International Research Journal of Pure & Applied Chemistry

22(7): 35-47, 2021; Article no.IRJPAC.73820
ISSN: 2231-3443, NLM ID: 101647669

Suggestion Petroleum Coke from Iraq Oil Mix. (T-21A+T-5) & PF2 as Alternative Fuel for Cement and Metallurgy

Sherwan Mohammad Simo[1*], Salah Aldin Naman[1], Kanaan Ramadan Ahmed[1], Akhmetov Arslan Faritovich[2] and Lapshin Igor Gennadievich[2]

[1]Department of Chemistry, Faculty of Science, University of Zakho, Iraq.
[2]Department of Oil and Gas Technology, Ufa State Petroleum Technological University, Ufa, Russia.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IRJPAC/2021/v22i730419
Editor(s):
(1) Prof. Wolfgang Linert, Vienna University of Technology, Austria.
Reviewers:
(1) Mohammad Bazvand, Sahnad Oil & Gas Research Institute, Iran.
(2) Seydou Sinde, International University of Grand-Bassam, Côte d'Ivoire.
Complete Peer review History: https://www.sdiarticle4.com/review-history/73820

Original Research Article

Received 08 July 2021
Accepted 18 September 2021
Published 25 September 2021

ABSTRACT

The feasibility of utilizing petroleum coke as an alternative fuel for cement kilns and other industries was suggesting. The feedstock using in this study are mixture (T-21A+T-5) Tawke and Shekhan PF2 AT residues were obtained from two Iraqi-Kurdistan crude oils by removing distillates boiling point up to 350°C using the atmospheric distillation unit. The coking processing of AT residues at high temperatures to produce gas, coking distillates and petroleum coke. Coking of AT residues were carried out at temperature 450-460°C and atmospheric pressure, at this temperature, the duration of heat treatment of the feed was 2h. 45 min for Tawke and 2h. 15 min for Shekhan. The choice of temperature and time of the experiments was made on the basis that a lower temperature increases the duration of the process, and at a higher temperature a significant reduction in the duration of the process according to GOST methods, it becomes difficult to obtain the target product with the required content of volatile substances. An increase in the duration of the coking process about 3 hours and more in all cases leads to a decrease in the content of volatile substances. The study was suggested petroleum coke can be using instead of fuel oil on industry effectiveness in cost reduction when switched over from fuel oil to petroleum coke. in the last of this work, after all

*Corresponding author: E-mail: sherwan.simo@uoz.edu.krd;

the measurements and characteristic obtained, two types of treatment scheme were proposed for how to refine these types of crude oils, which give petroleum products with a high sulfur content. The research proposed the technological, ecological and economic aspects of petroleum coke as fuel, including high sulfur content, use as energy in the electrical field (electro energy), and as an alternative fuel for cement production and metallurgical manufacture.

Keywords: Petroleum coke; Alternative fuel; High sulphur coke; Coking process.

1. INTRODUCTION

World energy demand will continue to grow over the next 25 years. According to the Organization of Petroleum Exporting Countries (OPEC) there is a clear expectation that this will increase by more than 52% by 2035 [1,2]. Discoveries of conventional sources of light, easy-to-access crude oil is becoming less common and current oil production levels are struggling to match demand [1, 3]. The main modern trends in the development of oil refining in the world is an increase in the production of motor fuels and petrochemical raw materials with the maximum reduction in the share of oil consumption in electrical and thermal energy as an energy boiler fuel. The ultra-deep degree of oil refining achieved in the USA due to the widespread use of secondary distillation processes such as catalytic cracking, hydrocracking, delayed coking, alkylation, isomerization, catalytic reforming, hydrodesulfurization [4, 5]. Petroleum provides fuels and lubricants for most transportation vehicles and essential precursors for the world’s petrochemical industries [6, 7]. The main technology in the first category is the delayed coking process, which is the most widely used in the refining industry. Catalytic hydrotreating belongs to the second category and is the second largest process of industrial application [8, 9]. Considerable interest in the selection of oils for the production of petroleum coke is the transition of sulfur from petroleum feedstock in the coking ore and coke. With a known pattern: the more sulfur in oils, the more it is in processed products and, in particular, in coking raw materials and in petroleum coke, the intensity of the "transition" of sulfur is characterized by the individual characteristics of oils [10].

Petroleum coke is a by-product of the oil refining industry. It has high heating value and low price. Owing to the increasing demand for heavy oil processing, the production of petroleum coke is increasing. The high availability and low price of petroleum coke make its combustion for power generation increasingly attractive [11]. The main challenges facing the Iraqi refining industry are the required to meet the need for motor fuels with minimal use of crude oil resources and reduce the production of boiler fuel. The solution to these problems is possible due to the inclusion of secondary processes for processing oil residues in the refinery process chains to obtain additional secondary distillate fractions, the hydrocatalytic refinement of which (in a mixture with straight-run distillates) results in a significant increase in the production of motor fuels [12]. As a suitable raw material for thermal processing, Author [13] which consider atmospheric oil residues (fuel oil) obtained at Iraqi refineries with lower raw material productivity. These fuel oils are taken from oils at the electro desalting unit with primary distillation unit (ELOU-AT) plants with a yield (43–45%), have a density in the range 938–967 kg / m3 and sulfur contain 3.9-4.2% wt. [13, 14]. At present, the sale of sour coke at foreign refineries is not a problem, since it is widely used not only for the production of anode and electrode products, but also in the cement and metallurgical industries, as well as household and energy fuels. However, this area of use of sulfur coke in Iraq has not yet been widely disseminated [11, 15]. That is why the aim was to research in this field.

Cement industries are striving to lower their production cost, one effective method of which is the substitution of traditional fuels such as coals, oil and natural gas with petroleum coke [16]. While oil refineries consider it a waste product, to the cement manufacturer it represents an economical fuel alternative. Lower costs and special precautions using petroleum coke as primary fuel source can substantially lower production cost. Besides the high calorific value that makes petroleum coke ideal for firing in a cement [4]. Furthermore the iron and steel industry is the largest energy-consuming manufacturing industry in the world [17]. About 95% of energy for an integrated steelmaking plant comes from solid fuel (mainly coal), 3-4% from gaseous fuel and 1-2% from liquid fuel, for this reason coke will be in the near future the better alternative fuel for metallurgy [18, 19].

2. EXPERIMENTAL

2.1 Crude Oil Sampling

The study was carried out on three Iraqi-Kurdistan region crude oil samples which are collected from the fields of Tawke well No. (T-21A and T-5), and Shekhan well No. (PF2).

2.2 Physical and Chemical Properties of Crude Oils

The study of physicochemical characterizations of the four crude oils (T-21A, T-5 and PF2) was carried out using the standard test methods of analysis, ASTM and GOST. Physical and chemical properties of crude oils were determining and measurement in Ufa state petroleum technological university, Faculty of Technology, department of oil and gas technology. Laboratory 531, and at university of zakho, Faculty of Science, Department of Chemistry, Research laboratory.

The first run of coking process carried out on 29.52 gm of mix.(T-21A+T-5) residue +350°C and the second on 20.44 gm of PF2 residue +350°C was distilled under specific conditions of heat input and rate of distillation are show in Fig. 3 [4]. The results of coking process are obtained from mix. (T-21A+T-5) and PF2 are illustrated in Table 8.

Fig. 1. Coking process (Ufa, Russia Lab.)

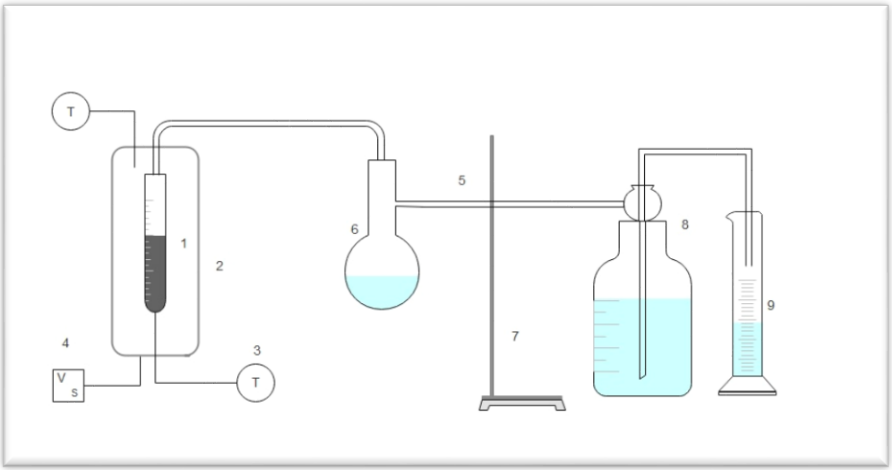

Fig. 2. The scheme of the installation of coking
1- ampul, 2- reactor, 3- thermostat, 4- voltage, 5- rubber, 6- Receiver, 7- stand and clamp, 8- bottle, 9- cylinder

As shown in Fig. 2, coking gas is taken into gasometers for analysis, several times during one experiment. The coking time, fixed from the moment vapors appear in the receiver until the end of the experiment, is 2–3 hours. The temperature of the liquid mass in the receiver 450 - 460 °C. Then, coke is dried and calculate the percentage weight of coke product for the mix. (T-21A+T-5) and PF2 are show in Fig. 4.

Fig. 3. Coke ampul after process

Fig. 4. Products from coking: residues +350 °C of the mix. (T-21A+T-5) and PF2.

3. RESULTS AND DISCUSSION

3.1 Physicochemical Properties of Crude Oils and Products

The physical and chemical characteristics of crude oil vary widely from one production field to another and even within the same field. Basic terms like light and heavy are used to characterize crude oil in terms of its boiling range, composition and sulfur content. It is important to discuss crude oil properties because refining technology has been developed in response to the differences between crude oil properties and final product specifications.

Table 1 shows some of the important tests used to determine the properties of T-21A, T-5 and PF2 crude oils, each of these properties give a certain value to the crude oil. The density of T-21A and T-5 crude oil is lower than PF2 crude oil, while the API gravity of T-21A and T-5 crude oil is higher than PF2 crude oil.

Determining the sulfur content in crude is important because the amount of sulfur indicates; the type of treatment required for the distillates, that sulfur has the most important effects on refining. It has the greatest influence on the value of the crude oil. Crude oil with higher sulfur content, generally requires more expensive processing than those with lower sulfur content. In Table 1 show that the Shikhan PF2 crude oil higher sulfur content than Tawke T-21A and T-5 crude oils. Trace metals vanadium and nickel contents directly increase with sulfur content. Ash contents, this test indicates the amount of metallic constituents in a crude oil [20,21]. The Tawke T-21A and T-5 crude oils have lower percentage of ash content than Shikhan crude oils PF2. Whereas, Shikhan PF2 crude oil has higher carbon residue than T-21A and T-5 crude oil.

3.2 Evaluation Atmospheric Distillation of Crude Oil Samples

Tables 2, 3 and 4 shows the data of atmospheric distillation according to (GOST 2177) obtain from T-21A, T-5 and PF2 crude oils through the atmospheric distillation of known volume. Distillate volume percentage was collected at standard temperature range with the IBP and FBP for T-21A, T-5 PF2 crude oils for each of them. These results indicated that T-21A and T-5 are lighter than the PF2 crude oils [22].

According to the results from atmospheric distillation the volume percentage of the product for Shikhan (PF2) crude oils is higher than in Tawke (T-21A and T-5) crude oils, as show in Fig. 5 the remain hydrocarbon in Shekhan (PF2) crude oil may be heavier than in Tawke (T-21A, T-5) crude oil, then the amount of Shekhan residue $^{+}$350°C products by atmospheric distillation (PF2 38%) is lower than Tawke residue $^{+}$350°C (40%)

Material balance of atmospheric distillation for T-21A, T-5 and PF2 crude oil in different volume percentage of distillation products between IBP and FBP were obtained from the distillation of the four different well crude oils with the residue are shown in Table 5. As the results the equal ratio of liquid derivatives such as gasoline and diesel are obtained by atmospheric distillation, and this indicates that the work carried out according to the standard specifications of the distillation process, which was done according to the standard GOST of work method.

As mentioned before, from the Table 5 it is clear that the percentage of residue is close for all oil samples, and even heavy ones have a lower percentage, and this is not reasonable. Although gasoline and diesel are derivatives of economic benefit and are required for use as fuel, these derivatives obtained in this study contain a high percentage of sulfur, which means that they must be sent for further refinement to the unit of hydrotreatment before using it as fuel.

Table 1. Physical and chemical properties of four crude oils

Value	Unit	Crude oils		
		T-21A	T-5	PF2
Density at 20 °C	g/cm3	0.8943	0.8943	0.9441
API gravity at 15.6 °C	° API	26.7	26.7	18.3
Sulfur	% Mass	2.8	2.96	5.15
Ash Content	% Wt.	0.1762	0.1825	3.563
Carbon Residue	%Wt.	5.65	3.89	9.39

Table 2. Distillation data and physicochemical properties of Tawke T-21A crude oil

Cuts	Distillate vol. % (ml)	Temperature ℃	Density g/cm^3	Sulfur content % wt.
1	10%	73-143	0.7192	0.2616
2	20%	143-180	0.767	0.284
3	30%	180-251	0.815	0.509
4	40%	251-290	0.8444	1.4889
5	50%	290-325	0.8706	2.5006
6	57%	325-347	0.8904	3.2672

Table 3. Distillation data and physicochemical properties Tawke T-5 crude oil

Cuts	Distillate vol. % (ml)	Temperature ℃	Density g/cm^3	Sulfur content % wt
1	10%	74-143	0.7003	0
2	20%	143-203	0.762	0
3	30%	203-253	0.782	0.489
4	40%	253-299	0.8033	1.439
5	50%	299-333	0.8659	2.758
6	60%	333-350	0.8859	3.779

Table 4. Distillation data and physicochemical properties Shekhan PF2 crude oil

Cuts	Distillate vol. % (ml)	Temperature ℃	Density g/cm^3	Sulfur content % wt.
1	10%	79-166	0.7382	0.193
2	20%	166-204	0.796	0.193
3	30%	204-242	0.816	0.797
4	40%	242-288	0.8342	2.867
5	50%	288-300	0.8549	4.214
6	62%	300-350	0.903	6.327

Table 5. Material balance of atmospheric distillation for crude oil samples

Results	Crude oils		
	T-21A	**T-5A**	**PF2**
Volume %	100	100	100
Gasoline	20	20	20
Diesel	40	40	42
Residue	40	40	38
Total	100	100	100

3.3 Physical and Chemical Properties of Residue +350°C

Tawke T-21A and T-5 residues, Shekhan PF2 residues were obtained from its crude oils by removing distillates boiling point up to 350 ℃ using the atmospheric distillation unit.

In Table 6 shows that the density of T-21A and T-5 residue is lower than PF2 residue, this indicated that the PF2 residue contained more aromatic compound than T-21A and T-5 residue +350°C, while T-21A and T-5 residue +350°C contained more paraffinic compound than PF2 residue. As the results Shikhan (PF2) residues +350°C higher sulfur content than Tawke (T-21A and T-5) residue +350°C.

3.4 Coking Process

Coking process is a method of processing residues at high temperatures (450-460°C) and near atmospheric pressure, with the aim of producing coke, liquid distillates and gas.

Coking of residues +350°C was carried out at temperature 450-460°C and atmospheric pressure, at this temperature, the duration of heat treatment of the feed was 2h. 15 min. to 2h. 45 min. The choice of temperature and time of the experiments was made on the basis that a lower temperature increases the duration of the process, and at a higher temperature and a significant reduction in the duration of the process, it becomes difficult to obtain the target product with the required content of volatile substances. As stated by Zaporin [23] an increase in the duration of the coking process from 2 to 3 hours and more in all cases leads to a decrease in the content of volatile substances. Also with an increase in the duration of the coking process, the dependence of the quality of coke on the type of raw material becomes insignificant [23].

The process of coking has become most common in many countries, which allows producing significant amounts of distillates and a minimum amount of coke. Another reason the common process of coking is that it is possible to produce petroleum coke as an alternative fuel for kiln cement [24].

3.4.1 Material balance of coking process

During the evaluation of Iraqi-Kurdistan oils, a different ratio of the product and residue fractions was found: 57% distillate and 43% residue +350 °C for mix. (T-21A+T-5) sample, while 62% distillate and 37% residue +350°C for PF2 sample. The physical and chemical characteristics of crude oil vary widely from one production field to another and even within the same field. It is important to discuss crude oil properties because refining technology has been developed in response to the differences between crude oil properties and final product specifications [4, 25].

In coking experiments, the products are gas, distillate and coke, the material balance of coking experience is presented in Table 7 and explain by flowchart in Figs. 6 and 7. The quality of the raw material for coking show in Table 6.

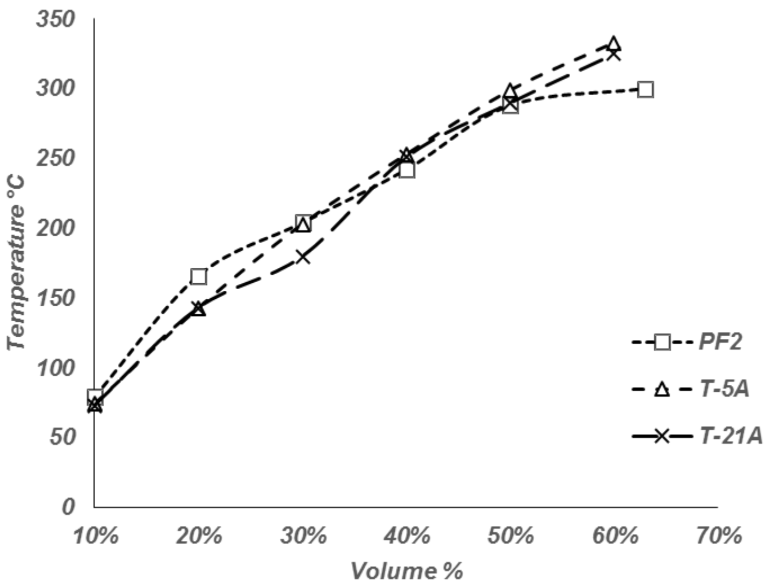

Fig. 5. Distillation Curves of T-21A, T-5 and PF2 crude oils

Table 6. Physicochemical properties of residue +350°C

Value	Unit	Residue $^{+}$350 °C		
		T-21A	**T-5**	**PF2**
Density at 20°C	g/cm^3	1.0122	1.0122	1.0255
Sulfur content	% wt.	4.39	4.09	6.70
Ash Content	% wt.	2.384	2.013	5.968
Carbon Residue	%wt.	8.59	7.61	17.93

Table 7. The Material balance of the coking process

Result	Residue $^{+}$350°C	
	mix. (T-21A+T-5)	**PF2**
Weight %	100	100
Gas	5.328	3.724
Distillate	56.736	28.615
Coke	34.32	60.574
Lose	3.6195	7.085
Total	100	100

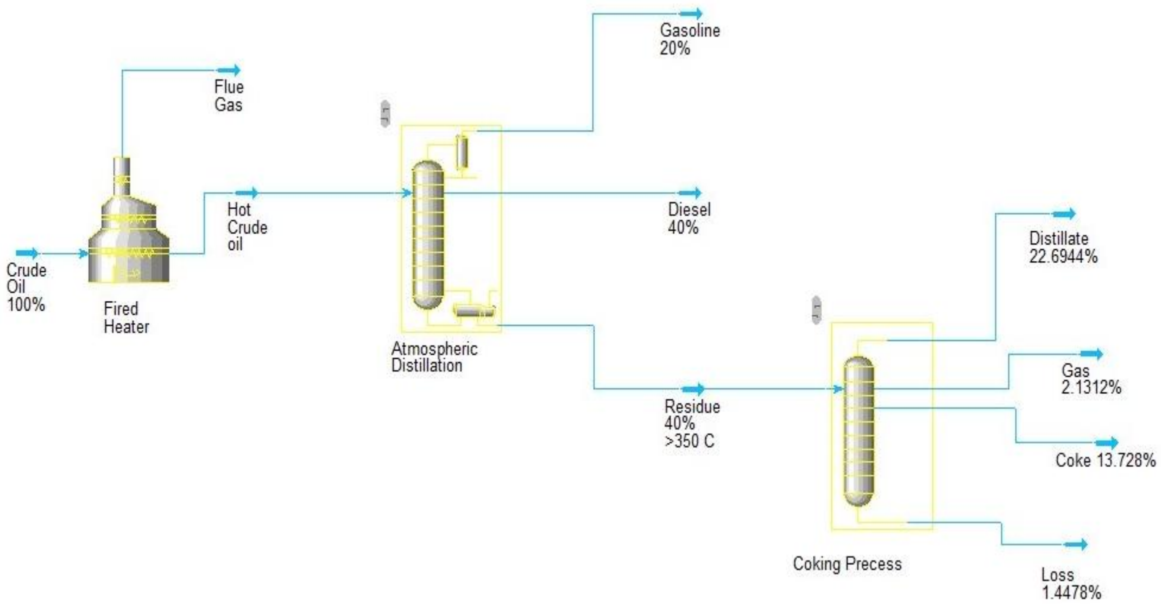

Fig. 6. Process flow diagram and material balance the coking process of mix. (T-21A+T-5) residue $^{+}$350°C

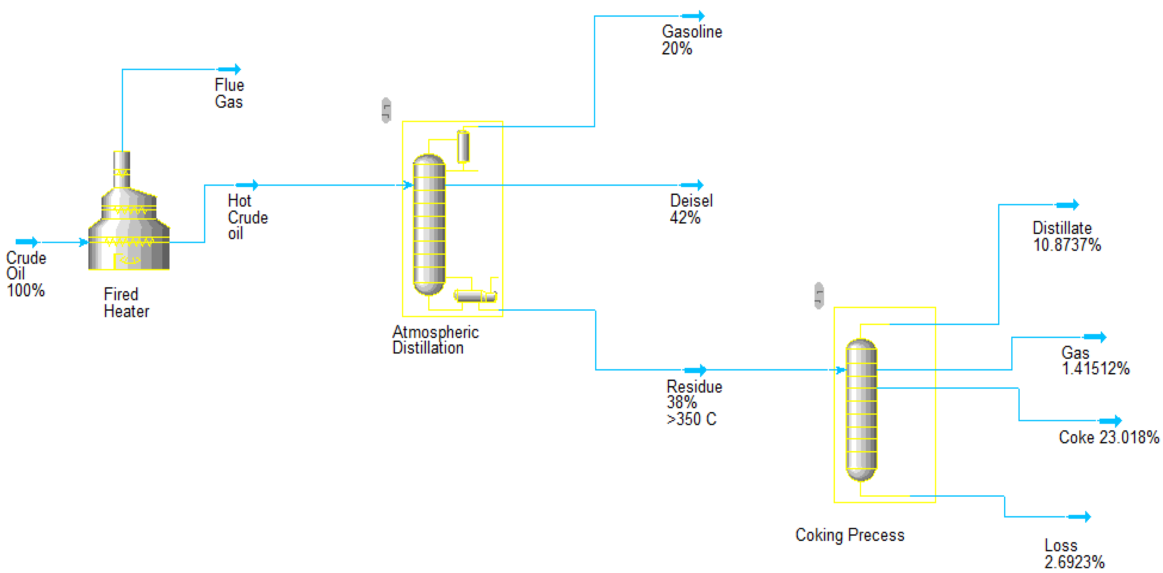

Fig. 7. Process flow diagram and material balance the coking process of PF2 residue $^{+}$350°C

At a temperature of 450-460°C, the percentage of gas during the process was 5.328% by mass for the mix. (T-21A+T-5) residue $^{+}$350°C and 3.724% for PF2 residue $^{+}$350°C. The content of volatile substances (distillates) in the average coke sample over the entire volume of the coke was 56.736% by mass for mix. (T-21A + T-5) and 28.615% of the PF2. The coke product was 34.32 by mass for T-21A residue $^{+}$350°C and 60.574% for PF2 residue $^{+}$350°C.

During coking, gas yield (5.328%) of mix. (T-21A+T-5) a higher than gas percent obtained from PF2 (3.724%) is observed, the total yield of distillate fractions T-21A is higher than PF2 distillate the result show in Table 7, this is due to different in chemical composition of crude oil residues. Total Result of Coking Process are given in Table 8.

In this work, the possibilities coking process of crude residue for the mix. (T-21A+T-5) and PF2 samples with different in a density, coking ability, sulfur content and ash content are shown. In the case of coking process of the residue $^{+}$350°C, carried out under test condition, even more significant withdrawals of the distillate fraction the mix. (T-21A+T-5) is (56.736%) and PF2 (28.615) are achieved with a minimum yield of gas. The yield of coke for PF2 was 60.5% higher than mix. (T-21A+T-5) 34.32%, this is due to the different in sulfur content and trace element in samples.

Sulfur, metals and ash are undesirable impurities in commercial coke. When containing them in large quantities, coke is suitable only as a fuel. However, in this case, the problem of environmental pollution rises.

The metal content in petroleum coke particularly vanadium and nickel if high causes hard burning and this may be overcome by fine grinding for petroleum coke. The high sulfur content of petroleum coke may cause operational problems in cement kilns, like blockage of cyclones and also environmental pollution by emissions, thus it is necessary to add small dose of raw meal (limestone) to reduce sulfur.

3.4.2 Characterization of coking distillate and coke

In table 9 shown the characterization of coking distillate and coke are product from mix. (T-21A+T-5) and PF2 residue +350°C. According to the results, PF2 coke is characterized by a high content of vanadium (447 ppm), nickel (138 ppm) and sulfur (0.9 wt. %). Whereas, mix. (T-21A+T-5) coke characterized by a content of vanadium (130 ppm), nickel (43 ppm) and sulfur (0.8 wt. %) lower than aforementioned sample. It is clear that, the metal and sulfur in PF2 coke is higher than mix. (T-21A+T-5) coke.

The coking distillate has low quality indicators: the content of sulfur compounds is 6.64% wt. for mix. (T-21A+T-5) residue +350°C and 7.87% wt. for PF2 residue +350°C, low stability, ash content 0.8% wt. for mix. (T-21A+T-5) coke and 0.9% wt. for PF2 coke, as shown in Table 9. For this reason, this fraction is usually sent to complete refinement. The gasoline fraction is sent to the naphtha splitter for separation into the light and heavy parts, after which it is hydrotreated. Light gas oil is raw materials for mixing with gas oils of other plants, heavy gas oil goes to hydrocracking as shown in Figs. 6 and 7.

Upon completion of the coking process, coke was collected and analyzed to determine the content of sulfur and ash. Table 7 shows the material balances of coking and the distribution of sulfur in products obtained by coking of the feedstock.

Table 8. Total result of coking process

Results	Residue $^{+}$350°C	
	mix.(T-21A+T-5)	PF2
Weight of sample (gm.)	29.52	20.44
Coking distillate wt.%	56.736	28.615
Coke wt.%	34.32	60.574
Gas wt.%	5.328	3.724
Gas cm^3	1430	692
Lose wt. %	3.6195	7.085
Duration process	2 h. 45 min.	2h. 15 min.

Table 9. Characterization of coking distillate and coke in coking process

Result	Coking Distillate		Coke 450°C	
	mix.(T-21A+T-5)	PF2	mix.(T-21A+T-5)	PF2
Density at 20 °C	0.86314	0.8351	-	-
Sulfur Content % wt.	2.09	2.44	6.64	7.87
Ash Content % wt.	0.0509	0.042	0.8	0.9
Metal content ppm;				
Vanadium	2	1	130	447
Nickel	-	-	43	138
Lead	3	2	14	61

3.5 Suggestion of Deep (Advanced) Refining Schemes for Heavy (Medium and High Sulfur Content) Feedstock

The understanding of the upgrading processes for heavy, medium and high sulfur content feedstock will help refiners to face current and future challenges such as how to deal with such a feedstock, how to meet environmental regulations and how to evaluate and optimize the processes (utilization of petroleum coke is both economic and environmental importance).

The attempt to solve the problem of refining of heavy feedstock such as (Tawke and Shekhan) sample conducted using coking process to obtain coke and other liquid fuel from high sulfur content residues. For example, in this work AT residue +350°C from Tawke crude oil with sulfur content of (4.39% wt.) and AT residue +350°C from Shekhan crude oil with sulfur content of (6.7% wt.) are used as feedstock in coking unit.

Coking consider one of the most economic processes which is provides a decrease in output to a minimum. Thus, coking process of Tawke and Shekhan feedstock is studied by material balance, (gases, the volatile content, and the main product coke).

Currently, foreign refineries selling high sulfur content coke is not a problem since it is widely used not only for the production of the anode and electrode, but also in the cement and metallurgical industries, as well as household and energy fuel. As a result of our work study and in order to deep oil refining and organize production of various fuels from medium and high sulfur content feedstock in KRG-Iraq were considered two scheme option for processing of Tawke and Shekhan crude oil.

The Figs. 8 and 9 are a schematic flow diagrams of a typical oil refinery of Tawke and Shekhan crude oil that depicts the various unit processes and the flow of intermediate product streams that occurs between the inlet crude oil (Tawke and Shekhan) feedstock and the final end products. There are many process configurations other than that depicted above. For example, the vacuum distillation unit may also produce fractions that can be refined into end products.

In this scheme (8) and (9), straight run fuels produced at AT unit and secondary distillate fuels (from coking unit) are sent to further treatment installation. The gasoline fraction is sent to the naphtha splitter for separation into the light and heavy parts, after which it is hydrotreated and sent to catalytic reforming unit, diesel goes to hydrotreating and AT residue sent to coke unit to produce (gas, coking distillate and coke). The results showed that analyzed coke has a high sulfur content, low ash and metallic content in samples. Therefore, petroleum coke of (Tawke and Shekhan) as show in diagram 1 can be applied as energy in the electrical field (electro energy), and in diagram 2 may be applied as alternative fuel for cement and metallurgy manufacture.

Commercial products from each suggested scheme includes: gasoline, kerosene, diesel, and coke. Because of in coking process heavy feedstock with medium and high sulfur content are converted into valuable products such as high-quality coke and raw materials for other refining process [26], the implementing the option 2 (Fig. 9) of refining schemes of Tawke and Shekhan crude oils.

Thus, the suggested refining scheme for Tawke and Shekhan crude oils (Figs. 7 and 8) are more preferable in comparison with the non-deep oil refinery schemes, both in term of profitability and environmental issue.

The drawback of this method is in that the coking products characterized by high-sulfur contents concentration. To compensate for the negative effect of organic sulfur in ore and in metallurgical coke used as fuel or reduction agent in blast furnaces, fluxes are contained in the feed, including calcium oxide in the form of lime. The calcium oxides react with the sulfur in the metallurgical coke and convert it into a non-organic form and removed with slags:

$$CaO + S + C \qquad CaS + CO \quad \ldots \quad (1)$$

The higher the sulfur content of the coke, the larger quantity of flux must be added in the form of the calcium oxide into flux. A large quantity of flux in cast iron production overloads the blast furnace, cutting down the output of cast iron.

There are published data on laboratory tests under stationary conditions, similar to coking in cubes, on effect of alkaline additives on sulfurous raw materials for coking. Much of organic sulfur in the raw materials reacts with potassium hydroxide, converting it into a water-soluble salt, which reduces the sulphur content [23]. A considerable quantity of Potassium Hydroxide was introduced, which means that the coke produced had to be washed with water to remove the excess of alkali.

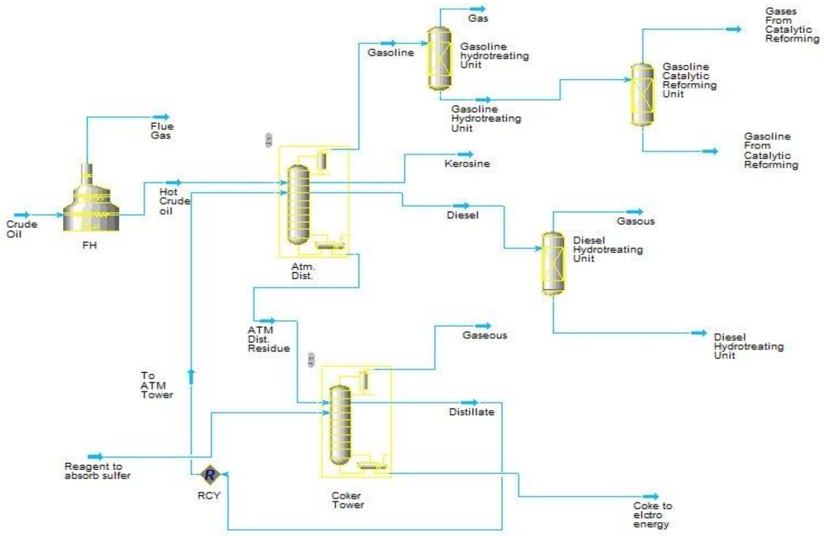

Fig. 8. Suggestions refining diagram1 of Tawke and Shekhan crude oil

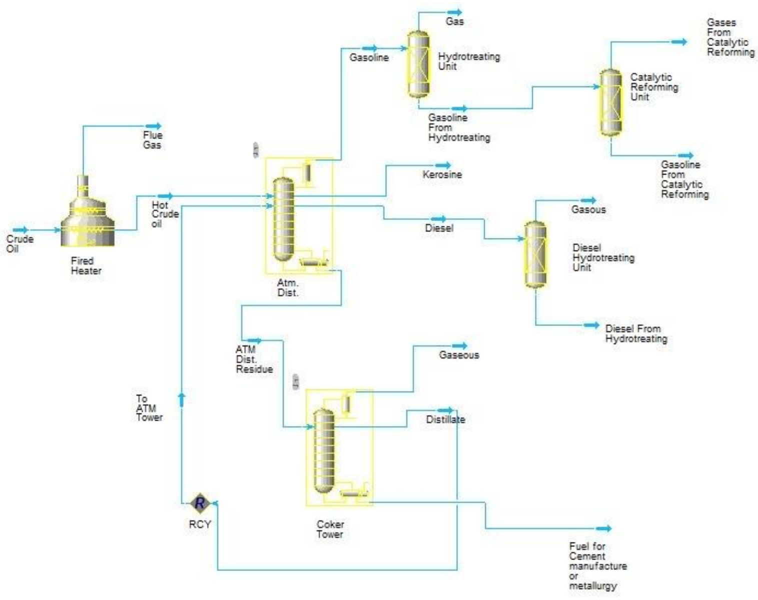

Fig. 9. Suggestions refining diagram2 of Tawke and Shekhan Crude oil

The introduction of additives coking in the charge of coking can significantly increase the yield, increase the strength characteristics of metallurgical coke and improve its quality. However, its high sulfur content (up to 5.0%), which predominantly goes into metallurgical coke, can reduce the quality of cast iron.

When burning petroleum coke obtained by adding Ca compounds to the coking feedstock, part of the sulfur from organic is converted to inorganic and remains in the ash in the form of CaS and CaS04, which are not quantified using this method. Calcium sulfide is insoluble in cast iron and goes into slag.

However, the need to add a large number of fluxes in the case of using metallurgical coke with a high sulfur content reduces the productivity of blast furnaces for the production of target products and, as a result, worsens the technical and economic indicators.

Experiments were carried out on the coking of raw materials with additives of oxide and Ca hydroxide in an amount of 2.0, 5.0 and 10% for raw materials. The choice of calcium compounds as additives is due, firstly, to the availability of calcium compounds, and, secondly, it is Ca compounds that are used as fluxes for desulfurization of cast iron.

Petroleum coke is a waste product from oil refining industry, but it represents an economical fuel alternative to the cement manufacturing (Proposed processing scheme 2). Using of petroleum coke means low cost of production, but also mean operational problem within the kiln system.

4. CONCLUSIONS

Utilization of petroleum coke is of both economic and environmental importance. It's by product from oil refinery (low price) make it a very attractive fuel, whereas, it's high carbon and sulfur content make it difficult fuel with respect to pollution concerns. The current approach, would provide a good opportunity for using petroleum coke to produce clean energy. The proposed process will take advantage of the otherwise demanding properties of petroleum coke as fuel. One of the benefits of using petroleum coke as kiln fuel is that after complete combustion, it leaves substantial amounts of ash content, which become part of the clinker and ultimately of the cement. These added ash content, thereupon, lead to saving per ton of cement produced, account of reduction in the cost of raw materials and their processing.

The study suggestion using coke instead of fuel oil in industry effectiveness in cost reduction when switched over from fuel oil to petroleum coke. In this work, after all the measurements and characteristics obtained, two types of treatment schemes were proposed for how to refine these types of oils, which give petroleum products with a high sulfur content. The coke was produced in diagram 1 is applied in electrical field as energy, and in diagram 2 is applied as alternative fuel for cement and other industries.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Lopez Y. Integrated processing for heavy crude oil. Sadhukhan Jhuma. University of Manchester, uk.bl. ethos. 2015;654796.
2. Haley D. The efficient use of coke. Iron castings research institute meeting Plymouth. Indiana; 2004.
3. Madlool NA, Saidur R, Hossain MS, Rahim N. A critical review on energy use and savings in the cement industries. Renewable and Sustainable Energy Reviews. 2011;15(4):2042-2060.
4. Omran Eid Jabir. USPTU, Chemical technology of fuel and high-energy substances; 2013.
5. Kondrasheva NK, Olkov PL, Kondrashev DO. Refinery Design Fundamentals. USPTU. 2003;57.
6. Adams J, Bornstein JM, Munno K, Hollebone B, King T, Brown RS, Hodson PV. Identification of compounds in heavy fuel oil that are chronically toxic to rainbow trout embryos by effects-driven chemical fractionation. Environmental Toxicology and Chemistry. 2014;33(4):825-835.
7. Karim AR, Hamasalih LO, Tofiq DI, Salih DM. A Comparative Elemental Analysis of the Different Kurdistan Crude Oil Fields. American Journal of Science and Technology 2015;2(2):74-78.
8. Chatziaras N, Psomopoulos C, Themelis N. Use of alternative fuels in cement industry. Proceedings of the 12th International Conference on Protection and Restoration of the Environment, A. Liakopoulos, A. K., C. Christodoulatos, A.

Koutsopsyros, Ed. ISBN 978-960-88490-6-8. 2014;521-529.

9. Rangel-German E, Camacho Romero S, Neri Flores U, Theokritoff WA. Thermal simulation and economic evaluation of heavy-oil projects. International Oil Conference and Exhibition in Mexico, Society of Petroleum Engineers; 2006.
10. Green K. Improve processing of'opportunity crudes': Consider these options to minimize adverse impacts when upgrading low-priced crudes. Hydrocarbon processing (International ed.). 2004;83(6):53-55.
11. Wang J, Anthony EJ, Abanades JC. Clean and efficient use of petroleum coke for combustion and power generation. Fuel 2004;83(10):1341-1348.
12. Stratiev D, Dinkov R, Nikolaev N, Stanulov K. Evaluation of impact of crude oil quality on refinery profit. Erdoel Erdgas Kohle. 2010;126(1):17-21.
13. Khairudinov IR, Tikhonov AA, Omran AD, Telyashev EG. Gas chemistry and modeling of chemical technological processes.Bashkir Chemical Journal. 2012;19(2).
14. Samborskaya MA, Gusev VP, Gryaznova IA, Wolf AV. Determination of the optimal parameters of the heating steam at oil fractionation plants.Scientific Bulletin of Novosibirsk State Technical University. 2015;59(2):157-168.
15. Vafin A, Zaporin VP. Selection of a scheme for deep processing of sulphurous oil with the production of a coking additive.AUNTY Young Scientist Bulletin. 2015;2:51-57.
16. Valyavin GG, Zaporin VP, Mansurov TF, Sukhov SV. Oil and Gas Journal. 2014;12(4):72-75.
17. De Beer J, Worrell E, Blok K. Future technologies for energy-efficient iron and steel making. Annual review of energy and the environment. 1998;23(1):123-205.
18. Morris AE. Iron resources and direct iron production. In Encyclopedia of Materials: Science and Technology, Buschow, K. H. J.; Cahn, R. W.; Flemings, M. C.; Ilschner, B.; Kramer, E. J.; Mahajan, S.; Veyssière, P., Eds. Elsevier: Oxford. 2001;4302-4310.
19. Rathod K, Gupta S, Sharma A, Prakash S. Energy-efficient melting technologies in foundry industry. Indian Foundry J. 2016;62(9):39.
20. Ali MF, Bukhari A, Saleem M. Trace metals in crude oils from Saudi Arabia. Industrial & engineering chemistry product research and development. 1983;22(4):691-694.
21. Matar S, Hatch LF. Chemistry of petrochemical processes. 2 ed.; Elsevier: Butterworth-Hienemann; 2001.
22. Neman SA, Saleem FM. Evaluation and improvement of gasoline and naphtha cut of Tawke crude oil wells, Zakho. J. OF petroleum and Gas Exploration Research. 2011;2(4):069- 079.
23. Valyavin GG, Zaporin VP, Sukhov SV, Mamaev MV, Bidilo IV, Valyavin KG, Stukov MI, Zagainov VS, Gabbasov RG. Production method for a modifying coking additive by delayed coking of residue oil. Google Patents: United States; 2015.
24. Zaporin VP, Akhmetov MM, KhatmullinIG, Vafin IA. Carbonization of medium-sulfur crude for producing low-sulfur coke. Chemistry and Technology of Fuels and Oils. 1989;25(10):503- 506.
25. Sawarkar AN, Pandit AB, Samant SD, Joshi JB. Petroleum residue upgrading via delayed coking: A review. The Canadian Journal of Chemical Engineering. 2007;85(1):1-24.
26. Akhmetov MM, Kajrlieva FB, Bukunova AS. Dependence of the quality indicators of petroleum cokes of the Atyrau refinery on the supply of high-sulfur oils. Bashkir Chemical Journal. 2009;16(2).

© 2021 Simo et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle4.com/review-history/73820