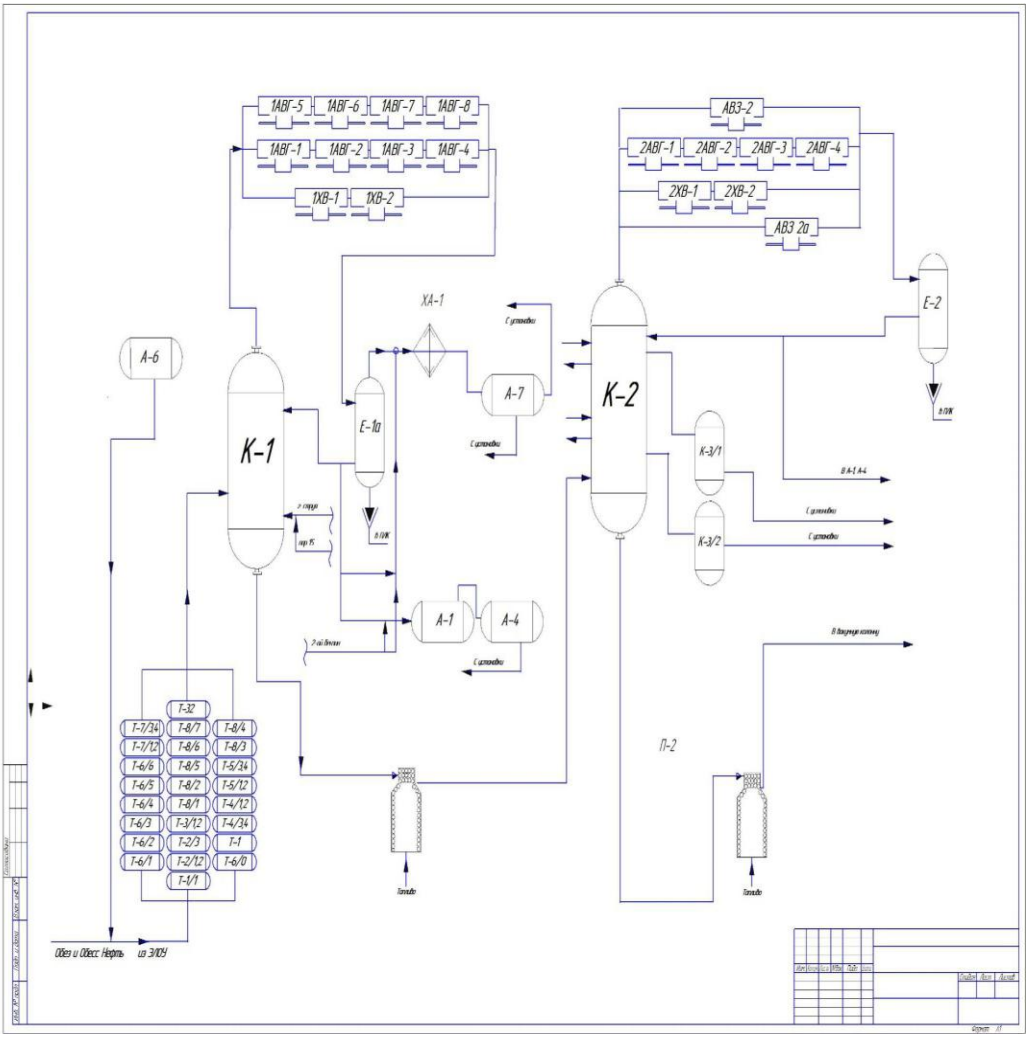

Figure 5: Principal flow chart of primary processing of petroleum emulsion at refineries in Russia.

6. Conclusion

The idea of building a new petroleum refinery capable of providing the Afri 6 (Euro 6) standard for petroleum products that are competitive in the European and American market and will be produced in Cote d'Ivoire looks promising.

In addition, the new refinery will provide new jobs, reduce the risk of shortage of electricity in the country and will facilitate the uninterrupted supply of petroleum products in the country and in the region. Especially if a pipeline is built between Abidjan and Abuja (the capital of Nigeria), it will be possible to solve medium-term problems with fuel supplies to Nigeria, which is the leading economic power in the region.

Thus, at present, given the globalization, the successful economic development of the Republic of Côte d'Ivoire is possible only in connection with the development of other countries.

Acknowledgements

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Refinery: Petroleum refinery plant.

GDP: Gross Domestic Product.
RF: Russian Federation.
ECOWAS: Economic Community of West African States.
Afri: the quality of fuel that meets the environmental requirements in Africa.

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[13] On the article Adiko Serzh-Bertrand, Kemalov Ruslan. Alimovich, "Development of petroleum refining in the Republic of Cote d'Ivoire-primary processing"
[14] The present study is devoted to the study of the technology of primary processing of S.I.R (Societe Ivoirienne de Raffinage). General modern technology of petroleum processing. Problems with primary processing technologies and opportunities for development of petroleum refining in the Republic of Cote d'Ivoire; advantage and disadvantages. Comparison of two types of technology (primary processing) between SIR for Côte d'Ivoire and general technology in Russia. Economic development is the link with mining and refining in the Republic of Cote d'Ivoire.
[15] The reliability of the results of the study is based on an analysis of the research conducted on the development of petroleum refining in the Republic of Cote d'Ivoire. The work is of interest from the point of view of development of the general technology of petroleum processing in the Republic of Cote d'Ivoire and the way of processing its petroleum
[16] Based on the above, I believe that the article can be recommended for publication in the journals database WEB of Sciences or Scorpius.
[17] Chief Engineer PJSC "HC Tatnefteprodukt" KTN Gainullin V.I.