THE INCREASE OF HEAVY OILS OCCURRENCE, THE STUDY OF ITS CHARACTERISTICS AND IMPACTS IN THE PRODUCTION, TRANSPORT AND REFINING OPERATIONS

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Abstract. *The petroleum is the main component of the world energetic matrix. Like this, it is natural the concern as for the exhaustion and the decrease of the oil reserves quality. On the other hand, the discovery of new oil wells maintains the hope in the continuity of the industry of the petroleum. The subject to analyze is that the discovery, of new oils reserves, it is constituted of oils with some characteristics very different from the characteristics of the conventional ones, whose chemical and physical chemical properties were adopted as calculation base for the project and operation of the most varied types of equipments of the current refineries. Like this it appeared the denomination of non conventional oils for some of the new and gigantic reserves discoveries. The great Fields that evidence these characteristics are the ones with heavy oils in Russian, Kazakhstan, China, Venezuela, Canada, Alaska and Brazil. These heavy oils with API degree below 22º have high viscosity value, they can present acidity, present varied sulfurous compounds content, increase of the metals content and larger heavy fractions production. The non conventional oils present rheological properties very different from the same properties of the conventional oils, mostly regarding the viscosity and to the density, whose values influence directly in the piping project, valves and pumps, among other equipments, of the so much operating system in the production phase as in the pumping, transport and processing of the non conventional oils. To overcome these technological obstacles, new such alternatives appeared as the pumping in core flow system that reduces very much the pressure drop through the two-phase flow for the piping, and the upgrading process, that it transforms heavy oils in synthetic ones, susceptible to be processed by the traditional refineries. Thus, the end of the petroleum era is far from ending, giving time so that the researches of the energetic alternative sources generate products capable to integrate efficiently the world energetic matrix.*

Keywords*: heavy oils, oil reserves, non conventional oils, upgrading, sulfur.*

1. PETROLEUM

The petroleum is a blend of complex hydrocarbons, also presenting other elements, as oxygen, sulfur, nitrogen and metals, whose concentrations can vary from an oil field to another. The petroleum medium composition is presented in the Tab. 1 (OSHA, 2005).

Table 1 -Medium petroleum composition.

Component	% (weight)
Carbon	84 – 87
Hydrogen	11 - 14
Sulfur	0 – 6
Nitrogen	< 1
Oxigen	< 1
Metals	< 1
Salts	< 1

Source: Adapted from OSHA (2005).

An important petroleum characterization parameter is its density, usually expressed in API gravity. According to Himmelblau (1984), the density in API gravity (American Petroleum Institute) is defined by the Eq. (1), in which - d - represents the relative density to 15.6 ^oC (60 ^oF).

$$^{o}API = \frac{141.5}{d} - 131.5 \qquad (1)$$

The crude oils are classified according to density in API gravity (Tab. 2) and the larger the value of the API gravity, the larger the value of the petroleum in the market (ONIP, 2007). Due to the composition of petroleum natural deposits, when the depth extraction increases, the heavier the oil becomes (Swain, 1997).

Tab. 3 shows the evolution of the API gravity of the petroleum feedstock processed by the North American refineries (EIA, 2007). With the decrease of the API gravity, the crude oils may present a higher content of some pollutants, among them the sulfur (Swain, 1997). Tab. 3 shows that the participation of the heavy oils presented a strong increment while the participation of the medium and light oils presented a clear decline. Nowadays, the USA refineries process around of 14.8 millions of barrels of petroleum a day, from which about 10.2 millions of barrels are imported (DOE/EIA, 2007). About the imported petroleum, 33% come from the OPEP countries (except Saudi Arabia), 15% come from Saudi Arabia, 36% come from no OPEP countries (except Canada) and 16% come from Canada. Therefore, based on those data, the increase of the supply of heavy oils is evidenced at the international market (USC, 2006).

Table 2 – Petroleum classification.

API gravity	Crude oil
<10.0	Extra heavy
11.0 – 22.0	Heavy
23.0 – 30.0	Medium
> 30	Light

Source: ONIP (2007).

Table 3 - Percentual variation (according to API gravity) of the total of petroleum imported by the United States.

Ano	<20.0	20.1 a 25.0	25.1 a 30.0	30.0 a 35.0	35.1 a 40.0	40.1 a 45.0	>45.1
1978	1.26	3.57	7.93	38.79	31.66	13.48	3.31
1980	1.70	6.18	9.25	38.43	27.02	13.56	3.85
1985	7.62	20.46	11.19	27.14	24.93	4.02	4.65
1990	3.64	14.96	18.13	34.44	23.21	2.94	2.67
1995	4.52	18.38	17.04	31.51	23.81	2.98	1.76
2000	6.21	18.88	13.41	36.90	19.83	3.44	1.35
2001	7.97	20.78	11.60	36.10	19.63	2.71	1.21
2002	8.28	22.29	11.44	35.28	18.29	2.67	1.75
2003	8.29	24.25	9.97	35.60	17.19	2.70	1.9
2004	11.13	23.70	8.18	34.57	17.68	2.10	2.64
2005	11.94	22.83	10.20	31.87	16.92	3.68	2.55
2006	13.10	23.40	11.13	28.32	15.60	5.69	2.76

Source: EIA (2007).

1.1. Conventional oils and unconventional oils

The conventional oils present minimum API gravity of 22 and viscosity, to the reservoir temperature, around 100 cP (centipoise), according to USGS (2003).

According to Mandil (2002) the unconventional oils are all the raw ones with API gravity below 20. Heavy oils have API gravity between 10 and 20. Oils extra heavy and bitumen have API gravity below 10 and the difference among them is in the respective viscosities to the reservoir temperature, larger than 10,000 cP for the bitumen and smaller than 10,000 cP for the extra heavy oils. The unconventional oils result from bacterial oxidation of conventional oils, inside of the rock reservoir, influencing on the physical and chemical properties, which are usually degraded, thus reducing the API gravity, increasing the viscosity and making the heavy metals, sulfur and nitrogen content higher. These properties do specific solutions for the production, transport and refining become necessary. Such solutions already exist, but they need technological innovations to become the exploration of unconventional raw oils more economically attractive, and to reduce the associated environmental problems substantially.

There are great unconventional oil beds in Canada and in Venezuela, that reach a total amount around 3 to 4 trillions of barrels, with recovery potential in the order of 600 billions of barrels, which could assist, satisfactorily, the future derivates needs for world consumption (USGS, 2003 and Hirsh et al, 2005). However the Athabaska oils (Canada) and the Boscan oils (Venezuela) contain a high sulfur content (4,27 and 5.27% in mass).

There are heavy oils In Brazil, such as: the Marlin oil that presents low sulfur content (0.78%), it is a heavy oil (API gravity 19.2) and acid (1.2 mg KOH/g), which has been produced in offshore fields, in the Campos basin; the petroleum Jubarte, with API gravity 17, which is extracted from the northern part of the Campos basin; the petroleum Siri, with

API gravity 13, which is extracted in the onshore part of Espírito Santo Basin. From the Petrobras proven reserves, 3 billions of barrels are constituted by oils with density below API gravity 19.

1.2. Conventional oils worldwide reserves

The Fig. 1 shows the relationship of the oil reserves, in 2004, among the countries belonging to OPEC, holders of 78% of the petroleum world reserves and of the OPEC non participating countries, which contribute with 22%. In the same Fig.1 the contribution of each OPEC participating country has been showed (OPEC, 2004).

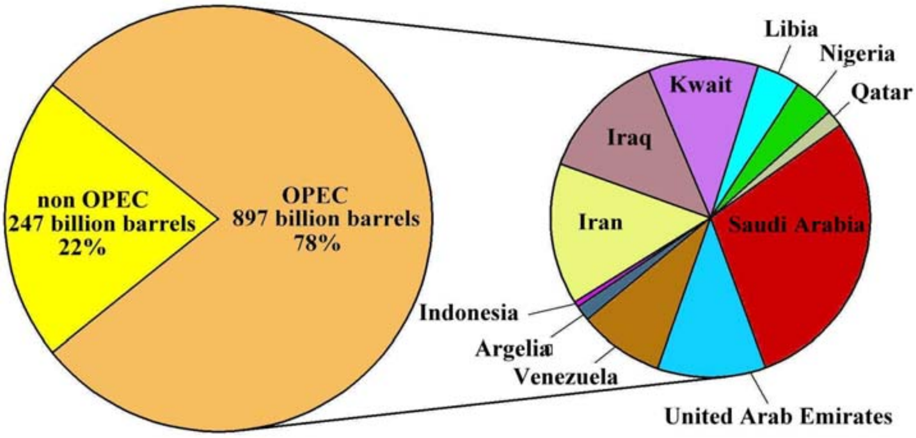

Figure 1 - Petroleum worldwide reserves of aligned and non aligned countries to OPEC in 2004.

1.3. Unconventional oils worldwide reserves

The Occident has 69% of the world reserves, technically recoverable, of heavy petroleum and 82% of the world bitumen reserves, also technically recoverable. The East, in turn, counts with 85% of the light petroleum world reserves. The heavy oils and the bitumen are present all over the world, as presented in the Tab. 4. The great accumulations of heavy petroleum are in the Orinoco area, in Venezuela, that contains 90% of the extra heavy petroleum world total. Eighty percent of the known bitumen reserves are in the Alberta area, in Canada. Together, those two hydrocarbon deposits contain reservations of about 3,600 billions of barrels of petroleum (Meyer et Attanasi, 2003).

The estimated technically recoverable volume of heavy petroleum (434 billions of barrels) and bitumen (651 billions of barrels), in known accumulations is approximately equal to the reserves of conventional oils, remaining in the Earth, according to Tab. 4 and Fig. 2.

Table 4 - Distribution, according to area, of heavy petroleum and bitumen reserves technically recoverable in trillions of barrels.

Area	Heavy oil		Bitumen	
	Recovery Factor (1) (%)	Technically Recoverable (billions of barrels)	Recovery Factor (1) (%)	Technically Recoverable (billions of barrels)
North America	0.19	35.3	0.32	530.9
South America	0.13	265.7	0.09	0.1
Occident	-	301.7	-	531.0
Africa	0.18	7.2	0.10	43.0
Europe	0.15	4.9	0.14	0.2
Middle East	0.12	78.2	0.10	0.0
Asia	0.14	29.6	0.16	42.8
Russia	0.13	13.4	0.13	33.7
East	-	133.3	-	119.7
World Total	-	434.3	-	650.7

On the tab.4, (1) recovery factors are based on technical estimates, published for heavy oils and bitumen producing. When unavailable, values were considered, for the recovery factor, in the order of 10% and 5% for heavy petroleum and bitumen in reservoirs formed by sandstone or for carbonate, respectively, according to Meyer and Attanasi (2003).

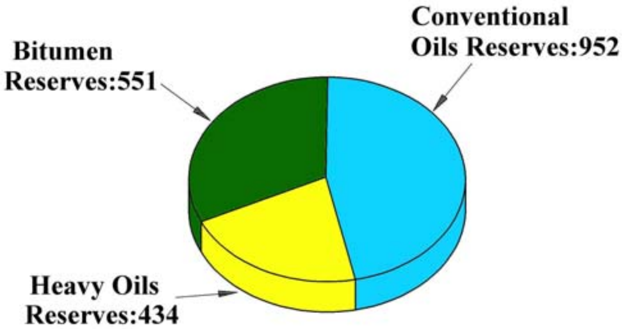

Figure 2 - World distribution of conventional and unconventional oils reserves, in trillions of barrels.

At Kazakhstan there are other similar geological formations which have a high potential of hydrocarbons beyond the Kashagan giant well, showing the expansion of the petroleum frontiers around the world. This can indicates that the end of the petroleum is so far, yet (Maugerim, 2004).

Next up, are presented the characteristics and properties of some petroleum from Mexico, Canada, China and Brazil, to show some relation among them.

1.3.1. Mexican oils

According to IMP (2006) the Maya petroleum is a mixture of heavy oils, which represents about 40% of the total of petroleum produced on Mexico. Tab. 5 presents some characteristics (properties and composition) of the Maya petroleum. At same table, we can see that Maya petroleum has high sulfur content (about 3.5% mass).

Table 5 - Maya petroleum characteristics.

Characteristics	Amount	Characteristics	Amount
Elementary analysis (% mass)		Metals (weight ppm)	
C	86.9	Ni	49.5
H	5.3	V	273.0
N	0.3	Ca	11.26
S	3.52	Na	44.83
-	-	Mg	2.04
-	-	K	20.25
-	-	Fe	2.16
Asphaltens (% mass. insoluble in nC_5): 12.7			
Density (20/4 ^oC)	0.9251 $g.cm^{-3}$	API gravity	21.31
Pour point (^oC)	- 30	Viscosity ($g.cm^{-1}.s^{-1}$)	
Ramsbotton carbon (% mass)	10.87	50 (^oC)	3.08
-	-	100 (^oC)	9.45

Source: IMP (2006)

1.3.2. Canadian oils

The petroleum industry is going back to the unconventional oils sources that appear as a promise of increase in the world energy supply. The bituminous sands of the Alberta area, in Canada, represent a great increment potential in the petroleum world supply. The current production of unconventional petroleum in Canada, occupies the twentieth first place in the world scale of petroleum production, equaling some OPEP countries (USC, 2006).

The bituminous sands are formed by finely divided rocks, containing from 75 to 80% of sand and clay, impregnated with bitumen. Heavy minerals as zirconium and pyrite, among others, are also present. The bitumen is a dark and sticky substance, containing from 4.4 to 5.4% of sulfur and heavy metals, among them nickel (69 to 85 ppm) and vanadium (81 to 218 ppm). The bitumen presents high density, in the range from 970 to 1,015 kg/m^3 (8 - 14 ^{o}API) and viscosity in the order of 50,000 cP (centipoise) at the reservoir temperature. Due to presenting low hydrogen content, the bitumen should suffer upgrading, producing synthetic petroleum of high quality, to be processed in refineries projected to operate with conventional oils.

As information from American Congress (USC, 2006), in the near future, the unconventional petroleum production, as the petroleum produced starting from the bituminous sands in Canada, will occupy a prominent place in the balance between the demand and the world supply of petroleum. The Tab. 6 presents certain characteristics of some Canadian oils, comparing them with the Athabasca bitumen.

1.3.3. Chinese oils

In China, the heavy oils have been found in all of the petroleum basins. The main fields producing of petroleum are located in the depressions of Anan, Abei, Bayindulan, Wuliyasitai, Honghaorsute, Jirgalangtu, Saihantala, Erennaor and Bayinchagan. (Dou et al, 1998). The main physical and chemical properties of the Chinese oils are presented in Tab. 7.

Table 6 –Canadian oils properties.

Petroleum	API gravity	Dynamic viscosity	S (% mass)
Alberta	36.8	5 cP to 20 °C	ND
Alberta sweet blend	35.1	7 cP to 15 °C	0.65
Atkinson	23.7	533 cP to 15°C	1.07
Avalone	36.0	83 cP to 15 °C	0.86
Athabasca bitumen	7.7 a 9.0	9,000 cP to 15 °C	ND

Source: ETC (2006).

Table 7 – Chinese heavy oils properties.

Production Field	Shengli		Xinjiang		Liaohe			Dagan	Huabe	"Offshore"
Petroleum name	Gudao blend	Gudong 1 – 19	Wuerhe heavy	Jiuqu blend	Gaosheng	Jin-16	Huan-17	Yangsanmu	Jin-7	Chengbei
API gravity	17.01	16.2	15.2	20.5	17.3	19.8	17.9	17.0	7.7	16.6
Density (kg/m^3) 20 °C	949.5	954.6	960.9	927.3	947.2	931.2	943.3	949.2	1013	952.2
cinematic viscosity (mm^2/s) 50 °C	333.7	548	405 a 100°C	381.3	2101 583 to 70 °C	69.7	96.4	6.38	1090 to 100 oC	615
Resin (%)	26.8	27.3	33.6	21.4	36.8	11.8	15.9	24.3	-	25.0
Paraffin	4.9	3.4	4.7	7.4	5.8	3.1	2.2	5.6	0	6.3
Carbonic residue (%)	7.4	8.3	8.4	5.4	10.7	4.8	4.8	6.7	14.1	8.5
S (%)	2.09	0.42	0.38	0.15	0.56	0.21	0.26	0.33	1.18	0.41
N (%)	0.43	0.46	0.65	0.35	1.06	0.37	-	0.31	0.59	0.52
Ni ppm	21.1	21.3	110	15.4	122.5	31.7	-	25	20	36.2
V ppm	2.0	0.9	<0.1	0.66	3.1	0.7	-	0.92	4	1.8

Source: Dou et al (1998).

Besides the high viscosity and high density, the Chinese oils present special characteristics, such as little or no asphaltens content insoluble in the heptane and great amount of resins, low sulfur content and high nitrogen content and moderate nickel (Ni) and very little vanadium (V) content.

The Chinese oils present low yield in light fractions, with boiling point below 350 °C, in the order of 10 to 20% and most of the heavy fraction present boiling point above 500 °C. According to this, those oils should be treated by different processes, from the economical point of view.

The catalytic cracking is one of the most important processes for the Chinese oils, increasing the yield in light fractions. The heavy oils with carbon Conradson content between 5 to 10% and metals content below 30 ppm (in terms of Ni and V) can be processed directly by the catalytic cracking, while the oils with Conradsom carbon content larger than 20% and heavy metals with content larger than 150 ppm cannot, because they interfere negatively in the catalyst efficiency, suffer a upgrading firstly with hydrogen, being processed later in the hydrocracking catalytic for the production of light fractions.

1.3.4. Brazilian oils

Tab. 8 presents the Brazilian reserves and distributions proven in billions of barrels, being verified that, of the total of the reservations, about 40% are of heavy oils, whose proven reserves are in petroleum fields as the one of Jubarte (proven reserves of 600 millions of barrels), Cachalote (proven reserves of 300 millions of barrels) and Marlim Leste (with estimated reserves in 150 millions of barrels).

The petroleum Marlim is rich in heavy fractions, presenting low sulfur content and high levels of basic sediments and water (in the stage of petroleum production, it is the relationship between the flow of water, more produced sediments, and the total flow of liquids or BSW - basic sediments and water. Tab. 9 presents the main characteristics of the heavy oils produced in Brazil, by June of 2003.

Tab. 10 presents comparative data among the characteristics of the acid petroleum Marlim with other oil blends, also Venezuelan acids, in which TAN means Total Acid Number. One can observes that the Marlim petroleum is the one that presents smaller sulfur content among the other oils presented in the table, which represents one more attraction for this petroleum in relation to the oils world market.

Table 8 – Reserves and distributions proven in Brasil.

Reserve (billions of barrels)		Distribution (%)	
Conventional petroleum (>22.3 °API)	5.62	Onshore	16
Heavy oil (<22.3 °API)	4.07	Shallow waters (< 400 m)	17
Total (conventional + HEAVY)	9.69	Deep water (400 – 1,000 m)	56
-	-	Ultra-deep waters (> 1,000 m)	11

Source: Marcuso and Nepomuceno (2003), apud Szklo et al (2006).

Table 9 – Main characteristics of some Brazilian heavy oils (until Jun 2003).

Petroleum	Participant oil fields	°API	Sulfur (%)	Light distillates fractions (%)	Average distillates fractions (%)	Heavy fractions (%)
Jubarte	Jubarte (100%)	17.1	0.57	16.07 (< 290 °C)	15.18 (290 – 380 °C)	68.75 (>380 °C)
Marlim	Marlim (96.6%) Voador (3.4%)	19.6	0.67	23.35 (< 290 °C)	18.35 (290 – 380 °C)	58.40 (>380 °C)
Marlim sul	Marlim sul (100%)	22.8	0.68	31.27 (< 290 °C)	13.01 (290 – 380 °C)	55.72 (>380 °C)

Source: Szklo et al (2006).

Table 10 – Selected characteristics of Marlim oil and some Venezuelan acid blends.

Properties	Marlim	Blends Venezuelan oils				
		Bachaquero	Menemota	Pilon	Merey	Laguna
API gravity	19.2	12.2	21.3	14.5	16.0	23.6
Enxofre (% mass by volume)	0.78	2.71	2.5	1.92	2.49	2.07
TAN (mg KOH/g)	1.26	3.65	1.15	1.52	1.24	1.03

Source: Szklo et al (2006).

2. PRODUCTION OF PETROLEUM

The petroleum natural deposits are subject to the pressure, due to the water that is below them, or from the gas that is on them or dissolved in the petroleum; by the way, the pressure tends to force the ascent naturally of the petroleum to the surface and the drainage continues while the pressure gradient between the natural deposit and the exterior, is great enough to maintain the operation. In this case, production calls for natural flow; as the pressure gradient decreases, it also reduces the production of petroleum. So that the production for natural flow becomes uneconomical, the petroleum should be impelled artificially up to the surface (Szklo, 2005).

Due to the chemical composition of unconventional oil, different methods should be adopted for the production of that type of crude oil. In some cases, a solvent is injected in the well and used steam to move the diluted material, becomes the recovery of the oil possible. Another adopted process, generated from the technological development, is the process SAGD (Steam-Assisted Gravity Drainage) that, by using steam, reduces the viscosity of the oil for the increase of the temperature of part of the reservoir, allowing the drainage for gravity for wells operated by horizontal rigs. Fig. 3 presents an illustration of the process SAGD (WEC, 2001).

According to Ali (2003), the production of heavy oil with steam injection is a reality, but the combustion in situ is a special process, that can be used in the cases in which it is not possible to use the steam.

Petrobras is developing the RECAGE Project - High Grade of Explotation and Production Fields Revitalisation" - seeking the recovery of ripe fields, that present accentuated production decline, as it happens with the Reservoir of Siri, in the Field of Badejo, in the Campos basin. The Reservoir of Siri, that has operated there for about two decades, has oil with density of API gravity 13, and viscosity, at the temperature of the reservoir, in the order of 300 cP, a characteristic highly negative that influenced directly in the adaptation of a ship platform FPSO (Floating, Production, Storage, Overload) to store the heavy oil of Siri (Revista Petrobras, 2007).

3. THE UPGRADING PROCESSES

The process of converting heavy oil and bitumen, considered unconventional oil, in synthetic raw oil, is called Process of Elevation of the API Gravity (CAPP, 2006).

The upgrading of the barrel bottom is one of the most important challenges in the processing of heavy oils. The composition and the different molecular structures of the heavy oils, in relation to the other kinds of petroleum, consists predominantly of the high concentration of hetero-atoms (among them the oxygen, the nitrogen, the sulfur and some metals), varying a lot in function of the origin of the heavy petroleum. The metals, as vanadium (V) and nickel (Ni) are frequently the most abundant hetero-atoms which cause of impurity in the heavy oils. (Rana et al, 2005).

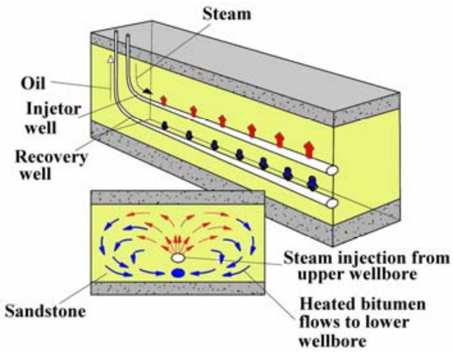

Figure 3 – Illustration of the SAGD process SAGD, according to WEC (2001).

Two different processes are used to convert heavy oil and bitumen (Oballa and Oballa, 1994):
a) rejection of the carbon through the processes of delayed cocking or of coking with fluidized bed;
b) hydrocracking through catalytic hydrogenation in expanded bed.

The process with rejection of carbon, according to OTS (2006), has its simplified flowsheet presented in the Fig. 4. The process begins with the addition of the solvent, usually condensed of natural gas (C5+), to the heavy oil or the bitumen, to make possible the use of a pump to drive the material diluted by the pipeline, from the production field to the updating plant, called Upgrader. The principal current of the process, that it is the Synthetic Petroleum, presents low content of sulfur and density API with appropriate value to be used by a refinery projected to process conventional oil. As one can be observed still in the Fig. 4, this type of processing of unconventional oil, besides producing synthetic petroleum, also produces petcoke and sulfur.

In Lloydminster, in Canada, the plant that operates with that process is feed with 8,440 m^3/d of crude diluted, producing 7,300 m^3/d of SCO (Synthetic Crude Oil), 400 t/d petcoke and 235 t/d of sulfur; The solvent is separated by distillation, producing a current of 1,840 m^3/d that returns for a parallel pipeline to that transports the diluted crude (OTS, 2006). It being considered that of the 8,440 m^3/d of diluted crude contain 1,840 solvent m^3/d, then of crude there will be 6,600 m^3/d; as the crude has density 1(one) approximately, then the petcock production will represent 6% in mass and the sulfur production, 3.5% also in mass.

The hydrocracking process through catalytic hydrogenation in expanded bed has simplified flowsheet presented in the Fig. 5, according to information in WOS (2006). In this process, they are neither produced the petcock nor the sulfur. A plant with this process type operates in Canada since April of 2003, projected to produce 130.000 barrels/d of crude synthetic and 60,000 barrels/d of vacuum residue, with feedstock of 155.000 barrels/d of bitumen more loads no bituminous, acquired from other refineries.

In the area of Hamaca, in Venezuela, heavy oils with density among 8^o to 10^o API gravity are transformed in synthetic oils with density around 26^o API gravity, through the upgrading process. In 2003, 500,000 barrels/d of synthetic petroleum were produced, showing the petcock and sulfur as by-products (HT, 2006).

4. TRANSPORT OF PETROLEUM

Due to its high viscosity, the extra heavy oils generate extremely high friction with the wall of the tubes of the pipeline, producing great head loss during the drainage of the well. This great head loss of the drainage has significant importance in the design of the diameter and thickness of the tubes, on the specification of the pumps and on the quantification of the necessary energy to the transport of the crude oil for the pipeline (Mandil, 2002).

For the transport of oils unconventional (extra heavy and bitumen) for pipelines, there are two options. An option is to adjust the viscosity, density and basic sediments and water, using an appropriate solvent, that it should be recycled and the other option is to increase the heating of the line of the pipeline, in way to guarantee that the viscosity of the oil, be inside of the limits demanded by the operation of the pipeline. This last option is known thoroughly and enough used, but with the disadvantage of presenting high costs due to the use of steam, increase of the corrosion of the oil and installation costs and maintenance of the thermal isolation (Gupta and Bruijn, 2000 and Mandil, 2002).

In the area of production of heavy petroleum, more specifically in the drainage by pump, the research that is giving more promising results it is the one of the two-phase drainage in tubes of the type core flow. This system has the function of solving the drainage problems in the tubulation, face to the properties of the oil as for its density and viscosity. The core flow has a device director of the water, which is guided for the walls of the tube, leaving the circular oil for the middle, second a pattern of ring drainage. The use of the drainage process with core flow gets to reduce the load loss in up to 225 times if compared with the drainage of the oil without the aqueous ring (Obregón, 2001).

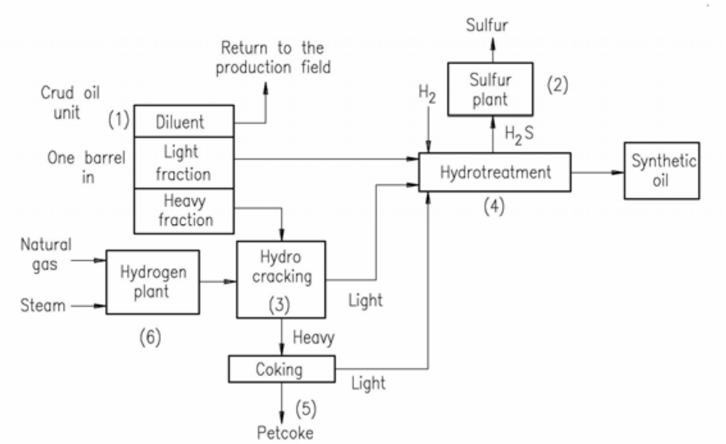

Figure 4 - Simplified flowsheet of unconventional oil processing, with petcoke, sulfur and synthetic oil production, according to OTS (2006).

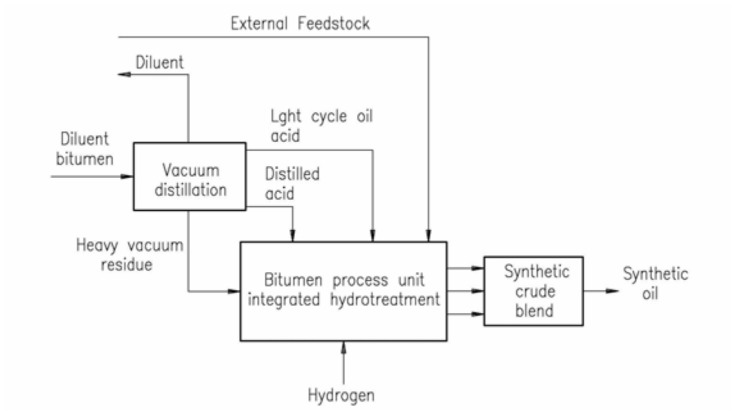

Figure 5 - Simplified flowsheet of oil unconventional processing, with production just of synthetic oil, according to WOS (2006).

5. PETROLEUM PROCESSING

The refineries, usually, process blends of petroleum, conveniently constituted in function of the composition of the crude oil. To process petroleum means to submit it to several unitary operations and chemical conversions, for the obtaining of the most different petroleum fractions (CEPETRO, 2005).

To process the crude oils more and more heavy and with larger pollutants content, especially the sulfurous compounds, it becomes necessary that in the outline of the refine the number of units of hydrotreatment be increased, what implicates in considerable demand of hydrogen.

Besides, the largest metals content in those crude oils elevates the desativation of the catalysts used in the units that operate with chemical transformations, which are fluidised catalytic cracking, catalytic reforms, hydrotreatment, etc. (Afonso et al, 2004).

The processing of acid crude oils forces the refiner to adopt some measured to minimize the equipments corrosion rate, mainly in the units of atmospheric and vacuum distillations, because in the process of these units there is the appearance of acid compounds. To avoid high rates of corrosion in the equipments, some classic solutions has been proposed: a) dilution: mixtures with other less acid crude oils (limited); b) use of inhibition of corrosion products (temporary); c) adaptation metal works of the units of distillation trying to decrease the corrosion rates (Bria, 2005).

6. NEW TECHNOLOGIES

The offer of heavy oils has been increased around the world, and the processing of those crude oils generates less light products and more residues, indicating the need of development of new technologies in the petroleum industry (Furimsky, 1999).

- RTP (Rapid Thermal Process): The RTP process consists of a soft type of pyrolysis (reaction catalyzed by temperature), in which the time of residence in the chemical reactor and the gases cooling is of the order of 2 (two) seconds, producing light crude oils with high yield. The process can convert heavy petroleum and bitumen in synthetic petroleum, using close facilities to the production field, reducing the need of the diluents use for transport for pipelines (Ensyn, 2002). Tab. 11 presents the improvement of the API gravity and cinematic viscosity in centistokes (cSt) of three Canadian crude oils (Belridge, Midway Sunset and San Burn) and of the Athabasca bitumen, also of Canada, after two passages for the reactor of the RTP process, according to WHOC (2006).

Table 11 – Viscosity and API gravity improvement for some petroleum and bitumen for the RTP Process.

Feedstock	Raw crude or bitumen		Once through product		Recycle product	
	API	Viscosity (cSt at 40 ^oC)	API	Viscosity (cSt at 40 ^oC)	API	Viscosity (cSt at 40 ^oC)
Belridge	13.4	750	16	100	19	35
Midway Sunset	11	2,500	15	120	20	50
San Ardo	10.4	11,000	16.9	92	18.5	45
Bitumen	8	40,000	14	150	19	60

Source: WHOC (2006).

- Cold Cracking: This process consists of the bombardment of the heavy petroleum or bitumen, in a conventional chemical reactor, for an electrons beam, produced by a linear accelerator of electrons. This process is called cold cracking because it occurs at temperatures in the range from 350 to 420 ^oC and the pressure is, practically, atmospheric while the thermal cracking occurs at temperatures in the range from 450 a 550 ^oC and the pressure is around 20 bar. Although the process is in the experimental phase, its principle is well know since the sixties years. The irradiant energy breaks some bonds among the atoms of the molecules, producing smaller molecules, improving the properties of the irradiated material. This way, there is an increase of the API gravity and reduction of the viscosity. If the bombardment happens in an atmosphere containing hydrogen, there will be formation of separable sulfurous compounds in the subsequent processing of petroleum (Mirkin et al 2003; USDE, 2006).

7. CONCLUSION

The petroleum world market is presenting strong evidences of increasing the offer of heavy oils and decrease of the participation of the medium and light oils. The discovery of new petroleum fields shows the occurrence of great amounts of oils statements unconventional, indicating that the petroleum is far from to end. As the petroleum industry grew technologically in function of the characteristics and properties of conventional oils, there is an indication that new technology to be developed for the production, transport and refine of the said unconventional oils. In that sense, the development of the drainage colors flow appears as a technological possibility to optimize the drainage of the petroleum starting from the producing well. The process of the upgrading, for his time, signals in the sense of transforming the unconventional oils in synthetic crude oils, which present compatible properties with the operational process of the conventional refineries. The RTP process reduces the viscosity and elevates the API gravity of the unconventional oils but, differently of the upgrading process, it needs smaller facilities and it can operate the production field close to, turning less severe the transport operation for pipeline. The cold cracking, although in the experimental phase, comes as an interesting option of upgrading. The practice already consolidated of using crude oils mixtures to obtain appropriate feedstocks to the current refineries, minimizes some aggressions to the equipments, maintaining the corrosion taxes in acceptable values. This way, even with the increase of the offer of heavy oils, the petroleum industry presents optimistic perspectives of could continue assisting to the consuming market of the most several hydrocarbons currents.

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8. RESPONSIBILITY NOTICE

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