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Marketing Survey Related to Expansion And Upgrading of ElObeid Refinery

A Thesis submitted for as Partial Fulfillment for the Requirement of the
Master Degree in Engineering Systems Management.

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الإستهلال

قال تعالى:

(قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا عَلَّمْتَنَا إِنَّكَ أَنْتَ الْعَلِيمُ الْحَكِيمُ)

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الإهداء

الي روح والدي العزيزين

حمدت الله حامد نعيمة

والنصيب ابراهيم فرحنا

اللهم اغفر لي ولهما وأرحمني وأرحمهما رحمة تغنيني عن رحمة من سواك وأجعلني
وما أقدم خالصا" لوجهك الكريم إنك نعم المولي ونعم النصير

الشكر والتقدير

الحمد لله الذي بنعمته تتم الصالحات، الحمد لله كما ينبغي لجلال وجهه وعظيم سلطانه، والصلاة والسلام علي أشرف المرسلين، سيدنا محمد وعلي آله وصحبه ومن دعا بدعوته الي يوم الدين.

الشكر لله العلي القدير الذي وفقني الي إكمال هذا البحث ، والشكر والتقدير لكل من وقف معي، وساندني بفكره ورأيه ، ولكل من أسدي الي نصيحةً ، أو قدم لي معروفًا" أو مد الي يد العون، أو علمني كلمة أو حرفاً، والشكر لكل من ساهم في اخراج هذا العمل الي حيز الوجود.

الشكر أجزله الي جامعة وادي النيل العظيمة التي منحتني هذا الفضل بقبولي أحد طلاب الدراسات العليا لنيل درجة الماجستير في نظم الإدارة الهندسية والشكر لها علي ما قدمت لي من خدمات فكان لها عظيم الفضل في انجاز هذا البحث.

أخص بالشكر كل الشكر من أحاطني برعايته وشرفني بإشرافه، وتابعني بتوجيهاته في إعداد هذا البحث، البروفسور / محمد ابراهيم شكري الذي تعهدني بالرعاية العلمية، والنصح والتوجيه والإرشاد والتدقيق، والمتابعة اللصيقة والتقويم الرشيد ، فقد أعطاني من علمه الرشيد وأقتطع لي من وقته الشئ الكثير، أمد الله في أيامه وبارك الله في أعماله ، وجعلها في طاعته أنه سميع قريب مجيب .

الشكر والعرفان لكافة العاملين بوزارة الطاقة والتعدين وأخص بالشكر فيه جميع العاملين بالإدارة العامة للتخطيط والمعلومات والإستثمار والإدارة العامة للإمداد والتوزيع وجميع العاملين بشركة مصفاة الأبيض المحدودة، ثم الشكر لكل من ساهم في اخراج هذا البحث علي هذا الوجه.

والحمد لله رب العالمين القائل: (وَمَا أُوتِيتُمْ مِنَ الْعِلْمِ إِلَّا قَلِيلًا) صدق الله العظيم.

(الإسراء ٨٥)

Table of Content

No	Description	Page No
	الإستهلال	I
	الإهداء	II
	الشكر والتقدير	III
	Abstract	IX
	مستخلص البحث	XI
	Chapter 1: Introduction	
١-١	Introduction	1
1-2	Research problem definition and importance	2
١-٣	The region which the Refinery expected to serve	2
١-٤	The future needs of oil products in Western, Southern and White Nile State from the year 2010 to 2015 in metric tons.	3
١-٥	New expansion for Elobied Refinery (upgrading)	3
١-٦	Research objectives	4
	Chapter 2: Theoretical Background	
٢	Back ground of oil industry in Sudan	6
٢-١	Introduction of oil Refineries	6
٢-٢	Refinery operation	6
٢-٣	Major products of oil Refineries	8
٢-٤	General Marketing	12
٢-٥	Sudan's oil market	١3
	Chapter 3 Petroleum Products	
٣	The current consumption of Petroleum products in Sudan	16
٣-١	Sudan products market needs	16
٣-٢	Expected expansion future development	١8
٣-٣	The needs of Sudan for the oil products	١9
٣-٤	Needs of petroleum products in Western ,Southern and White Nile State.	٢1
٣-٥	Future of oil products consumption in Sudan	26
٣-٦	Petroleum products –current situation	٢8
٣-٧	Products distance to transfer and rate of transport for the products	٢9
٣-٨	Crude oil in Sudan	30

٣-٩	Chapter 3 summary	34
	Chapter 4 Results & analysis	
٤-١	Khartoum Refinery products	٣7
٤-٢	Elobied Refinery products	37
٤-٣	The actual oil products consumed in Western and Southern State to the term from 1/1/2009 till 30/9/2009 in metric tons	38
٤-٤	Comparison between the actual needs of oil products in Western and Southern State to the actual Elobied Refinery products during 2005 to 2008 in metric tons	٣٩
٤-٥	Future oil products needs for Western and Southern State from 2010 to 2015 in metric tons.	٤٢
٤-٦	The necessity of justification of upgrading Elobied Refinery Company.	٤٣
٤-٧	Chapter 4 summary	٤٥
	Chapter 5 Conclusion & recommendations	
٥	Conclusion & recommendations	٤٨
٥-١	Conclusion	٤٨
٥-٢	Recommendations	٥4
٥-٣	References	٥5
5-4	Appendices	56

List of Table

No	Description	Page No
١-١	Future needs of oil products for domestic & industrial uses in Western, Southern and White Nile State from 2010 to 2015 in metric tons.	٣
٣-١	Actual Sudan oil products consumption during 1970 to 2008 in metric tons.	18
٣-٢	Market demand forecast for oil products in Sudan from year 2009 to 2016 in metric ton	20
٣-٣	Actual consumption of oil products since 2005 to 2008 in metric tons.	21
٣-٤	Actual LPG consumption to the year 2000 to 2008 in metric tons.	٢3
٣-٥	Mogas consumption 2000 to 2008 in metric tons.	٢٤
٣-٦	Kerosene consumption from 2000 to 2008 in metric tons	٢٤
٣-٧	Gas oil consumption from 2000 to 2008 in metric tons	٢٥
٣-٨	Fuel oil consumption from 2000 to 2008 in metric tons	٢٥
٣-٩	Diesel oil consumption from 2000 to 2008 in metric tons	٢٦
٣-١٠	Jet A consumption from 2000 to 2008 in metric tons	٢٧
٣-١١	Sudan oil products needs during 2010 till 2030 in metric tons	٢٨
٣-١٢	Actual consumption during 01/01/2009 till 30/09/2009 in metric tons	٢٩
٣-13	Crude oil blocks information	3٢
٣-١٤	Sudanese Crude oil specifications	3٣
٣-١٥	Importing crude oil since 1975 to 1998 in barrels	3٤
٣-١٦	Exporting crude between 1999 and 2007 in barrels	3٤
٣-١٧	The countries which imported Sudanese crude oil between the years 2001 and 2007	3٥
٣-١٨	Average price for OBEC crude since 1994 to 2007	3٥
٣-١٩	Average price for Nile blend crude since 1994 to 2005	3٦

ξ-١	Extracted products of Khartoum Refinery since 2000 to 2006 in metric tons	3٩
ξ-٢	Elobied Refinery extracted oil products since 1996 to 2009 in metric tons	ξ٠
ξ-٣	The actual oil products consumed in Western and Southern States from 1/1/2000 till 30/9/2009 in metric tons.	ξ١
ξ-ξ	Comparison between the actual needs of oil products in Western and Southern States to Elobied Refinery oil products production during the term from 2005 to 2008 in metric tons.	4٢
ξ-٥	Lack quantity in metric ton to the term from 2005 to 2008 in metric tons.	4٢
ξ-٦	Lack of oil products for Western and Southern States and extra costs.	4٣
ξ-٧	Future oil products, needs for Western and Southern States from the year 2010 to 2015 in metric tons.	4ξ
ξ-٨	oil products, needed for Western State to the term from 2010 till 2015 in metric tons.	4ξ
ξ-٩	Crude oil production forecast during the year 2010 to 2017 in barrels per day.	4٥
5-1	Overall mass balance of the products after the expansion	5٢
5-2	The capital installed cost for the expansion	5٢
5-3	Crude feed specification	5٣
5-4	Gas oil product specification	5ξ
5-5	Mogas product specification	5٥

List of Figure

No	Description	Page No
2-1	Crude oil distillation	6
2-2	Distillates a residuum Diagram	9

ABSTRACT

The research tackled Elobeid refinery since 1979 and its stages and problems included background about petroleum industry in Sudan.

The research problem questions are:-

- 1- What are the bottle necks of the refinery now?
- 2- Which products after the upgrading and expansion?
- 3- What is the amount of products produce after expansion to cover the needs of western & southern states of Sudan?
- 4- How can we distribute the oil products of the expansion and increase the area consumption?

The main objectives of the research is to solve the bottle neck of the refinery and produce the needed oil products for western & southern states with economical price due to Elobeid refinery location which is near to crude oil area while Khartoum refinery is very far from crude oil area.

To achieve the research objectives the following hypothesis are identified:-

- 1- The location of the refinery which is in the central of the Sudan.
- 2- Elobeid refinery is near to crude oil area especially block 1,2,4 (Nil blend crude) and block 6 (Fula crude) , block 5a sergas crude and block 3,7 Dar crude while the area around the refinery in western and southern states needs for oil products are great. Now there are covered from Khartoum refinery.
- 3- Availability of Nile blend crude pipe line which is now supplying Elobeid by crude from Huglug.
- 4- Availability of petro energy pipe line crude from block 6 (Fula) which is connected with Elobeid refinery.
- 5- The Petrodar pipe line which carries crude from block 3,7 is near Elobeid about 300 k m to the east .

This information is collected from ministry of energy and mining, net and some books. The new paragraph used the following research methodologies. The induction and historical approaches.

The research (study) recommends , the following :-

- 1- To study construction of oil products from Elobeid refinery to Adoc unity state which passes throughout southern Kordafan state to supply that area by products.
- 2- To study injection of surplus oil of Elobeid refinery into GNPOC pipe line so as to be exported and then allow Elobeid refinery operated continuously.
- 3- To study LPG marketing in western and southern states and its availability of transportation and LPG cylinders .
- 4- To study mogas marketing in western and southern states and the neighboring countries (Chad and Central Africa).

بسم الله الرحمن الرحيم

مستخلص البحث

تتاول البحث مصفاة الأبيض منذ انشاءها والمراحل التي مرت بها والمشاكل الحالية وخلفية عن صناعة النفط بالسودان حيث تمثلت مشكلة البحث في التساؤلات الآتية:

١. ماهي مشاكل المصفاة الحالية؟

٢. ماهي المنتجات الواجب انتاجها بعد عملية التأهيل والتوسعة ؟

٣. ماهي المنتجات الواجب انتاجها بعد عمليات التوسعة لتغطية احتياجات

المنطقة الغربية والجنوبية من السودان ؟

٤. كيفية توزيع المنتجات وإمكانية زيادة الإستهلاك للمنتجات ؟

يهدف البحث الي مجموعة من الأهداف أهمها تحديث وتوسعة المصفاة لتوفير المنتجات البترولية للمنطقة التي تحيط بالمصفاة مع مراعاة التكلفة الإقتصادية والإستفادة من موقع المصفاة وقربه لمناطق إنتاج الخام بدلا" من جلب المنتجات من مصفاة الخرطوم لبعدها من آبار البترول.

لتحقيق أهداف البحث تم اختيار الفروض الآتية:

١. موقع المصفاة وسط السودان.

٢. قرب المصفاة لمناطق انتاج البترول وحاجة الولايات الغربية والجنوبية للمنتجات البترولية.

٣. مرور خط نقل الخام لشركة النيل الكبرى للبترول وتزويد المصفاة حاليا" بمزيج النيل.

٤. مرور خط بترولانرجي (الفولة) بالمصفاة ووجود توصيله بالمصفاة .

٥. قرب خط خام شركة بترولدار (فلوج) للمصفاة ٣٠٠ كلم شرقا".

تم الحصول علي معلومات البحث من وزارة الطاقة والتعدين والشبكة العنكبوتية و تم استخدام بعض المناهج البحثية منها:

المنهج الإستقرائي والمنهج التاريخي والمنهج الإستنباطي.

و توصلت الدراسة ل:-

١. دراسة تشييد خط أنابيب لنقل المنتجات من مصفاة الأبيض الي ولاية الوحدة
٢. منطقة أدوك البحر مروراً بولاية جنوب كردفان لتوفير المنتجات لهذه المنطقة..
٣. دراسة تسويق منتج البوتاجاز للولايات الغربية والجنوبية وتوفير وسائل نقل الغاز والإسطوانات للمستهلكين.
٤. دراسة حقن فائض انتاج الفيرنس من مصفاة الأبيض في خط نقل الخام الخاص بشركة النيل الكبرى للبترول بغرض التصدير مع خام مزيج النيل.
٥. دراسة تسويق منتج البنزين في الولايات الغربية والجنوبية ودول الجوار (تشاد ، وأفريقيا الوسطي) .

Chapter One

1-1 Introduction:

Elobied Refinery is a facility which was originally built in 1979 at bridge port, Texas and first served the liquid energy corporation as 10000 Barrel per day crude topping plant. In 1995 it was revamped by chime Bakers filed, California. The plant was modified and rebuilt for the Elobied Company. Elobied Company, a company wholly owned by the Sudanese Petroleum Corporation, the local construction and commissioning of the refinery was completed in July 1996. The refinery stands as an evidence for the good decision, planning, acting and the close follow up of the official authorities to reach the target.

And this target is what the political and technical authorities in the ministry of energy and mining had challenged on it.

The refinery consists of the following facilities:

- * Storage tanks.
- * Heat exchangers.
- * Crude heaters
- * Main column and side stripers.
- * Water and air coolers.
- * Pumps.
- * Cooling water tower.
- * Steam boilers.
- * Control room
- * Plate forms
- * Work shop and ware house.
- * Plant power generation.
- * Laboratory.
- * Civil defense and fire fighting system.

* Organization chart.

The main objective of Elobeid Refinery is to process Nile blend crude to cover the oil products needs to the area around which is western, southern and White Nile state. The refinery design to process 10000 Barrel per day in 1996 and due to increase demand of oil products especially Gas oil and fuel oil so the Refinery expanded on 2003 to 15000 Barrel per day to cover the needs.

1-2 Research problem definition and importance:-

The research covers the problem of Elobeid Refinery upgrading from the points of current and future production and expected areas which the refinery can serve. On the top of this the question is these areas can consume all the expected production.

The importance of this research comes out from the results of marketing survey which shows the necessity of upgrading the refinery and at the same time gives a strong data base in which the picture of products consumption is very clear.

1-3 The region which the refinery expected to serve:

Elobied Refinery oil products served western Region, Southern Region and White Nile Region especially Gas oil, Kerosene and also served fuel oil to Khartoum North power station, Kenana sugar factory, Nyala and Elfasher power station beside All Cement factories in Sudan. Also Elobied Refinery supply Diesel oil for all power stations in Elobied, Elnuhood, Kadogly, Genana, Faw and Port Sudan. Elobied Refinery served Khartoum Refinery by Naphtha. In the future we expect the consumption of oil products increased because some new factories should be completed and some old factories expanded like White Nile sugar Factory, Cement factories like Eltakamol, Elsalam beside Maspeo cement factory and Rabak cement factory All of this needs more fuel oil and white products.

1-4 The future needs of petroleum products for domestic and industrial uses in western, southern and White Nile state from the year 2010 to 2015 in metric tons:

According to the data shown below on table No 1-1 which brought from ministry of energy and mining of Sudan which indicates the existing capacity of Elobied Refinery would not satisfying the needs of western, southern and white Nile Region so the up grading and expansion to the Refinery should be done during 2010 till 2015 so the good news of founding Additional fula crude beside heglug crude supply our new production line with the processing capacity of 15000 Barrel per day brining the over all processing of the whole refinery up to 30000 Barrel per day, See below table No(1-1).

Table (1-1): Future needs of oil products for domestic and industrial uses in western, southern and White Nile Region 2010 to 2015 in metric ton (brought from ministry of energy and mining Sudan).

Year	Gas oil	Mogas (ton)	LpG(ton)	Fuel oil(ton)
٢٠١٠	555249	٨٤٨٨٠	١٥٩١٤	٨١٢٤٧
٢٠١١	600448	٨٩١٢٤	١٦٧٠٩	٨٥٣٠٩
٢٠١٢	630470	٩٣٥٧٩	١٧٥٤٤	٨٩٥٧٤
٢٠١٣	٦٦١٩٩٣	٩٨٢٥٨	١٨٤٢١	٩٤٠٥٢
٢٠١٤	٦٩٥٠٩٢	١٠٣١٧١	١٩٣٤١	٩٨٧٥٤
٢٠١٥	٧٢٩٨٤٧	١٠٨٣٢٩	٢٠٣٠٨	١٠٣٦٩١
Average	٦٤٥٥١٦	٩٦٢٢٣	١٨٠٣٩	٩٢١٠٥

1-5 New expansion for Elobeid refinery (upgrading):-

It is proposed to use advanced, mature and reliable technologies in the world, in order to insure the production of high quality products that meet the area market demand. In principle, the most advanced technologies should be selected either Chinese or international targeting for reliability, safety, high efficiency and ultimately high profitability.

The refinery have proposed on option which involves the installation of an additional 15000 Barrel per day crude distillation unit and 20 000 Barrel per day catalytic cracking unit for processing the resultant Long residue products from the crude distillation units in to gasoil, gasoline, Kerosene, liquefied petroleum gas(LPG)etc .In addition , Naphtha reforming unit is to be considered for treatment of the naphtha stream from the crude unit, The refinery are also looking to increase the reliability of existing units through a better and more timely maintenance replacement regime. The plant have also identified quality control, minimizing Losses and waste, introducing more training programs and seminars as means of improving the plants production, safely and environmental performances.

1-6 The Objectives of this Research:-

The objectives of this research:

- 1- To study the need of oil products for industry and domestic to Western states, southern states and part of White Nile state which is near Elobeid.
- 2- To study the basis of Sudan crude oil available resources and future petroleum products market demand.
- 3- To study the situation of the refinery now and where its products distributed and the bottle necks of the existing Refinery.
- 4- To study for expansion including the needs and the new size capacity and from where we can get the crude.
- 5- To study market analysis including crude resources and products market.
- 6- To study the existing Elobeid Refinery utilities and other facilities shall be utilized to the maximum.
- 7- To study the advantages of expansion of Elobeid Refinery comparing to other internal Refineries in Sudan like Khartoum Refinery and Port Sudan Refinery.
- 8- To study and covers the scope of work should be done to the expansion.

- 9- To study commercial, mature reliable and advanced technologies shall be adapted to attain high technical and economic indices within the international norms.
- 10- To study the political situation of the area of the refinery for the needs of the products to the future which decide the capacity of the expansion and if the southern states will separate there is problem.

Chapter Two

2- Back ground of oil industry in Sudan:

2-1 Introduction of oil Refineries:

An oil Refinery is an industrial process plant where crude oil is processed and refined in to more useful petroleum products, such as gasoline, diesel fuel, asphalt base, heating oil, kerosene, and liquefied petroleum gas oil refineries are typically large sprawling industrial complexes with extensive piping running thought, carrying streams of fluid between large chemical processing units.

2-2 Refinery operation:

The oil refining process starts with a fractional distillation column as can be seen in the bellow drawing in figure No (2-1):

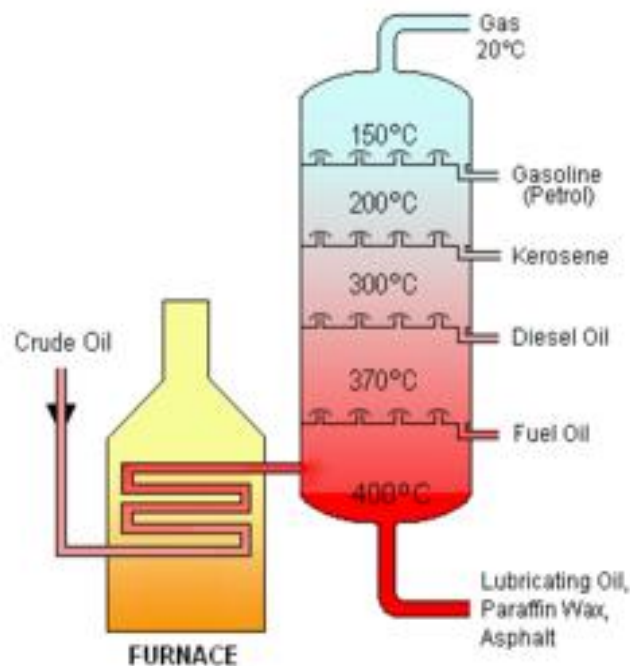


Figure (2-1): Crude Oil Distillation

Crude oil is separated into fractions by fractional distillation. The fractionating column is cooler at the top than the bottom because the fractions at the top have lower boiling points than the fractions at the bottom. The heavier fractionating columns are often broken up (cracked) to make more useful products. All of the fractions are subsequently routed to other refinery units for further processing raw oil or unprocessed (crude) oil is not useful in the form it comes in out of the ground. Although "light sweet " (low viscosity, low sulfur) oil has been used directly as a burner fuel for steam vessel propulsion the lighter elements form explosive vapors in the fuel tanks and so it is quite dangerous, especially so in warsh for this and many other uses, the oil needs to be separated in to parts and refined before use in fuels and lubricants, and before some of the by products could be used in petrochemical processes to form materials as plastic, and foams. Petroleum fossil fuels are used in ship, automobile and air craft engine. These different hydrocarbons have different boiling points, which mean they can be separated by distillation. Since the light liquid elements are in great demand for use in internal combustion engines, a modern refinery will convert heaving hydrocarbons and lighter gaseous element in to these higher value products using complex and energy intensive processes. Oil can be used in so many various ways because it contains hydrocarbons of varying molecular masses form and lengths such as paraffin's, aromatics, naphthenic (or cycloalkanes) alkenes, dines, and alkynes. Hydrocarbons are molecules of varying length and complexity made of only hydrogen and carbon atoms. The various structures give them their differing properties and there by uses. The trick in the oil refinement process is separating and purifying these.

Once separated and purified of any contaminants and impurities, the fuel or lubricant can be sold without further processing. Smaller molecules such as isobutene and propylene or butylenes can be recombined to specific octane requirements of fuels by processes, such as alkylation or less commonly,

demonization. Octane grade of gasoline can also be improved by catalytic reforming, which strips hydrogen out of hydrocarbon to produce aromatic, which have much higher octane rating intermediate products such as gas oils can even be reprocessed to break a heavy, long – chained oil into a lighter short-chained one, by various forms of cracking such as fluid catalytic cracking, thermal cracking, and hydro cracking. The final step in gasoline production is the blending of fuels with different octane ratings, vapor pressure, and other properties to meet product specifications. Oil refineries are large scale plants, processing from about hundred thousand to several hundred thousand barrels of crude oil per day. Because of the high capacity, many of the units are operated continuously (as opposed to processing in batches) at steady state or approximately steady state for long periods of time (months to years). This high capacity also makes process optimization and advanced process control very desirable.

2-3 Major products of oil Refineries:-

There are numerous products obtained from crude oil. Most products of oil processing are usually grouped into three categories:-

- Light distillates.
- Middle distillates.
- Residuum.

This classification is based on the way crude oil is distilled and separated into fractions (called distillates and residuum). As can be seen in the below drawing in figure No (2-2):

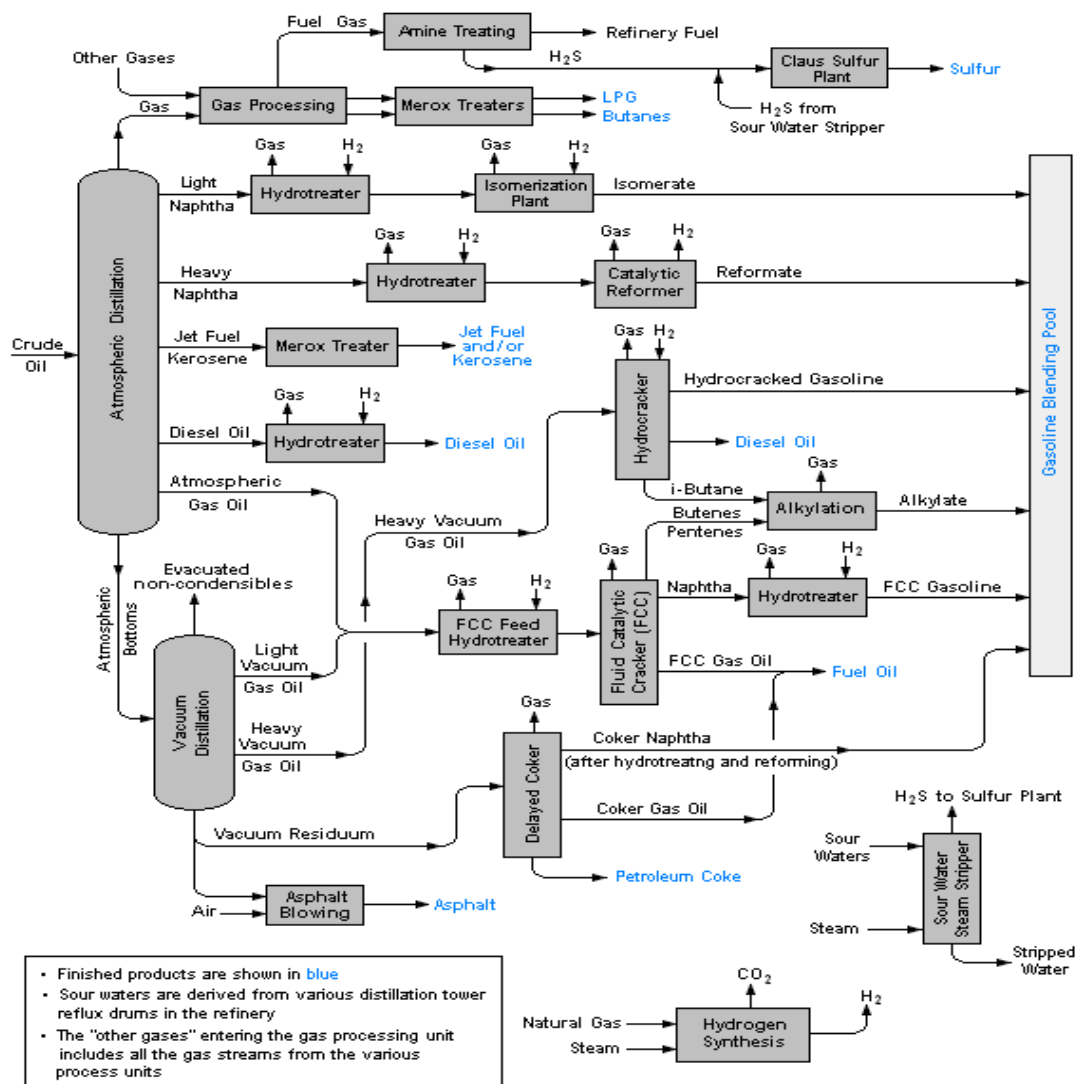


Figure No (2-2): Distillates a residuum Diagram

Different hydrocarbon chain lengths all have progressively higher boiling points, so they can all be separated by distillation. This is what happens in an oil refinery- in one part of the process crude oil is heated and the different chains are pulled out by their vaporization temperatures. Each different chain length has a different property that makes it useful in a different way. The list below shows some of the major component:

1- Petroleum gas: used for heating, cooking, making plastics, lighters

* Small alkanes (1 to 4 carbon atoms).

- Commonly known by the names methane, ethane, propane, butane.
- Boiling range = less than 104 degrees Fahrenheit / 40 degrees Celsius.
- Often liquefied under pressure to create LPG (liquefied petroleum gas). Liquefied petroleum Gas (LPG) consists principally of propane and butane and is produced for use as fuel and is an intermediate material in the manufacture of petrochemicals. The important specifications for proper performance include vapor pressure and control of contaminants.

2- Naphtha or ligroin-intermediate that will be further processed to make gasoline.

- Mix of 5 to 9 carbon atom alkanes.
- Boiling range – 140 to 212 degrees Fahrenheit / 60 to 100 degrees Celsius.

3- Gasoline – motor fuel, a blend of hydrocarbons with boiling ranges from ambient temperature to about 400 °F. the important equalities for gasoline are octane number (antiknock), volatility (starting and vapor lock), and vapor pressure environment control) additives are often used to enhance performance and provide protection against oxidation and rust formation.

- liquid
- mix of alkenes and cycloalkanes (5 to 12 carbon atoms)
- boiling range-104-401 degrees Fahrenheit / 40 to 205 degrees Celsius

4- Kerosene-fuel for jet engines and tractors, starting material for making products.

- Liquid
- Mix of alkanes (10 to 18 carbons) and aromatics
- Boiling range = 350 to 617 degrees Fahrenheit / 175 to 325 Celsius

Kerosene is a refined middle –distillate petroleum product that finds considerable use as a jet fuel around the world in cooking and space heating. when used as a jet fuel, some of the critical qualities are freeze point, flash point, and smoke point, commercial jet fuel has a boiling range of about 375°—525 °F, and military jet fuel 130° -550 F. kerosene ,with less-critical specifications, is used for lighting, solvents, and blending in to diesel fuel.

5- Gas oil or diesel distillate-used for diesel fuel and heating, starting material for making other products

- Liquid
- alkanes containing 12 or more carbon atoms
- Boiling range= 482 to 662 degrees Fahrenheit /250 to 350 degrees Celsius.

The desirable qualities required for gas oil include controlled flash and

Pour points, clean burning, no deposit formation in storage tanks, and a proper diesel fuel cetane rating for good starting and combustion.

6- Lubricating oil- used for motor oil, grease, other lubricants

- liquid
- Long chain (20 to 50 carbon atoms) alkanes, Cycloalkanes Aromatics.
- Boiling range=572 to 700 degrees Fahrenheit /300 to 370 Celsius.

7- Fuel oil –used for industrial fuel, starting material for making other Products.

- Liquid
- Long chain (20 to 70 carbon atoms) alkanes, cycloalkanes Aromatics.

- Boiling range= 700 to 1112 degrees Fahrenheit/ 370 to 600 degrees Celsius.
- 8- Residual fuel:-Residual fuel are heavier oils, that remain after the distillate fuel Oil and lighter hydrocarbons are distilled away in refinery Operations many marine vessels, power plants, sugar Factories Commercial buildings and industrial facilities use residual fuels or Combinations of residual and distillate fuel for heating and Processing. The two most critical specifications of residual fuels are viscosity and low sulfur content for environmental control.
- 9- Asphalt- tar used to pave roads. It is dark brown-to black cement- like material obtained by petroleum processing and containing bitumen's as the predominant component. It used primarily for road construction and roofing materials, and thus must be inter to most chemicals and weather conditions.
- 10- petroleum waxes :
- Paraffin waxes- made of long-chain alkane hydrocarbons
 - Microcrystalline wax-with very fine crystalline structure.
- 11- Petroleum Coke: Coke is a residue high in carbon content and low in hydrogen that is the final product of thermal decomposition in the condensation process in cracking it is almost pure carbon with a variety at uses from electrodes to charcoal briquettes.
- 12- Petrochemicals are products derived from crude oil refining, such as ethylene, propylene butylenes, and isobutylene that are primarily intended for use as chemical feed stocks in the production of plastics, synthetic fibers, synthetic rubbers and other products.

2-4: General Marketing:

In popular usage, marketing “is the promotion of products, especially advertising and branding. However, in professional usage the term has a wider meaning of the practice and science of trading, The American marketing Association (AMA) states. “Marketing “is an organizational function and a set of processes for creating, communicating and delivering value to customers and for managing customer relationships in ways that benefit the organization and its stake holders”.

Marketing practice tends to be seen as a creative industry, which includes advertising, distribution and selling. It is also concerned with anticipating the customers’ future needs and wants, which are often discovered through market research. The scientific study of marketing is a wide and heavily inter connected subject with extensive academic publications. Marketing methods are also informed by many of the social sciences, particularly psychology sociology, and economics. Anthropology is also small, but growing influence. Market researches under pins these activities. Through advertising, it is also relater to many of the creative arts. The marketing literature is also infamous for re-inverting itself and its vocabulary according to the times and the culture.

Marketing is asocial process by which individuals and group can obtain what they need and want by creating offering and freely exchanging products and services of value with others. For a managerial definition marketing has often been described as “the Art of selling products.” Also marketing is the whole sale and retail distribution, including tanker truck transportation, of refined petroleum products such as gasoline and diesel fuel to business, industry, government and public consumers.

2-5: Sudan Oil Market:

The activities of exploration in Sudan began in late 1950s, in the coastal areas of Red Sea. The results of exploration by Italy's Agip oil Company indicated that There is considerable a mount of natural and liquefied gases in Suwakin and Bashair. After Agip, other western oil companies like oceanic oil company, Total Texas Eastern, union Texas and Chevron moved to search, but no results were made and most companies relinquished their concession. In 1964 Port Sudan Refinery was built by BP. And Shell with 25 thousand barrel per day which produces mogas, kerosene or jet, gas oil and fuel oil. The crude oil to supply the refinery is imported while the products of the refinery transported by rail wagons and road Tankers to all the country through Marketer Company like Shell, Mobil, Total and Agip.

In 1974 Chevron, operator of a consortium in which Shell (Sudan) development company Ltd Took a 25% interest, got permission to search for oil.

In 1978 Chevron found the first oil in the Muglad Basin stretching deeply in to western upper Nile in the south. In 1978 a pipe line diameter 8" -816 km length was built to transfer finished products from Port Sudan to Alshagara. In 1981 Chevron did a second, more moderate find at the predominantly Dinka area Adar Yale in melut Basin, east of the white. For exploratory wells showed flow rates of 1500 and more barrels a day. Chevron believed there was a potential all the way south to Malakal and east to the Ethiopian border.

In 1982 Chevron made a third, much large discovery at Heglig, 70 km north of unity field, which was home of the nuer. Chevron began to develop unity and Heglig oil fields. In 1980, the government granted an 118000 km² concession to French-Belgium Total. UN like Chevron, Total did not begin to exploit because of security problems. This remained so for a quarter country. In 1984 most petroleum exploration operations ended because of civil war in south and had not resumed as of mid.

In 1991, so the government divided the former Chevron concessions in to smaller units, and in 1992 awarded the melut Basin- Blocks 3 and 7 to gulf petroleum corporation-Sudan (GPC). In 1996 GPC drilled and reopened Chevron's wells and built small topping unit in Abogapra 2000 barrel/days and Elobeid Refinery with 10000 barrel/day which received the crude by road tanker from Heglig to Muglad and from Muglad to Elobeid by rail way. Blocks 1,2 and 4 A new discoveries was done by foreign companies like state petroleum (Canada) CNPC China and Malaysia company forming a consortium called the Greater Nile Petroleum Operating Company (GNPOC). In 1997, GNPOC began to build a 1610 km oil pipe line from the oil fields to marine export terminal on the red sea. On August 31, 1999 the first 1500 barrel of crude oil travelled through pipe to be loaded on to a tanker which departed for refiners in the Far East. In 1998 Khartoum Refinery beginning it is construction between CNPC (China) and SPC (Sudan) 50/50 joint venture which completed on 2000 with capacity of 50000 barrel per day and supplied by Nile blend crude through GNPOC pipe line. Since then oil production and export have increased steady and new discoveries have been made.

In 2003 the CNPC announced the discovery of a "world class" oil filed in block 3 and 7 east of the White Nile. In 2003 oil production averaged 270000 Barrel per day and in 2004, 304000 Barrel per day. The signing of the CPA in January 2005 improved conditions for oil production and export. Until 2006 Sudan had only one major upstream project block 1, 2 and 4 operated by GNPOC in Muglad Basin. And one crude oil pipe was constructed from Fulog to Port Sudan transferred crude blended low quality Dar blend. The country's crude oil production almost doubled 434000 Barrel per day by late 2006. Khartoum Refinery was expanded to 100000 Barrel per day after completion of Fula pipe line which supplied Khartoum Refinery by 40000 Barrel per day and GNPOC supplied by 60000 Barrel per day. so Sudan

began exporting motor gasoline through pipe line constructed from Khartoum to Port Sudan.

Chapter Three

3: The current Consumption of petroleum products in Sudan:

3.1: Sudan products market needs:

Development of Sudan down stream sector refining has not paralleled that of crude oil production. It can not meet the burgeoning increasing in demand, especially for diesel and for Aviation fuel. Khartoum refinery and Elobeid Refinery was predicated on production for domestic consumption while port Sudan Refinery was stopped since 1999. The two Refineries (Elobeid Refinery and Khartoum Refinery) Capacities about 115000 Barrel per day which is not enough to satisfy the consumption of products in Sudan especially gasoil which have demanding increasing yearly and also jet A consumption is too high.

Khartoum refinery refines more gasoline than it needs and export this surplus by pipe line 12 inch diameter from Khartoum to port Sudan (800km), but it will continue to need to import diesel (Gasoil and aviation fuel for the fore see able future to bridge the gap between local supply and demand.

All petroleum operations in Sudan are supervised by Sudanese Petroleum Corporation. The prices of all petroleum products are regulated and are subsidised. Since 1989 the distribution and marketing of fuels products is carried out by Agip, Mobil, and Shell and Nile petroleum. After that time new marketing companies was appeared like Amonia, Muthag, Pinta, Nepta, Nahla, Wataneya, Bashair and Matheow. The distribution infrastructure consists of river tankers (for south), road tankers, pipe lines and Rail wagons system, all of which are in need of improvement. There is a product Jetty at Port Sudan and 55 storage depots with total capacity of 285000 m³. The pipe line runs from Port Sudan to the major consuming centre of Khartoum (Shagara). Petroleum products account for almost all of commercial energy consumption. The transport and industrial sector are the main consumers of

gasoil, residual fuels and gasoil. The break down of consumption per products is provided below as example for some years since 1970: Table No (3-1)

Table (3-1): Actual Sudan oil products consumption during 1970 to 2008

Year	Product consumption per metric ton							Total
	Gasoil	Mogas	Jet	Fuel oil	Diesel	kerosene	LPG	
1970	٢٧١٣٥٩	٩٦.٢٢	٣٦٣١١	٢.٧٧٠.	٢٧٣٧٩	٥٦.٤٣	٢.١٨	٦٩٦٨٣٢
1971	٢٩٧٨٤٩	٩٧٢٢٣	٣٣٦٣٣	٢١٤٦٥٣	٢٥٦٣٦	٦٢٦٤٣	٢٣.٣	٧٣٣٩٤.
1972	٢٩٦٦٢٤	٩٩.٨٣	٣٧.٠.	٢.١٤.٨	٢٢٣٨٩	٦٦١٣٤	٢٤١.٠	٦٩١٧٤٨
1973	٣٢١.٠.٠.	١.٢٨٣٣	١٨٢٩٦	٢٢.٢٨٥	٢٥٢٧٥	٥.٧٦٣	٢١.٦	٧٤.٥٥٧
1974	٣١٨٤.٦	١.٣٨٤٧	٤٣٥.٩	١٧٥.٥.	٢٥٥.١	٣١٩٧٨	١٨.١	٧.٠.٩٢
1975	٣٤٥٣٨٢	١١.٦٧٤	٤٩٧٢٩	١٩.١٥.	٢٥٩٤٩	٣٥٦١١	١٤٩٧	٧٥٨٩٩٢
1976	٣٨٣٧٤٨	١٢٧٨٦٧	٤٨٣٢٩	١٨٢١٤٦	٢٤٤٨٢	٣.٦٧٨	٤٧٢٢	٨.١٩٧٢
1977	٤٣٩٩٧٧	١٤٧٢٧٦	٤٩٢٣٧	١٥٨٣٦٥	٢٦١.٩	٣١٥٧٧	٤.٦٩	٨٥٦٦١.٠
1978	٤٤٦٥٢٤	١٥٨٣.٢	٤.٠.٥.	١٤٨٣١١	٢٥٩٧١	٣١٩٧٩	٤٣.١	٨٥٥٤٣٨
1979	٤٧٧٢٧٧	١٧٢.٧٩	٤٧.٦٣	١٦٧٢١٩	٢٢٨٧٦	١٧٢٦٦	٣٧.٣	٩.٧٤٨٣
١٩٨٠	٥١.٥٥٣	١٩.٩٣١	٤٤٦٢٨	١٧.٥.١	٢.٤.٧	١٧٧١٦	٥.١٩	٩٥٩٧٥٥
١٩٨١	٥٣٩٩٧٢	٢١٢٢٤٧	٤١٧٧٩	١٨٦٦.٣	١٨٣٣٤	٢.٣٩١	٥٧١٤	١.٢٥.٤.
١٩٨٢	٥٦.٩.٤	٢.٢٥.٤	٥٢٧٤٩	١٨٨٧٩٢	٢١٦٨٣	١.٩٩٦	٦١٦٢	١.٤٣٧٩.٠
١٩٨٣	٧٥٧٧٨٥	٢.٨٦٨.	٦٣٢٩.٠	٩١٥٩٧	٢٥٤١٤	١٧١٩٥	٧٨٧١	١١٧١٨٣٢
١٩٨٤	٥٣٦٧٧١	١٦٩.٦٩	٦٣٩٨٤	٩٤٨٧٥	٢٦٣٧١	١٣٢٤٧	٧.٣٢	٩١١٣٤٩
١٩٨٥	٣.٦٤٦٥	١٧٦٢.٥	٨١٥١٨	٨٩٤٩٩	٢١٦٣٥	١٢٦٧١	٨١٦٩	٦٩٦١٦٢
١٩٨٦	٦٣٣٤٦٦	٢.٣٢٣٣	٨٥٧٢.٠	١.٨٦٢٨	٣٢٢٨.٠	١٨٤٨١	١.٥.٢	١.٩٢١.٠
١٩٨٧	٦٦٢٨٦٦	٢٢.٥٥٦	٨١٤٣٢	١١.٩١٩	٣٤٨٨٦	١٥.١٦	١.٦٢٦	١١٣٦٣.١
١٩٨٨	٧٤٥٢٣٥	٢٣٢٣٩٥	٧٣٨٧٣	٩٣٢١٩	٣٨٣٢.٠	٢٢٣٢١	١.١٤.٠	١٢١٥٥.٣
١٩٨٩	٧١٦٣٧٧	٢١٥٩٤٨	٧٥٩٩٣	١٣٣٩٥٩	٣٨١٦٦	٢٣٧٩.٠	١.٥٧٩	١٢١٤٨١٢
١٩٩٠	٧٢١٢٨٧	٢٣.١١٩	٧٣٧٣٥	١٦٢٥٥.٠	٣١.٨١	١٧٢٤١	١٢٨٤٩	١٢٤٨٨٦٢
١٩٩١	٧٦٧٥٣.٠	١٧٤٢٦٢	٧١١٣٣	١٦٧٦٥٢	٢٨٧٥١	١٧٩٨١	١١٦٤.٠	١٢٣٨٩٤٩
١٩٩٢	٧٤١٥٩.٠	٢.٦٦٣٦	٨٧١٢٩	١٥٩.٩٦	٣٧٤١٨	١٣٢٨٤	١٣٢٦.٠	١٢٥٨٤١٣

1993	7091.0	179723	74740	292317	24.20	4727	12140	1247087
1994	724290	184730	7.870	370307	27142	0993	13197	14.0084
1995	784712	178109	79431	330.7.	40311	3773	17110	134246.
1996	722347	2.3144	707.9	3.8882	41987	1.448	19417	137183.
1997	7734.1	21778.	70427	387121	34498	9.71	227.3	10.7899
1998	771717	220307	92349	299.18	48.07	1107.	237.0	1471711
1999	81017.	202177	1.3343	37.7.2	00777	7772	237.0	1717417
2000	834917	273470	110883	417.90	74788	2040	31977	173908.
2001	1.217.7	307012	134893	4.7783	49141	7497	0891.	2.37342
2002	1.80721	371873	138.18	47.728	77772	87.2	97939	220.047
2003	119.240	37791.	139777	440041	0.982	1.947	1.04.3	231.8.3
2004	138.072	4.1774	190792	414778	07.89	17133	182.77	2747484
2005	1784819	42.341	27.493	43.141	09.73	13907	198410	3.77238
2006	2.09170	492874	27834.	407710	47977	12273	274397	3722731
2007	2347832	049927	232978	437774	43913	8793	204489	38737.7
2008	2347719	089987	4.81.7	0.08.8	40874	7083	2498.4	410278.
Total	3.87966	8023641	3324771	9408787	137107	768874	148297	008...7
	8				1		0	7

Source: ministry of energy and mining, Khartoum Sudan, 2010.

3.2: Expected expansion future development:

Based on the information provided by ministry of energy and mining of Sudan, oil products demand in Sudan market is rising sharply in the near future. Market demand for cast for oil products in Sudan from 2009 to 2016 more over, there are potential markets in southern of Sudan and western of Sudan and also in the neighboring countries in Africa like Chad, Central Africa and Nagar and also in international market. So Elobeid refinery in the central of Sudan and all the southern and western region and white Nile state

is near for it according to that the expansion is very necessary while the crude oil Blocks is near to Elobeid Refinery comparing to Khartoum refinery and we have two crude pipe line connected with Elobeid Refinery which is Fula for petroenergy company and GNPOC pipe line from huglig while the third pipe line is Petrodar pipe line which is about 320 Km to the East. Due to that the expansion project is propost to process the mixed crude from Block 5a and Block 6 or from Block 1, 2, 4 if their production is increased. The expansion project is planned to be completed in construction and put in to production by the end of 2015, The over all processing capacity of the whole refinery will be increased up to 4080 ton/day, at that time according to the recommended technical process configuration and market for cast of oil products demand in Southern, Western and white Nile state made by ministry of energy and mining, Elobeid Refinery products will satisfy the market demand of that area (Southern states , Western states and white Nile state).

3.3: The needs of Sudan to the Oil products:

According to the information provided by ministry of energy and mining of Sudan, the oil products demand in Sudan market is rising sharply in the near future, so the details are shown in table No (3-2) below which explain the market Demand forecast for oil products in Sudan from 2009 to 2016 (Unit: $\times 10^3$ ton).

**Table (3-2): Market demand fore cast for oil products in Sudan
From year 2009 to 2016 (Unit: $\times 10^3$ ton):**

Year	٢٠٠٩	٢٠١٠	٢٠١١	٢٠١٢	٢٠١٣	٢٠١٤	٢٠١٥	٢٠١٦
Mogas	592.2	٦٢١.٨	٦٥٢.٩	٦٨٥.٥	٧١٩.٨	٧٥٥.٨	٧٩٣.٦	٨٣٣.٣
Gasoil	٢٦٤٩	٢٩١٥	٣٢.٦	٣٥٢٧	٣٨٧٩	٤٢٦٧	٤٦٩٤	٥١٦٤
Jet fuel	٣٢٢	٣٣٨	٣٥٥	٣٧٢	٣٩١	٤١٠	٤٣١	٤٥٣
Kerosine	١٤.٥٩	١٥.٣٢	١٦.٠٨	١٦.٨٩	١٧.٧٣	١٨.٦٢	١٩.٥٥	٢٠.٥٢
LPG	٣٤٤.٣	٣٦١.٥	٣٧٩.٦	٣٩٨.٦	٤١٨.٥	٤٣٩.٤	٤٦١.٤	٤٨٤.٥
Fuel oil	٦٨٧	٧٢١	٧٥٧	٧٩٥	٨٣٤	٨٧٦	٩٢٠	٩٦٦

Source: Ministry of Energy and Mining, Sudan, 2010

For clearing the actual oil products consumption to the western and southern states are shown below on table No (3-3) since year 2005 to year 2008 in metric ton and the information was taken from ministry of energy and mining which give Actual Data for the consumption of oil products to all country.

**Table (3-3): Actual consumption of oil products
Since 2005 to 2008 (Metric tons)**

State	Gasoil mt	Mogas Mt	Jet fuel mt	Fuel oil mt	Diesel oil mt	Kerosine mt	LPG mt
<u>2005</u>							
North kordafan	91427	17.7.	7287.	114	12479	309.	187 7
South kordafan	10913	718	1422	-	1477	30	22
West kordafan	110887	783	802	-	120.	01.	-
North Darfour	917.	3208	3487	-	1777	13.	97
South Darfour	12800	2281	3.21	-	8480	817	488
West Darfour	3799	897	-	-	477	-	87
Southern States	139.7	3790	-	-	3848	-	37
Total	27294 7	288.1	71741	114	29733	0.81	27. 8
<u>2006</u>							
North kordafan	12094	18479	03194	-	14730	2819	20. 2
South kordafan	179.9	099	40.7	-	1097	72	9
West kordafan	99214	1773	710	-	1747	122	-
North Darfour	872.	3378	2133	-	2297	97	2
South Darfour	1.408	3203	8.3	-	7937	7.7	787
West Darfour	4777	939	1.1	-	932	9	-
Southern	81333	1.17.	778	-	1217	-	7.

Reference to Sudanese petroleum corporation (SPC) data and information's records, the actual consumption with an over look to the rest of Sudan during the period from the year 2000 up to year 2008 in metric ton was as shown below in tables; No: (3-4) to table No (3-10):

Table (3- 4): Actual LPG consumption for years (2000 to 2008) (Ton)

state	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Khartoum	23703	39574	54326	64997	130141	13858 4	20742 1	169837	169055	997638
Jazeera	2358	6199	18249	17968	24952	31261	39022	51552	46267	237828
W.Nile	628	1898	6332	6645	8944	9464	6656	6588	6864	54019
Nile Vallay	1350	3199	5820	5345	5491	5968	7032	9283	8017	51505
Red sea	1859	2494	2845	2749	3163	3765	4037	4433	4938	20283
Kassala	862	2113	4085	2922	3295	3421	4031	3654	4170	28553
state	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Northern	781	1912	3730	2656	3425	3159	2788	3174	3119	24744
N.kordafan	207	797	1679	1153	1672	1877	2502	3799	3380	17066
S.kordafan	9	43	30	31	14	22	9	6	97	261
B.Nile	194	539	697	566	275	185	151	348	101	3056
N.Darfour	6	35	43	83	25	97	2	59	133	483
S.Darfour	20	107	103	288	670	575	686	693	571	3713
Southern	0	0	0	0	0	37	60	73	109	279
Total	31977	58910	97939	10540 3	182067	19841 5	27439 7	253499	246821	1439428

Source: Sudanese Petroleum Corporation, 2010

Table (3-5): Mogas consumption for years (2000 to 2008) (ton)

state	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Khartoum	169627	227610	221217	234715	250294	257689	305760	338277	373008	2378197
Jazeara	20698	39402	46076	31090	40825	47851	50462	43395	45418	365217
W.Nile	8364	8398	8275	10343	10456	10208	14710	17948	18053	106755
Nile Vallay	8032	8844	7925	7242	15578	15816	15162	18284	19739	116622
Red sea	15591	19036	16329	20787	21093	29377	30303	30591	30533	213640
Kassala	18108	23344	21934	16706	22344	23854	28373	15819	13903	184385
Northern	5194	8355	6514	3817	7205	3782	7351	18591	11121	71930
N.kordafan	3885	7662	18507	25947	20977	17070	18479	21128	28588	162243
S.kordafan	168	325	6931	4974	3213	1501	2372	1165	2289	22938
B.Nile	1092	1384	4224	2579	2770	2964	2172	3260	6236	26681
N.Darfour	870	3413	2575	1995	2339	3258	3368	2668	2634	23120
S.Darfour	11245	9207	11197	7521	3441	3177	4192	3380	5297	58657
Southern	601	٥٣٢	١٥٩	١٩٤	1139	3795	10170	4939	5053	26582
Total	263475	357512	371863	367910	401674	420342	492874	519445	561872	3756967

Source: Sudanese Petroleum Corporation, 2010

Table (3-6): Kerosene consumption for the years (2000 to 2008) (ton)

state	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Khartoum	557	4124	4586	5123	6570	4296	5247	4822	3602	38927
Jazeara	89	1115	1852	2448	3412	2541	1827	2060	1738	17082
W.Nile	0	6	59	56	7	0	0	-	-	128
Nile Vallay	3	11	0	0	115	36	280	17	107	569
Red sea	953	916	110	329	400	557	279	189	294	4027
Kassala	113	385	30	215	341	412	280	262	291	2329
Northern	16	60	1	81	48	0	534	1	-	741
N.kordafan	30	195	700	1083	2438	3590	2819	945	284	12084
S.kordafan	0	96	238	698	1566	545	194	10	-	3347
B.Nile	0	0	0	0	57	14	0	-	-	71
N.Darfour	0	112	273	88	21	130	97	56	95	872
S.Darfour	23	477	857	825	1248	816	716	104	161	5227
Southern	0	·	·	·	0	0	0	57	11	68

Total	1784	7497	8706	10946	16223	12937	12273	8523	6583	85472
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Source: Sudanese Petroleum Corporation, 2010

Table (3-7): Gasoil consumption (from year 2000 to 2008) (ton)

state	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Khartoum	362416	457736	493673	630612	744584	840602	1071057	1292839	1352326	7245845
Jazeara	62429	67869	86827	94155	100452	100515	112208	89851	95794	810100
W.Nile	54174	54421	64810	59069	69186	60937	83010	84147	79895	609649
Nile Vallay	46726	44784	45064	30156	57043	78043	73160	65228	54163	494367
Red sea	107430	135917	115747	13599	145358	192439	223704	208714	194108	1459016
Kassala	50369	50770	34298	29164	37860	47841	70650	32168	40518	393836
Northern	38600	62704	56154	29871	38860	58961	70702	94004	69151	519007
N.kordafan	35697	26135	28608	49696	39020	131799	120594	114226	136190	641593
S.kordafan	26847	67227	97997	85207	1021741	9320	117123	18808	20836	668018
B.Nile	7465	8465	12072	7953	14907	9320	12280	19328	20574	112364
N.Darfour	5806	8651	11338	6005	7530	9160	8710	13068	14020	84288
S.Darfour	31017	33033	31060	26312	18932	16664	14624	13885	17769	203286
Southern	5941	٣٩٩٤	٨٠٧٣	٦٤٤٦	4456	13906	81333	122229	89600	335678
Total	834917	1021706	1085721	1190245	1380062	1651604	2059155	2168495	2184944	13577047

Source: Sudanese Petroleum Corporation, 2010

Table (3-8): Fuel oil consumption (from year 2000 to 2008) (ton)

State	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Khartoum	278496	327670	377464	461355	317649	337273	392851	348509	393270	3174537
Jazeara	8063	185	1345	109	1443	479	460	40	311	12435
W.Nile	63204	53837	68107	31194	60548	49609	28487	54002	59895	468883
Nile Vallay	5980	15586	18208	7514	24254	27960	19036	17517	23980	160035
Red sea	2526	8066	2385	2253	143	474	2903	2969	5954	27673
Kassala	-	-	73	-	4017	5691	5736	376	-	15893
Northern	2943	95	3045	3115	6104	7081	8142	9829	13802	54456
N.kordafan	1620	1244	-	-	-	114	-	-	-	2978
S.kordafan	-	-	-	-	-	-	-	-	-	-
B.Nile	-	-	-	-	-	-	-	-	-	-
N.Darfour	-	-	-	-	-	-	-	-	-	-
S.Darfour	-	-	1	-	510	-	-	3224	1418	5153
Southern	-	-	-	-	-	-	-	-	100	100
Total	362832	406683	470628	445540	414668	428681	457615	436466	498730	3921843

Source: Sudanese Petroleum Corporation, 2010

Table (3-9): Diesel oil consumption (from year 2000 to 2008) (ton)

state	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Khartoum	24744	24787	-	7551	-	-	-	-	-	87549
Jazeera	-	-	-	84	-	-	-	-	-	84
W.Nile	-	-	19223	-	-	-	-	-	-	-
Nile Vallay	13562	7490	9979	17348	15163	14871	618	444	1058	89777
Red sea	15615	4335	8755	6429	11969	9176	12811	13864	13514	97692
Kassala	3838	5278	-	5705	7484	5231	4079	2527	3799	46696
Northern	1302	145	7444	60	-	62	-	-	-	1569
N.kordafan	877	2739	7444	9611	10181	12469	14735	13724	14595	86375
S.kordafan	-	-	-	-	974	2677	3342	1969	2184	11146
B.Nile	-	-	-	-	-	-	-	-	-	-
N.Darfour	1098	460	3.7	111	1080	1777	2296	1420	13.3	10367
S.Darfour	9061	2807	626	2345	6286	8962	8869	5935	4587	49479
Southern	909	1090	871	1738	2447	3848	1217	982	715	13822
Total	71006	49141	77672	50982	56089	59073	47967	40870	41755	494556

Source: Sudanese Petroleum Corporation, 2010

Table (3-10): Jet A consumption (From year 2000 to 2008)(ton)

state	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Khartoum	91089	102653	106339	108732	138694	181549	205273	183246	364434	1482009
Jazeera	-	-	-	-	-	-	-	43	311	354
W.Nile	545	330	2	-	-	-	-	-	-	877
Nile Vallay	-	297	-	-	-	-	-	-	-	297
Red sea	2871	3240	3521	2801	2500	6909	8421	3866	3389	37518
Kassala	19	53	-	53	-	-	104	-	-	229
Northern	788	993	1188	707	608	394	582	259	212	5731
N.kordafan	17429	22407	24054	24306	43954	62860	53194	29710	35622	313536
S.kordafan	-	-	-	١٢٦	٢٦٣	٢٢٧٤	٥١٢١	١٣٦٤	١١٢	٩٢٦٠
B.Nile	47	٧٤	-	-	-	-	١٩٤٠	٥٨٣	٩٦٠	٣٦٠٤
N.Darfour	1290	١١٣٩	٩٥٥	١٣٨٣	١٣٩٣	٣٤٨٦	٢١٣٣	٦٩٩٩	١٠٨٣	١٩٨٦١
S.Darfour	1805	3707	1959	1668	8380	3021	904	2801	1412	25657
Southern	-	-	-	-	-	-	-	1536	252	1788
Total	115883	134893	138018	139776	195792	260493	277672	230407	407787	1900721

Source: Sudanese Petroleum Corporation, 2010

3-5: Future of oil products consumption in Sudan:

According to Sudanese petroleum corporation, the Sudan's need of oil products will increase; for LPG, Mogas and fuel oil to 5% (yearly) while Jet A consumption will increase to 3% but gas oil will increase to 10% till 2011 and then drop to 5% (yearly). The expected consumption of oil products by Sudan during the next years from 2010 to 2030 estimated in metric ton shown in table no (3-11) bellow:

Table (3-11): Sudan oil products needs during 2010 till 2030(ton)

Year	Gasoil	Mogas	Jet A	Fuel oil	LPG
2010	3164544	636614	254578	1007235	294603
2011	3480999	668445	262215	1014382	309333
2012	3655049	701867	270082	1021886	324800
2013	3837801	736960	278184	1029766	341040
2014	4029691	773808	286530	1038040	358092
2015	4231176	812499	295126	1046727	375996
2016	4442735	853123	303980	1055849	394796
2017	4664871	895780	313099	1065427	414536
2018	4898115	940569	322492	1075484	٤٣٥٢٦٣
2019	5143021	٩٨٧٥٩٧	٣٣٢١٦٧	١,٠٨٦,٤٣	٤٥٧,٢٦
2020	5400172	١,٠٣٦٩٧٧	٣٤٢١٣٢	١,٠٩٧١٣١	٤٧٩٨٧٧
2021	5670180	1088826	352396	1108773	٥٠٣٨٧١
2022	٥٩٥٣٦٨٩	١١٤٣٢٦٧	362967	1120997	529064
2023	6251374	1200430	373856	1133832	555518
2024	6563942	1260452	385072	1147309	583293
2025	6892139	1323475	396624	1161460	612458
2026	7236746	1389648	408523	1176319	643081
2027	7598584	1459131	420779	1191920	675235
2028	7978513	1532087	433402	1208302	708997
2029	8377439	1608692	446404	1225502	744447
2030	8796311	1689126	459796	124363	781669

Source: Sudanese Petroleum Corporation, 2010

3-6: Petroleum products – current situation:

The actual consumption during the period from 01/01/2009 till 30/9/2009 in metric ton was as shown in table no (3-12) below:

**Table (3-12) The actual Consumption during 01/01/2009 till 30/9/2009
(Ton)**

state	Gasoil	Mogas	Jet A1	Kerosine	Fuel oil	Diesel oil	LPG
Khartoum	1025355	306308	124240	1273	288037	-	137055
Jazeera	77841	38430	-	610	44	-	40082
W.Nile	85194	22932	-	-	55247	-	6750
Sennar	24761	8406	-	-	-	-	3785
B.Nile	24485	7096	-	-	-	-	176
Nile Vallay	48784	19919	-	-	6026	16	9649
Nothern	30187	6471	23	-	3076	433	2885
Red sea	131136	22748	3250	213	2524	1237	4022
Kassala	39470	13634	-	46	-	2278	4667
Gaderif	53677	17822	-	-	2600	1455	2983
N.kordafan	110022	25022	13346	471	-	11816	3788
W.kordafan	71772	١٦٥٥	٢٢١	١٨	-	١٧٢٠	-
S.kordafan	١٨٦٢١	٢٠٨٦	-	١٨	-	١٥٧٤	-
N.Darfour	١٢٨٠٦	٣٧٢٧	٤٢٤٧	-	٢٠	١١٩١	٢٧٦
W.Darfour	١٥٧٠	95	792	-	-	1192	-
S.Darfour	14576	3011	4920	-	2767	3488	411
Southern	70989	٢٢٤٤	٢١١	-	-	65	143
Total	1841246	501606	151250	2649	360340	26465	216672

Source: Sudanese Petroleum Corporation, 2010

3-7: Products distance to travel and rate of transport for the products:

Before 1996 most of products and crude oil imported through Port Sudan and then distributed to all country by pipe line to ALshagara or by road trucks and rail wagons. After that when Elobeid Refinery and Khartoum Refinery were built so there are four points for products distribution which they are:

- ALshagara (Pipe line end)
- ALGaily (Khartoum Refinery)
- Port Sudan (imported products)
- Elobeid Refinery

So on the appendix we attached four tables which are:

1. Table No (3-13); which explain the transport rate and distance from ALshagara to up country.
2. Table No (3-14); which explain the transport rate and distance from aLGaily to up country.
3. Table no (3-15); which explains the transport rate and distance from Port Sudan to up country.
4. Table No (3-16); which explain the transport rate and distance from Elobied to up country.

Mainly we transport most of products by Road tankers so in Sudan we have about 39 Transport companies each one have more than 15 tankers average capacity 9500 to 16000 Gallon for tanker while the companies which have less than 15 tankers is approximately 22 companies and their tankers capacities average 5500 to 8500 gallon per tanker. According to information taken from ministry of energy and mining the number of tankers approximately 1s 1260 tanker and petrotrans is one of the biggest public transporting company.

The rail way in Sudan is very important for transporting oil products which have 507.2thousan ton capacity which equivalent to 24% of oil products needed to travel.

The river transporting is very important for transporting oil products to southern states and their capacity about 9000 metric ton. (31 Sandel)

The pipe line transporting is very important and we have:

- 1- The old pipe line which constructed in 1976 belongs to Sudanese petroleum pipe line company (SPPC) with length 815 km and diameter 8 inch from Port Sudan to ALshagara with five Booster station and it was refamped on 1996 and its capacity increased to 600 thousand ton per year and it can work on reverse direction for exporting oil products from ALGaily to Port Sudan.
- 2- The export Mogas pipe line also belongs to Sudanese Petroleum pipe line Company. The length of pipe line is 741 km from ElRawyan to Port Sudan with diameter 12 inch with capacity 1.5 million ton per year.
- 3- The export crude pipe line which belong to greater Nile petroleum company constructed during 1998 to 1999 which length 1610 km from Heglig to port Sudan which diameter 28inch and 450 thousand barrel per day .
- 4- Fula crude oil pipe line which is belong to petro energy company constructed in 2003 with length 720 km from Balela to Khartoum refinery with 24 inch diameter and 200 thousand barrel per day.
- 5- Adarail crude oil pipe line which belongs to Petrodar Company constructed in 2006 with length 1500 km from Falog to Port Sudan with 32 inch diameter and 500 thousand barrel per day. And this pipe line is transporting crude oil from block 3& 7 to Bashair 2 Port Sudan.

3-8: Crude oil in Sudan:

According to information from ministry of energy and mining in Sudan the exploration was began since 1959 in red sea state from Mahamad gool north side to Tokar south side by Agip company and in 1979 Chevron have license for exploration in Moglad and Abo Gabra area Abuaye and it was stopped on 1983 due to civil war. There are many companies comes to Sudan and began exploration like union Taksass, Sun Oil company, Total company Philips and state petroleum company. All these companies are improved exploration in Sudan especially block 1,2,4 and they made a consortium in 1995 called greater Nile (GNPOC) and then they began commercial production for crude oil so the first crude oil shipment on 31/8/1999.

3-8-1: Crude oil blocks information:

According to information from ministry of energy and mining in Sudan table No (3-13) explain the full information about the crude oil in the bloc.

Table (3-13): Crude oil Blocks information

Operating Companies	Area k m²	Block
GNPOC	٥٠٠٠٠	1,2,&4
Petrodar	٧٢٤١٩	3&7
WNPOC	٢٠١٩٩	5-B
Petro Energy	٣٨٤٦٨	٦
WNPOC	٦٥٨٥٦	٨
Suda Pak	١٢٦٠٩٠	٩
Free	٥٧٦٠٤	١٠
Sudapak	٢٩٥٨٥٥	١١
Sahara	٤٢٨٨٨	12-A
free	--	12-B
Coral	٢٤٦٠٠	13
Salima	١٣٥٠٢٠	١٤

Rspoc	٢٨١٠٠	١٥
Ipsl	--	١٦
star	--	١٧
Sudan Pak	٤٤٢٨٥	A
Total	١١٨٥٨٦	B
Apco	٦٥٠٠٠	C

Source: Ministry of Energy and Mining, Sudan, 2010

The Sudanese crude oil has three types with difference specifications and on table No (3-14): bellow can find full specifications about these Sudanese crude.

Table (3-14): Sudanese crude oil specifications

specification	Nile blend crude	Dar crude	Block 6 crude
Density API deg	0.864 kg/L	0.9026kg/L	0.9353kg/L
BS &W Vol %	0.8 vol %	1Vol%	2.4 vol%
Pour point C	33C	39C	12C
Salt content	174 MG/1	7PTB	35 MG/1
Sulpher wt.%	0.073WT%	7WT%	0.10WT%
Viscosity at 50 deg	32 MM ² /s	31CST	707MM ² /s

Before the end of the year1999 the Sudan imported crude oil and then refining it on Port Sudan refinery. But from 31/9/1999 Sudan started exporting crude.

Table (3-15): Crude oil importing since 1975 to 1998 in Barrels

Year	Quantity Barrel	year	Quantity Barrel
۱۹۷۵	8279251.2	۱۹۸۷	3510365.6
۱۹۷۶	7641428.3	۱۹۸۸	5433251.3
۱۹۷۷	7750848.0	۱۹۸۹	4336878.9
۱۹۷۸	7328455.4	۱۹۹۰	6123889.7
۱۹۷۹	6841034.4	۱۹۹۱	7618258.1
۱۹۸۰	7044113.1	۱۹۹۲	4691914.4
۱۹۸۱	5924512.1	۱۹۹۳	2286703.1
۱۹۸۲	5376552.2	۱۹۹۴	2875470.0
۱۹۸۳	5244947.8	۱۹۹۵	4007948.2
۱۹۸۴	4203033.4	۱۹۹۶	4874867.0
۱۹۸۵	5051220.4	۱۹۹۷	4881112.44
۱۹۸۶	5961625.3	۱۹۹۸	3111458.27

Table (3-16): Exporting crude since 1999 to 2007 in Barrel

Year	Quantity Barrel
۱۹۹۹	3274317
۲۰۰۰	15240228
۲۰۰۱	7602498
۲۰۰۲	10941657
۲۰۰۳	42252330
۲۰۰۴	۵۱۳۷۷۸۲۹
۲۰۰۵	۵۲۲۱۱۵۶۹
۲۰۰۶	۴۷۹۳۱۶۷۶
۲۰۰۷	۶۸۷۵۷۲۰۸

The most important countries that are importing Sudanese crude are shown on the table No (3-17) below.

Table (3-17): countries that imported Sudanese crude during term 2001 to 2007

Country	Times of shipment
China	١٨٩
Japan	٩٣
Korea	١٦
Singapore	١٠
Italy	٦
Taiwan	٤
Indonesia	٤
Australia	٢
Other Country	٤
Total	٣٢٨

The Nile blend crude is very good crude comparing to other crude in the world and its price internationally is better and according to information from the ministry of energy and mining of Sudan below is the average price to Nile blend exporting prices since 1999 to 2005 beside the average price to OBEC crude since 1994.

Table (3-18): Average prices for OBEC crude since 1994 to 2007

year	Prices USD Dollar barrel	year	Prices USD Dollar barrel
1994	15.53	2001	23.12
1995	16.86	2002	24.36
1996	20.29	2003	28.1
1997	18.68	2004	36.05
1998	12.28	2005	50.64
1999	17.48	2006	61.08
2000	27.6	2007	57.97

Table (3-19): Average price Bile blend crude (USD/barrel) sine 1999 to 2005

Year	Average price (USD/barrel)
1999	21.4
2000	25.8
2001	22.89
2002	25.79
2003	27.0
2004	36.39
2005	50.37

3.9 Chapter Three Summary:

According to information in chapter three which was brought from the Ministry of Energy and mining, many facts were found and below is the summary of the main facts:

1. Development of Sudan's downstream sector refining has not paralleled that of crude oil production. It cannot meet the burgeoning and increasing in demand, especially for diesel and aviation fuel.
2. Port Sudan Refinery was stopped since 1999.
3. Khartoum Refinery and Elobeid Refinery were predicated on production for domestic consumption, only with capacities of about 115000 barrels per day.
4. Khartoum Refinery refines more gasoline than it needs and exports this surplus by pipe line of 12 inch a diameter from Khartoum to port Sudan (800km).
5. Sudanese petroleum Corporation in Sudan supervising all petroleum operations in Sudan.
6. The distribution infrastructure consists of river tankers (for South), road tankers, pipe lines, rail wagons system, all of which are in need of improvement.

7. When we look at table No 3-1 it shows that the Sudan's oil products, consumption was increasing yearly.
8. When we look at table No 3-3 we find that the actual consumption of oil products since 2005 to 2008 is increasing yearly e.g. in 2005 gasoil was 262946 metric tons this was for the Western and Southern of Sudan and in 2008 gas oil was 365077 metric tons whereas Elobeid Refinery's production yearly is 161000 metric tons which is not enough to satisfy the needs of the Western and Southern states. So, expansion is important.
9. The Sudanese crude oil has three types with different specifications as shown on table 3-14 attached which is Nile blend crude, Dar crude and Block 6 crude.
10. Elobeid Refinery capacity now is not satisfying the needs of the Western and Southern states, so, gasoil and Mogas are being brought from Khartoum by road tankers and the price of all oil products in Khartoum and Elobeid are same so the Sudanese petroleum Corporation should pay the transporting fees of the quantities of oil products from Khartoum to Elobeid.
11. Market demand's forecast of oil products in Sudan from 2009 to 2016 moreover there are potential markets in Southern and Western of Sudan and also in the Neighboring countries in Africa like Chad, Central Africa and Nagar and also in international market. So Elobeid Refinery which is in the central of Sudan with all Southern and Western regions and White Nile states nearby it and according to that the expansion is very necessary. Also the crude oil blocks are near to Elobeid Refinery comparing to Khartoum Refinery and we have two crude pipe lines connected with Elobeid Refinery which are Fula for Petoenergy Company and GNPOC pipe line from Higleg whereas the third pipe line is Petrodar pipe which is about 320 km to east.

12. The expansion project is proposed to process mixed crude from block 5a and block 6 or from block 1,2,4 if their production is increased.
13. The expansion project is planned to be completed in construction and put into production by the end of the year 2015. The overall processing capacity of the whole Refinery will be increased up to 4080 tons/day equivalent to 30000 barrels per day.

Chapter Four Results & Analysis

4-1 Khartoum Refinery products:

Khartoum Refinery produces eight products: fuel oil, gasoil, kerosene, jet, fuel, liquefied petroleum gas (LPG), coke and mogas. The table No (4-1) below explains actual extracted products of Khartoum Refinery sine 2000 to 2006 in metric tons:

**Table (4-1): Extracted products of Khartoum Refinery
since 2000 to 2006 in metric tons:**

Year	Coke	Kerosene	LPG	Jet fuel	Gasoil	Feul oil	Mogas	Total
2000	-	2556	162412	-	737948	9175	484189	1496280
2001	-	1493	214892	114693	782691	-	841991	2045760
2002	-	-	240685	168968	915850	-	884620	2210123
2003	-	-	229137	155890	975232	10779	857894	2228932
2004	17200	-	278921	197000	1165273	-	950893	2609287
2005	90013	-	259456	201269	1193120	-	917578	2661436
2006	205931	-	322588	182264	1675968	-	1139077	3525828
Total	313144	4049	1908091	1020084	7536082	19954	6176242	16777646

4-2: Elobeid Refinery products:

The Refinery products four products only which are fuel oil, gas oil, kerosene and Naphtha. Also the Refinery products diesel oil by blending gasoil 70% plus fuel oil 30% to be used for power stations.

The table (4-2) below explains actual extracted products Of Elobeid Refinery sine 1996 to 2009 in metric tons.

**Table (4-2): Elobeid Refinery extracted oil products
since 1996 to 2009 (Ton)**

Year	Gasoil	Naphtha	Kersoine	Feul oil	Total
1996	5365.1	1038.8	90.5	36568.4	43062.8
1997	24756.7	7240.7	5392	140114.9	177504.3
1998	31076	6211	8367	124308	169962
1999	39487.8	12637.8	14509	142109.5	208744.1
2000	93265.0	29842	33244	280633	436984
2001	88883.5	21045	28259.4	239756.9	377944.8
2002	104544.1	24229.3	33503.4	290078.3	452355.1
2003	127123.1	28081.5	36530.9	357706.9	549442.4
2004	134445.5	26981	38010.9	361639.4	561076.8
2005	141606.03	27299.70	40404.68	385330.44	594640.9
2006	140900.64	24245.21	41438.54	385351.55	519935.9
2007	114010	19070	30937	307604	471621
2008	126600	24547	32510	339663	523320
2009	123342.4	23270.6	31171	316322	4941.06

4-3: The actual oil products consumed in Western and Southern States according to the Ministry of Energy and Mining information which is stated below on table 4-3 in terms from 1/1/2000 till 30/9/2009 in metric.

Table (4-3): The actual products consumed in Western and Southern States from 1/1/2000 till 30/9/2009 in metric tons:

State	Gas oil	Mogas	Keroisne	Jet	LPG	Fuel	Diesel
N- Kordofan	110022	25022	471	13346	3788	-	11816
W. Kordofan	71772	1655	18	221	-	-	1720
S. Korofan	18621	2086	18	-	-	-	1574
N. Darfour	12806	3727	-	4247	276	20	1192
S. Darfour	14576	3011	-	4920	411	2767	3488
W. Darfour	1570	95	-	792	-	-	1192
Southern states	70989	2244	-	211	143	-	65
Total	300356	37840	507	23737	4618	2787	21046

With reference to the information above concerned the actual consumption of oil production in Western and Southern States of Sudan compared to the actual production of oil products in Elobeid Refinery we notice that its production is not enough. So, the lack of oil products comes from Khartoum Refinery which economically is not O.K because the prices of oil products in Elobeid and in Khartoum are the same and in this case the difference in price. We should be mean that recognized the transportation fees which are paid by the General petroleum Corporation which should be used to upgrade Elobeid Refinery to satisfy the needs of Southern, Western and other parts of White Nile state.

4-4: Comparison between the actual needs of oil products in Western and Southern States to the actual Elobeid Refinery oil production during the term from 2005 to 2008 in metric tons as shown below in table (4-4):

Table (4-4): Comparison between actual needs of oil products in western and Southern States to Elobeid Refinery (ORC) oil products production during the term from 2005 to 2008 in metric tons

Year	Gas oil		Mogas		Jet		Keroisne		LPG		Fuel oil	
	W & S needs	ORC	W & S needs	ORC	W & S needs	ORC	W & S needs	ORC	W & S needs	ORC	W & S needs	ORC
2005	262946	141606	28801	27300	71641	-	5081	40404	2608	-	114	385330
2006	342394	140900	38581	24245	62020	-	3826	41438	3259	-	-	385351
2007	384198	114010	37083	19070	44981	-	1342	30936	-	-	3224	307604
2008	365077	126600	46861	24547	39111	-	551	32510	-	-	1418	339652

With reference to the table (4-4) above we found that Elobeid Refinery Company (ORC) production is not enough to satisfy the needs of the area around and the lack of oil products for this area was brought from Khartoum Refinery by road tankers and below is table No (4-5) which explains the lack quantity in metric tons.

Table (4-5): Lack quantity in metric ton to the term from 2005 to the 2008 in tons

Year	Gasoil	Mogas0	Jet A	LPG
2005	121340	28011	71641	2608
2006	201494	38581	62020	3259
2007	270188	37083	44981	3500
2008	238477	46861	39111	4218
Average	207875	37634	54438	3396

- Elobeid Refinery company (ORC) gas oil production is not enough for the need of Western and Southern States. The average lack quantity equals 207875 metric tons yearly.
- Elobeid Refinery Company (ORC) products naphtha yearly 33000 tons where as the Western and Southern States need an average of 37634 tons of Mogas yearly. It can install a reformer to Elobeid Refinery to correct turn naphtha into mogas so as to satisfy the area by mogas instead of bringing it from Khartoum which is very expensive.
- Western and Southern States average needs of jet are 54438 metric tons yearly which are not produce in ELbeid Refinery. All this quantity was brought from Khartoum Refinery Company (KRC).
- The averages of yearly needs for LPG are 3396 metric tons Western and Southern States which is not available in ELObeid Refinery Company (ORC) and it should be brought from Khartoum Refinery (KRC).
- Always Sudanese petroleum Corporation controls oil and petroleum products prices and due to this the policies of the prices of the products in Khartoum Refinery, Elobeid Refinery and port Sudan Refinery are the same. So when we want to fill the gap of the oil products in Western and Southern States transport fees from Khartoum to Elobeid it must be paid by Sudanese petroleum Corporation. Table No (4-6) below explains the lack and extra costs:

Table (4-6): Lack of oil products for Western and Southern States and extra costs:

Year	Gas oil		Mogas		Jet		LPG	
	Lac ton	Extra cost SDG	Lack ton	Extra cost SDG	Lack ton	Extra cost SDG	Lack ton	Extra cost SDG
2005	121340	9707200	28011	2520990	71641	7880510	2608	471970
2006	201494	16119530	38581	3472290	62020	682200	3259	589781
2007	270188	21615040	37083	3337470	44981	4947910	3500	633395
2008	238477	19078160	46881	4217490	39111	4302210	4218	763331
Average	207875	16630000	37634	3387060	54438	5988180	4496	614574

4-5: Future oil products, needs for Western and Southern States from 2010 to 2015 in metric tons as show in table (4-7) below :

**Table (4-7):
Future oil products, needs for Western and Southern States from the
year 2010 to 2015 in metric tons**

Year	Gasoil	Mogas	Jet A	LPG	Fuel oil
2010	440521	52775	32597	6464	3902
2011	484573	55414	33575	6787	4097
2012	508802	58184	34582	7126	4302
2013	534242	61093	35619	7482	4517
2014	560954	64148	36687	7856	4743
2015	589002	67355	37788	82449	4980
Average	519682	59828	35141	7327	4423

If comparison is done during 2011 then we need to calculate the needs of oil products for Western States of Sudan which is explained below in table No (4-8) during the term from 2010 till 2015 in metric tons.

**Table (4-8): Oil products needed for western states
to the term from 2010 till 2015 in metric tons**

Year	Gasoil	Mogas	Jet	LPG	Fuel oil
2010	336404	49633	32307	6264	4902
2011	370044	52115	33276	6577	4097
2012	388546	54720	34274	6906	4302
2013	407973	57456	35302	7251	4517
2014	428371	60329	36361	7613	4743
2015	449789	63343	37432	7994	4980
Average	396855	56266	34828	7100	4423

With reference to the information on this chapter Iv which was brought from the Ministry of Energy and Mining we find that Elobeid Refinery must be expanded to satisfy, the area around the Refinery by oil products. The results are obtained from the analysis of the information on different tables on chapter Iv state the following:

4.6 The necessity of justifications upgrading Elobeid Refinery Company (ORC):

1. The site of Elobeid Refinery in central Sudan is proposing a suitable expansion to increase the Refinery's production capacity from its current basis of 15000 barrels/per day of crude oil to 30000 barrels per Day phase one (2010 to 2015).
2. The current crude oil supply in Sudan is originating from block 1,2,4 (Nile blend, block 6 (Fula) and all of them are near to Elobeid Refinery and the crude oil pipe lines pass through Elobeid Refinery.
3. Block 3,7 (Dar blend) pipe line is about 320 km to the east from Elobeid Refinery and table No (4-9) below explains the crude oil production forecast in barrels per day.

**Table (4-9): Crude oil production forecast
during the year 2010 to 2017 in barrels per day**

Year	Block 1,2,4		Block 3 & 7		Block 6		Block 5A		Total G share
	Production	G. share	Production	G. share	Production	G. share	Production	G. share	
2010	175342	109589	295890	205479	60000	15280	60000	25740	356088
2011	145205	84932	298630	208219	60000	15280	60000	30000	339431
2012	120548	73973	293151	191781	70000	18080	50000	25000	308833
2013	101370	68493	276712	164384	1000000	27080	130000	71500	331457
2014	84932	63014	257534	153425	1000000	27080	160000	104000	347518
2015	73973	57534	221918	131507	1000000	27080	140000	84000	3000121
2016	65753	49315	180822	160849	80000	21080	125000	75000	252244
2017	54795	41096	161644	95890	80000	21080	110000	66000	224066

4. Based on the information provided by the Ministry of Energy and Mining, oil products demand in Sudan market is rising sharply in the near future.
5. The existing capacities of internal refineries in Sudan Elobeid Refinery, and Khartoum Refinery are not enough to satisfy the demand where as port Sudan Refinery had already been stopped sine 1999 due to its age and the crude type is not available in Sudan where as importing crude is expensive.
6. The high expected demand of oil products in Western, Southern and white Nile states of the Sudan in the near now is covered from Khartoum Refinery which is so far away and economically its not logical. So, Elobeid Refinery should be expanded to supply these states.
7. A proposal oil products pipe line from Elobeid Refinery through Southern Kordofan to Southern States of Sudan (ADOK) can assist transferring products of Elobeid Refinery to those states,
8. Elobeid Refinery production should satisfy the Western, Southern & White Nile State of Sudan and the surplus should be exported to Neighboring African countries like Chad, Central African and Nagger.
9. Beside the above results the main objectives of upgrading the Refinery include:
 - Capturing profitable opportunities.
 - Increasing refinery reliability and efficiency.
 - Improving products quality and quantities.
 - Reducing losses and waste.
 - Incorporating advanced technologies and maintain pace setter status.
 - Maintaining a safe and clean environment.
 - Enhancing personnel welfare, organizational development and staff training.

4-7: Chapter four Summary:

1. Khartoum Refinery produces eight products, fuel oil, kerosene, jet fuel, liquefied petroleum gas (LPG), coke and mogas while Elobeid Refinery (ORC) produces only four products which are naphtha, kerosene, gas oil and fuel oil and it can produce diesel oil by blending gas oil with fuel oil to produce diesel oil for power station,
2. The design capacity of Elobeid Refinery during the year can produce 429000 metric tons of fuel oil and 161000 metric tons of gas oil and 39600 metric tons of kerosene and 33000 metric tons of naphtha.
3. The average consumption of gas oil for Western and Southern States is about 300356 metric tons per year where as Elobeid Refinery's production for gas oil is 161000 metric tons per year which is not enough.
4. Mogas consumption for Western and Southern States is about 46861 metric tons where as Elobeid Refinery's production is about 33000 metric tons per year and that the production of naphtha should be sent to Khartoum Refinery for treatment and then again is returned to Western and Southern States for use.
5. The lack quantity in metric tons for Western and Southern States during the term 2005 to 2008 is gas oil 207875, mogas 37634, jet A 54438 and LPG 3396 and all these quantities were brought from Khartoum Refinery and the difference of price is paid by Sudanese Petroleum Corporation.
6. During the term 2005 to 2008 the Sudanese Petroleum Corporation yearly paid on average of 16630000 SDG for gas oil and 3387060 SDG for mogas and 5988180 SDG for jet A and 614574 SDG for LPG.
7. Future oil products for the Western and Southern states during the years 2010 to 2015 in metric tons average constitute on of 519682 gasoil, 59828 mogas, 35141 jet A, 7327 LPG. And 4423 fuel oil, metric tons.

8. If comparison was done during 2011 then we have to calculate the needs of oil products for Western states of Sudan and drop the needs Southern states and then make the expansion for the Refinery to satisfy Western states only.
9. The side Elobeid Refinery in central Sudan proposing a suitable expansion to increase the Refinery's production capacity from its current basis of 15000 barrels per day phase one (2010 to 2015).
10. The current crude oil supply in Sudan is originating from block 1,2,4 (Nile blend) block 6 (Fula) and all of them are near to Elobeid Refinery and never the less moreover the crude oil pipe line pass through Elobeid Refinery.
11. Block 3/7's (Dar blend) pipe line is about 320 km to the east from Elobeid Refinery.
12. According the information provided by the Ministry of Energy and Mining, oil products, demand in Sudan market is rising sharply in the near future.
13. The existing capacities of internal Refineries in Sudan Elobeid Refinery and Khartoum Refinery is not enough to satisfy the demand where as Port Sudan Refinery had already been stopped since 1999 due to it is age and the crude type not available in Sudan where as importing crude is expensive.
14. The high expected demand of oil products in Western, Southern and the white Nile states of the Sudan in the near future is so great. Look at the table No 4-8 where as most of its needs now is covered from Khartoum Refinery which is so far away and economically it is not logical. So, Elobeid Refinery should be expanded to supply those states.
15. A proposal oil products, pipe line from Elobeid through Southern Kordofan to southern states of Sudan (Adok) can assist transferring products of Elobeid Refinery for those states.

16.If the expansion of Elobeid Refinery is done its production will satisfy the western, southern and white Nile states of the Sudan in the near future and the surplus should be exported to the Neighboring African countries like Chad, central Africa and Nagger.

17.Beside the above results the main objectives of upgrading the Refinery include:

- Capturing profitable opportunities.
- Increasing refinery reliability and efficiency.
- Improving products quality and quantities.
- Reducing losses and waste.
- Incorporating advanced technologies and maintain setter status.
- Maintaining pace and clean environment.
- Enhancing personnel welfare, organizational development and staff training.

Chapter five

5: Conclusion & Recommendation:

5:1 Conclusion:-

This research is an investigation into the upgrading of Elobeid Refinery. The research includes the study of the market's need which the Refinery will cover and the availability at crude oil in the area around the Refinery. The research aims at finding a suitable size for the expansion to satisfy the needs of oil products the area near the Refinery; especially the Western, Southern States, and some parts of the White Nile States; putting the Khartoum Refinery production into consideration. According to the basis of the study the following conclusions were draw out.

1. The existing unit of Elobeid Refinery's capacity now is 15000 barrels per day which is not enough to satisfy the Western State, Southern States and some parts of the White Nile States. The maximum production of Elobeid Refinery now is 161000 metric tons of gas oil, 33000 metric tons of naphtha, 39600 metric tons of kerosene and 429000 metric tons of fuel oil.
2. The future average needs of the oil products for Western States, Southern States and some parts of the White Nile State, are approximately, gas oil 645516 metric tons, mogas 962233 metric tons, liquefied petroleum gas (LPG) 18039 metric tons which indicate that the consumption is increasing yearly and if DarFour war is stopped the consumption will rise even more.
3. The availability of crude oil from block 1,2,4 Helug and from block 6 Fula and Dar blend block 3/7 is about 320km to the east of Elobeid Refinery.
4. The existing crude pipe lines which are GNPOC Pipe line petro Energy Pipe line both are pass through Elobeid Refinery.

5. The proposal for a new oil products pipe line from Elobeid Refinery to Adok through Southern Kordofan State to transfer oil products to Southern Kordofan State and Southern State of Sudan is very necessary.
6. Mogas consumption in Western and Southern States is not enough because of the limited capacity of Refinery which denotes the necessity of the expansion of the Refinery.
7. Liquefied petroleum gas (LPG) consumption is very weak in Western and Southern States which is due to unavailability of LPG cylinders and most of the people in the area use wood instead of LPG.
8. Jet A consumption in Western States now is very high due to DarFOur war and United Nations aireoplanes and this is not steady consumption and if the war stops the consumption of the jet will decreased.
9. Elobeid Refinery should be upgraded to double existing capacity by adding 15000 barrels per day in addition to the old unit of crude distillation unit (CDU) so that the Refinery capacity in the future will be 30000 barrels per day. (and 20000 barrel per day catalytic unit for processing the resultant long residue products from the crude distillation units in to gas oil, gasoline. Kerosene, liquefied petroleum gas (LPG) etc). in addition, naphtha reforming unit is to be considered for treatment of naphtha stream from crude unit. The Refinery is also looking forward to increasing the reliability of existing unit through a better and more timely maintenance replacement regime. The plant has also identified quality control, minimized losses and waste, introduced more training programme and seminars as means of improving the plant production, safety and environmental performances. The table No (5-1) below shows the overall mass balance expected for the expansion.

**Table (5-1):
Overall mass balance of the products**

Over all				
	In put		Out put	
Component	Tones/day	%	Tones/day	%
Crude	5080	100		
Residues	-		1353.3	33.17
Flare gas	-		136.82	3.53
Hydrogen	-		4.71	0.12
LPG	-	30.54	0.75	
Gasoline	-		491.91	12.06
Kerosene	-		322.32	7.9
Gas/oil/diesel	-		1739.14	42.66
Losses			1.26	0.03
Total	4080	100	4080	4080

The capital installed cost for the expansion is estimated as 92.5 million dollars as explained below on table (5-2)

Table (5-2): The capital of the expansion

Item	Costs (US \$m)
CUD	20
Naphtha unit	17
Deep thermal gas oil	32.5
LPG unit	2
Storage	13.8
Electrics	1.8
Civil	3.6
Instrumentation & control	1.8
Total	92.5

The crude oil's feed for the expansion unit specification is shown below in table (5-3)

Table (5-3): The crude oil's feed for the expansion unit specification

Test	Result	Units	Method
Density @ 15c	854.4	Kg/m ³	ASTMD4052
Sulphur	0.4	% WT	IP 336
Mercaptan Sulphur	0.0013	% WT	ASTMD 3227
Total nitrogen	0.074	% WT	ASTMD 5762
RVP	<0.1	PSI	ASTMD 55191
Pour point	+36	C	ASTMD 97
Kinematic viscosity@ 50c	20.95	SCT	ASTMD 445
Kinematic viscosity@ 100c	5.563	CST	ASTMD 445
Organic chloride	10.7	WT PPM	ASTMD 4929
Conrad son carbon residue	3.7	% WT	ASTMD 4530
Total acid number	<0.01	MGKOH/9	IPLA
Flash point (ABCL)	33	C	IP 170
Wax @ - 30C	10.9	% WT	BP237
Nickel	5	Wtppm	ASH & icp
Vanadium	<1	Wt ppm	ASH & icp
Ashaltene	0.04	% WT	IP 143
Ash	0.02	% WT	ASTMD95
Salt	5258	Lb/mddl	Ip265
Sediment	0.01	% vol	ASTMD 95
Calorific value	45.78	MJ/Kg	ASTMD 240
Sediment & water	3.81	% vol	Cale
Water	0.38	% Vol	ASTMD 1377
Light ends analysis	-	-	IP344
Methane	<0.01	% WT	
Ethane	<0.01	% WT	
Propane	<0.01	% WT	
Iso- Pentane	0.03	% WT	
n- Butane	0.07	% WT	
Iso- Pentane	0.07	% WT	
n- Pentane	0.11	% WT	
Cyclopentance	0.01	% WT	
Neo pentance	0.01	% WT	

The gas oil's specification is shown below on table (5-4)

Table (5-4): Gas oil's product specification

Test	Specification	Test methods
Density (150°C), kg/1	0.820-0.870	ASTMD 1298
Color	Max 3	ASTMD 1500
Cetance index	Min 52	ASTMD
Kinematic viscosity at 20°C	2.2 – 8.8	ASTMD 445
Cloud point Deg ° C	Max 10	ASTMD 2500
Sulphur content %m	Max 1	ASTMD 1552
Copper strip corrosion C3-hrs100°C	1	ASTMD 130
Carbon residue Conrad son %m	Max 0.05	ASTMD 189
Water content %v	Max 0.05	ASTMD 95
Sediment %m	Max 0.01	ASTMD 473
Ash %m	Max 0.01	ASTMD 482
Flash point PMCC Deg°C	Min 57	ASTMD 93
Neutralistion value strong Acid No.Mg/	Nill	
Koh / g total Acid No. Mg/Koh/g	Max 0.025	
Distillation : recovery at 350°C% vlume	Min 80	ASTMD 86

The mogas's product specification is shown below on table (5-5)

Table (5-5): Mogas's product specification

Test	Specification	Test methods
Density (15 °C), Kg/l	Aver 718.5	ASTMD 1298
Research octane No (Ron) Distillation	Min 84	ASTMD 156
10% evaporated at Deg °C	Max 75	
50% evaporated at Deg °C	Max 125	
90% evaporated at Deg °C	Max 180	ASTMD 86
End point	Max 205	
20% - 10%	Min 8	
Residue	Max 2	
R.V.P KPa	Max 55	ASTMD 323
Colour	Range	
Sulphur content %m	Max 0.1	ASTMD 1266
Socter test	-	ASTMD 484
Existent gum /100ml	Max	ASTMD 381
Odour	Market table	
Induction period special test	Min 240	ASTMD 525
N- Heptanes insoluble gum	Max 0.8	SMS 1422
Mg/100 ml	Max1	SMS 2030
After 4 weeks @ 30 Cmg/100 ml additvbes		
Orange g/m (cube)	1.3	
Red g/m (cube)	0.3	

5.2 Recommendations:

More investigations are required in some areas to support the upgrading project of Elobeid Refinery, in name:

1. Studying the validity of building for oil products pipe line from Elobeid Refinery passing through Southern Kordofan to Adok into Unity State to supply the southern States by oil products from Elobeid Refinery.
2. Studying the injection of surplus of fuel oil in Greater Nile Pipe line so as to be exported is due to availability of rooming in the pipe of GONPOC and lack of crude of Nile Blend in block 1,2,4 Hegleg.
3. Studying the market of liquefied petroleum gas (LPG) in Western and Southern states because its consumption now is very poor due to many reasons as the availability of LPG, transportation and, cylinders in the area.
4. Studying the market of mogas in the Western and Southern states and the neighboring African countries so as to assist in increasing the phase- two up grading from 2016 to 2020 for ELOBEID Refinery.

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38.16	48.51	0.03	0.04	0.04	0.04	0.03	307	ربك
39.40	50.09	0.03	0.04	0.04	0.04	0.03	317	عرجس
39.53	50.24	0.03	0.04	0.04	0.04	0.03	318	كذبة
48.66	59.57	0.04	0.04	0.04	0.04	0.04	377	الجيبين
66.80	72.21	0.05	0.05	0.05	0.05	0.05	457	الرك
94.22	119.75	0.08	0.09	0.09	0.09	0.08	758	سكان
134.85	235.10	0.16	0.17	0.17	0.17	0.16	1488	جربا
76.94	97.80	0.07	0.07	0.07	0.07	0.07	619	الايض
		0.10	0.10	0.10	0.10	0.10		كريمة
		1.49	1.49	1.49	1.49	1.49		شالا
		1.49	1.49	1.49	1.49	1.49		الفاشر
		1.93	1.93	1.93	1.93	1.93		الجنتنة
		0.19	0.19	0.19	0.19	0.19		والدي خلفا



2009/6/4 م

التمرة/ وطات/م سن /أع ت د/د 1/


السيد/

السلام عليكم ورحمة الله

الموضوع/ فواتر الضخ المبري بالهيدرو

المرافق الخطاينا بنفس التمرة اعلاه بتاريخ 2009/5/3 والخاص بتعديل كشوفات ترحيل المنتجات من
والتي الولايات المختلفة لتقرأ بالجنبة (SDG) بدلا عن الدينار تلحق لكم لكشوفات المعدلة وفق الفاتر
المعدلة وذلك اعتبارا من يوم 5/مايو/2009.

والكم فائق المبر


المدير العام
الإدارة العامة للشؤون المالية

التمرة مبر
بالتوقيع
السيد/ محمد
السيد/ محمد
السيد/ محمد
السيد/ محمد

مخون -
شركات شريك التكتيبات البرونية.
الإدارة العامة لإمدادات النفط والتسويق.
الغرفة القومية لنقل البترول والسوائل.

صورة للسيد/ الأمين العام
حسابات النفط

المدنية	المساحة كل	جراوير ل.ج.لتر	بازول ل.ج.لتر	اسفلت ل.ج.لتر	حصى ل.ج.لتر	الكيرومين ل.ج.لتر	الديزل ل.ج.لتر	الفيريس ل.ج.لتر
الصبوب	68	0.75	0.01	0.01	0.01	0.01	10.74	3.45
الكاملين	98	0.01	0.01	0.01	0.01	0.01	15.48	12.18
بورخير	113	0.01	0.01	0.01	0.01	0.01	17.36	14.05
المصماديجما	135	0.01	0.02	0.02	0.02	0.01	21.03	16.78
مناش	186	0.02	0.02	0.02	0.02	0.02	29.39	23.12
الجليد	135	0.01	0.02	0.02	0.02	0.01	21.33	16.78
شادي	179	0.03	0.03	0.03	0.03	0.03	23.28	22.26
المتمة	136	0.03	0.03	0.03	0.03	0.03	29.39	23.12
عظيرة	315	0.04	0.04	0.04	0.04	0.04	49.77	39.15
بنقلا	512	0.10	0.10	0.10	0.10	0.10	80.90	63.64
الغشينة	185	0.01	0.02	0.02	0.02	0.01	21.33	16.78
الدويم	198	0.02	0.02	0.02	0.02	0.02	31.28	24.61
النفوة	225	0.02	0.03	0.03	0.03	0.02	35.55	27.97
المناقل	279	0.03	0.03	0.03	0.03	0.03	44.09	34.88
الحاج عبد الله	234	0.03	0.03	0.03	0.03	0.03	38.97	29.09
سنان	296	0.03	0.03	0.03	0.03	0.03	48.77	36.79
الجواش	286	0.03	0.03	0.03	0.03	0.03	45.19	35.55
الموسكي	328	0.04	0.04	0.04	0.04	0.04	51.82	40.77
ساحة	377	0.04	0.04	0.04	0.04	0.04	59.57	48.86
الذنين	358	0.04	0.04	0.04	0.04	0.04	56.56	44.50
البحجار	415	0.05	0.05	0.05	0.05	0.05	65.57	51.53
الضرموم	492	0.05	0.06	0.06	0.06	0.05	77.74	61.15
الدمالين	544	0.06	0.06	0.06	0.06	0.06	85.95	67.62
الروصيرص	550	0.06	0.06	0.06	0.06	0.06	85.90	68.36
الكرمل	740	0.08	0.08	0.08	0.08	0.08	118.92	91.88
الفاو	275	0.03	0.03	0.03	0.03	0.03	43.45	34.16
القطارفا	413	0.05	0.05	0.05	0.05	0.05	65.25	51.33
دوكة	483	0.06	0.06	0.06	0.06	0.06	75.31	60.04
الغلابات	668	0.07	0.07	0.07	0.07	0.07	89.74	70.60
كسلا	633	0.07	0.07	0.07	0.07	0.07	100.01	78.88
حلمم الغربية	543	0.06	0.06	0.06	0.06	0.06	85.79	67.49
حظا الجديدة	631	0.17	0.17	0.17	0.17	0.17		
سكبات	1054	0.12	0.12	0.12	0.12	0.12	188.53	131.01
حيد	984	0.11	0.11	0.11	0.11	0.11	165.47	122.31
سراكن	1100	0.12	0.13	0.13	0.13	0.12	178.54	140.46
بورسودان	1190	0.13	0.14	0.14	0.14	0.13	188.02	147.91
بورسودان	1273	0.14	0.15	0.15	0.15	0.14	207.94	158.85

311.55	167.55	199.50	0.71	0.73	0.13	0.16	0.16	1348.00	البنوع
119.15	48.86	55.50	0.23	0.23	0.03	0.05	0.05	377.00	البريد
121.13	48.10	57.28	0.23	0.24	0.03	0.05	0.05	387.00	الغرس
121.13	48.23	57.42	0.23	0.24	0.05	0.05	0.05	388.00	الغزالة
133.02	55.56	66.16	0.26	0.27	0.06	0.06	0.06	447.00	الجلود
149.87	65.60	78.00	0.30	0.31	0.07	0.07	0.07	527.00	الريش
208.51	102.92	122.54	0.45	0.47	0.10	0.10	0.10	828.00	الجمال
353.16	193.63	230.58	0.81	0.84	0.19	0.19	0.18	1658.00	الخراب
190.97	85.64	101.97	0.38	0.39	0.09	0.09	0.08	689.00	الاصطاد
114.59	44.13	52.64	0.52	0.52	0.12	0.12	0.12	356.00	المرور
113.60	43.60	51.80	0.52	0.52	0.12	0.12	0.12	350.00	الذبة
113.60	43.50	51.80	0.52	0.52	0.12	0.12	0.12	350.00	الزجاجة
229.31	115.22	137.20	0.85	0.85	0.19	0.19	0.19	927.00	الزبي حنشا
319.75	172.65	205.67	2.18	2.18	0.48	0.48	0.48	1389.00	الطائر
311.95	167.80	199.60	2.16	2.16	0.48	0.48	0.48	1350.00	الضالا
			1.36	1.36	0.30	0.30	0.30		الضخين
408.29	222.37	264.77	3.51	3.51	0.78	0.78	0.78	1784.00	الوشيا
332.25	178.74	212.82	0.75	0.73	0.17	0.17	0.17	1435.00	الزاي
224.51	110.87	132.02	0.48	0.50	0.11	0.11	0.11	892.00	الحدقي

المدينة	المسافة كم	الحث ق ح للث	كرومين ق ح للث	العار ق ح للث
هيا	206	0.02	0.02	45.32
سكات	136	0.02	0.02	29.92
كسلا	557	0.06	0.06	122.54
خلم القرية	647	0.07	0.07	142.34
حلف الجديدة	717	0.08	0.08	157.74
الضارف	777	0.09	0.09	170.94
الغار	915	0.10	0.10	201.30
منلي	1004	0.11	0.11	220.88
سنا	1114	0.13	0.13	245.08
التمارين	1362	0.16	0.16	299.64
الحصاحصا	1055	0.12	0.12	262.10
الخرموم	1190	0.14	0.14	264.95
شدي	1369	0.16	0.16	301.18
عطيره	1505	0.17	0.17	331.10
دقلا	1702	0.19	0.19	374.44
ريك	1214	0.14	0.14	267.08
كوستي	1224	0.14	0.14	269.28
كناة	1225	0.14	0.14	269.50

فئات النقل من مدينة بورسعيد

المسافة كم	المتنزين	جان أول	الدين	الفرجين	الفئة
206	0.02	0.02	32.55	25.61	هيا
136	0.02	0.01	21.49	16.90	سككات
557	0.06	0.06	88.01	69.23	كسلا
647	0.07	0.07	102.23	80.42	خشم القوية
717	0.08	0.08	113.29	89.12	حلقا الجديدة
777	0.09	0.09	122.77	96.58	القضارف
915	0.10	0.10	144.57	113.73	الفاو
1004	0.11	0.11	158.63	124.79	مدني
1114	0.13	0.12	176.01	138.47	ستار
1362	0.16	0.16	215.20	169.29	الدمارين
1055	0.12	0.12	166.69	131.13	الحصا حيصا
1190	0.14	0.13	188.02	147.91	الخرطوم
1505	0.17	0.17	237.79	187.07	شمال
1702	0.19	0.19	268.92	211.55	دنتلا
1214	0.14	0.13	191.81	150.90	ريك
1224	0.14	0.13	193.39	152.14	كوسمى
1225	0.14	0.13	193.55	152.26	كشانة
1524	0.17	0.17	240.79	189.43	الابيض

تساقط النقل من مدينة الأبيض بالولاية

المدينة	المسافة كلم	الحاصل لوزن ق.ج. للتر	الحاصل ق.ج. للطن	التحويل ق.ج. للطن	النسبة
اسنني	550	0.06	0.06	39.07	68.36
سعال	440	0.05	0.05	55.25	54.03
كديشي	320	0.04	0.04	40.18	39.78
إريك	330	0.04	0.04	41.44	41.02
كثانة	341	0.04	0.04	42.82	42.39
أنغلو	625	0.07	0.07	78.49	77.69
الفضارف	767	0.08	0.09	36.32	95.34
كسلا	973	0.11	0.11	122.19	120.94
ورقسودان	1524	0.17	0.17	191.33	189.43
بيلا	700	0.43	0.43	87.90	87.01
البلح	250	0.03	0.03	31.39	31.07
كثانلي	290	0.03	0.03	36.42	36.05
امرواية	160	0.02	0.02	20.09	19.89
الجنيبة	1100	0.73	0.73	135.13	135.72
أنهود	245	0.03	0.03	30.77	30.43
دغلا	1131	0.12	0.12	142.03	140.89
المضعين	589	0.23	0.23	73.07	72.71