

Petroleum Industry in South Sudan: Evaluation of Production Performance & Petroleum Resources in Dar Petroleum Operating Company

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Abstract:- South Sudan Petroleum industry is fairly mature, however; updates about the status of the industry remains limited, the literature has provided little on some of the aspects of the industry related to production and petroleum reserves, this study aims to evaluate petroleum production performance and remaining reserves in Dar Petroleum Operating Company (DPOC) oilfields in block 3 & 7; examined over a period of ten years; starting from 2011 to 2021, this is expected to shed some light on the subject; and provide recommendations for further research. Method applied; is the collection of secondary data related to production, reserves and information; necessary to support the analysis; sourced from Ministry of Petroleum depository; and from the Joint Operating Company, which was used in quantitative analysis; and presentation afterwards, it was found that the production profile and forecast could only be improved by introducing oil enhancement technologies; to improve Recovery Factor (RF) from about 23% to around 33%; which could make up approximately one third of the Discovered Petroleum Initially in Place (PIIP) as per the best industry practices. And that; exerting more efforts on exploration in the areas not properly covered earlier; could replenish the reserves in addition to annual petroleum resources review that has achieved some addition recoverable volume of 81.72 MMstb. Over the years covered by the study scope. The limitation of the research was the lack of data about of reasons related to quick decline of production after the resumption and reinstatement of production in April 2013 connected to the sudden decline in production after 2013 resumption.

Keywords:- Estimated Ultimate Recovery (EUR), Petroleum Initially in Place (PIIP), Petroleum Resource, Production Volume, Reserve, Processing, Recovery factor (RF), Remaining Petroleum Reserves

I. INTRODUCTION

Petroleum became a strategic resource; that has bewitched every nation and driving economies to failure when; in shortage or success; when in abundance. Shortly following the first well drilling, Petroleum has been gaining momentum in the global markets. Colonel Edwin Drake was reported to have had the first chance of drilling a successful well of a 70 – feet depth, in Titusville- Pennsylvania in 1859, when a discovery of oil was made, (Kadafa, 2012). The discovery had obviously consolidated the urge for making more discoveries, followed by a rush for oil that extended to this present time. Petroleum resources are important for the energy security of every country, this made it a top

commodity the whole world is eager to understand and control. South Sudan became independent from The Sudan; in July 2011, it inherited crude oil production volume of around 360,000 bpd (Barrel per days), from three contract areas, namely; (1) block 1, 2 & 4 (1a, 1b and 4s); Operated by a company established under the name of Greater Pioneer operating company (GPOC), while; block 2b in Panthaou (Heglig) and other oilfields in Abyei; were being contested by the two countries.(2) Block 3 & 7 (3E, 3D and 7E) of Dar Petroleum Operating Company (DPOC), and (3) Block 5A of Sudd Petroleum operating Company (SPOC). The purpose of this study is to evaluate the Petroleum resources and production performance and potential forecasts thereof. The scope of this study covers only DPOC and from 2011 to 2021 covering Petroleum reserves and production. Those aspects of production performance and petroleum resources have not sufficiently been covered recently in the literature. In The Sudan; and before cessation of South Sudan; more than a decade ago, there were studies, reviews and update being made available. This paper should be able to update the industry's current state of affairs in the Republic of South Sudan as far as reserves and production are concerned.

II. METHODS AND MATERIALS

The methodology employed in developing this paper; is collection of the required secondary data from reports and studies by Dar Petroleum Operating Company and the data and information from the depository of the Regulating body; in this case “Ministry of Petroleum of the Republic of South Sudan and The Petroleum Authority,” the data are analyzed for the purpose of evaluating and highlighting petroleum reserves and production performance over a number of years. Relevant Literature are consulted to form the theory upon which the paper is anchored.

III. PETROLEUM RESOURCES FOR ENERGY

Petroleum is an energy resource that has dominated global energy markets, and as per a report of British Petroleum (BP, 2022), Petroleum contributes to about 30.95% of the total global primary energy use, and further stated that; at a time when a share of petroleum consumption seemed diminishing, certain world events allowed for some increase in consumption; at a growth rate in the period between 2011 and 2021 - from about 0.7% to around 6% per annum in year 2021 alone. This growth pattern shows the importance of Petroleum for use in the global energy mix, that wouldn't be easily replaced from being a prime energy source sought by consumers on one side; and on the flip side; as a driving force of producers economies.

While there were no new discoveries of Petroleum made in the last decade, British Petroleum reported that gradual decrease in the net global petroleum reserves is already taking place (BP, 2021). And further stated that; the fluctuating prices of petroleum, has multiplied in the last 35 years (BP, 2022) . As petroleum reserves shrink; and relatively becoming expensive. It has become one of the many factors limiting the use of petroleum and has provided an opportunity for gradual migration to cleaner energy resources (Sharma & Shrestha, 2023). However, the developing countries seem to be adapting well to the fluctuating prices of petroleum and would acquire it no matter what; because of energy intensity of Petroleum and relative ease in use.

IV. BRIEF DESCRIPTION OF SOUTH SUDAN GEOLOGY

The geology of South Sudan could be described in the context of the then Sudan; hence, is considered part and a parcel of the 'Greater Sudan Geology'. (Schlueter, 2006), stated that geology of the Greater Sudan is largely known to be underlain by Precambrian rocks that were almost reactivated solely; during the Neoproterozoic Pan-African tectono-thermal event, and specifically; in the northeast, center and southwest of the then Sudan "Greater Sudan". South Sudan current oilfields are located Southwest and Center of the Greater Sudan; and its rich geology is made up of sedimentary basins of Melut and Muglad; created during the period of the evolution of the western central east African rift systems. According to (Schull, 1988; Lirong, et al., 2007) these basins were formed on the pre-Cambrian crystalline and metamorphic basement by an extensional tectonism believed to have begun in the Jurassic-Early Cretaceous era.

The petroleum systems of South Sudan are made up of; Muglad basin - A system having both Abugabra and Aradeba as source rocks; Bentiu as reservoir formation and Baraka as caprock. While Melut basin, has layers of Galhak, Renk and Algayga acting as source rocks and Yabus formation is known to be a reservoir formation. Both Melut basin and Muglad basin are important for South Sudan Hydrocarbons sector for being responsible for the current oil reserves; as they became the sources of supply of current production operations; and believed as well to be bearing potential for future oil prospects in the country. (Zhao, et al., 2020), described Melut Basin as a passive rift basin that has oil -rich sub-basins originated from Central African Shear Zone (CASZ), and recommended further delving into the petroleum geology in order to find new hydrocarbons patterns of disposition needed to promote exploration in the Melut Basin for future exploration activities. Muglad basin is on the other hand having a potential for more oil finds; and specifically in Block 4s in Kaikang part of Block 1,2 & 4; where oil discovery was made and expected to be appraised and developed in order to add more resources to the current production volumes.

V. BACKGROUND OF SOUTH SUDAN PETROLEUM INDUSTRY

The very first activities of exploration for hydrocarbons; mainly (Oil & Gas) in the Greater Sudan – long before the cessation of the Republic of South Sudan; was reported by (UC, 2009) ,to have been in the Red Sea; carried-out by AGIP Oil; an Italian Company in the year 1959, later followed by other companies in their quest for hydrocarbons resources. Nevertheless, all their efforts went futile in that region. Afterwards; other parts of the country were explored; where some positive progress was later made. That; led to the discovery of hydrocarbon resources in the region of the Current South Sudan (Ali , 2010).

As far as South Sudan is concerned; Chevron "an American Oil Company" was licensed and authorized in year 1975 to explore hydrocarbons potential in South Sudan acreages; among other areas mainly in South-West of the then Sudan. The exploration activities were eventually fruitful in 1979, when Chevron made successful discoveries in Unity and Panthau also known as (Heglig) in South Sudan, which afterwards; became the current Oilfields in South Sudan. However, and in 1992, Chevron company decided to sell its interests to Concorp; a Sudanese private company; during the regime of the Sudanese National Islamic Front (NIF). Thereafter; a sequence of farming-in and farming-out activities were experienced until

China National Petroleum Corporation CNPC of China, and Petronas of Malaysia in 1996; jointly formed a consortium and assign the Greater Nile Operating Company (GNPOC); to be the sole operator of the oilfields of Block 1,2 & 4. Later joined by ONGC of India, and afterwards a pipeline of 1,600 Km was built by GNPOC, and became operational in 1999; when the first export was achieved at Bashayer Terminal. Petrodar Operating company (PDO) was then established; between CNPC, Petronas and Althani to develop the Melut Basin Petroleum Resources in Upper Nile state and later in 2006 a pipeline of 1,400 Km was built to export Dar Blend through Bashayer two Marine terminal on the Red Sea.

VI. SOUTH SUDAN PETROLEUM RESERVES

Petroleum deposits in formations are known to be available in quantifiable reserves; as dictated by the geology with favorable conditions; that could lead to its generation and maturation over millions of years. According to (Höök, 2009), all fields of oil & gas are made-up of limited geological structures as a result, they have an upper boundary; that tells the quantity of hydrocarbons they contain. Being limited, the structures of South Sudan oilfields are not any different, as pay zones are understood to be thin layers and do not qualify to produce oil for a longtime, contrary to what was earlier thought. Dwindling hydrocarbon resources are becoming the known surprise; as the world once believed that oil resources could deplete soonest, but yet expect to use it for a very long time. This situation is what positioned petroleum at the forefront of the energy industry utilization.

Oil companies are valued based on the hydrocarbon reserves they hold; and licensed to manage, (Nadjakovic, et al., 1996). Likewise, the value of a host country is wholly or partially determined based on hydrocarbon resources endowments; as well as other resources, South Sudan is today valued based on its petroleum reserves at more than 90% of the other resources, because Petroleum sector was the first to be developed for more than two decades; and has become the main source of revenues for now, until other resources are developed, that time, the formula is expected to change.

(BP, 2006), BP Statistical review of world energy in 2006; reported, the proven reserves of the Sudan to be 6.4 billion barrels, in South – Central and Central regions of the whole Sudan then. And reported that the country is estimated to have vast potentials of hydrocarbons reserves (BP, 2006). While this report was done prior to independence of South Sudan, the figure didn't remain the same, this requires to be highlighted in order to avoid the confusion of Sudan and

Republic of South Sudan today; which are now two separate and sovereign states.

Based on the records of the current oil operating companies, in the Republic of South Sudan and the data depository in the Ministry of Petroleum, the reserves are reported as of 1st January 2021 to be 5.8 billion barrels PIIP, while; EUR was found to be 1.31 billion Barrells, 23% of RF and the Petroleum Remaining Reserves PRR stand at 473 million barrels; in Block 3 &7 operated by Dar Petroleum Operating Company in South Sudan Upper Nile State. Since it is believed that, the world energy development in the early years of the 21st, will be influenced and determined a great deal by complexity of many economic, technical, natural and political factors, (Ivan, et al., 2018). For that matter, South Sudan needs to set its energy strategy right, to be ready and stay ahead of the game of at least; the energy security of its own and the region.

Table 1: Discovered Petroleum Resources

Year	PIIP MMstb	RF %	EUR MMstb
<i>2010</i> *	5,412.38	22	1,202.76
2011	5,446.20	22	1,213.12
2012	5,502.89	22	1,210.88
2013	5,488.34	22	1,213.09
2014	5,412.77	23	1,260.13
2015	5,405.86	23	1,259.75
2016	5,385.41	23	1,257.11
2017	5,391.24	23	1,262.40
2018	5,471.33	24	1,320.83
2019	5,742.80	23	1,315.83
2020	5,745.31	23	1,297.23
2021	5,756.88	23	1,314.41

Year 2010 is marked () and *in italic*, to underline the last year; before the independence of South Sudan.

From table (1) above, it is clear that the Petroleum Initially in Place (PIIP), Recovery Factor (RF) and Estimated Ultimate Recovery (EUR) are not fixed numbers , this is happening because Petroleum, Resources are subject to continuous reviews annually, when reserves are added or subtracted as a result of new facts and activities being undertaken every year; to improve understanding of the resource-base of the country and investors upstream assets in a particular acreage or lenience area by undertaking a review

of studies i.e., Field Development Plans (FDPs) and Full Field Reviews, (FFRs), and any new exploration activities conducted in the block.

Based on the records populated in table (1) of the DPOC operating company, in the Republic and the data depository in the Ministry of Petroleum, the reserves are reported as of 1st January 2021 to be 5.8 billion PIIP, while EUR was found to be 1.31 billion barrels m while Recovery F actor RF was 23%.

A. Petroleum Resources Performance in DPOC

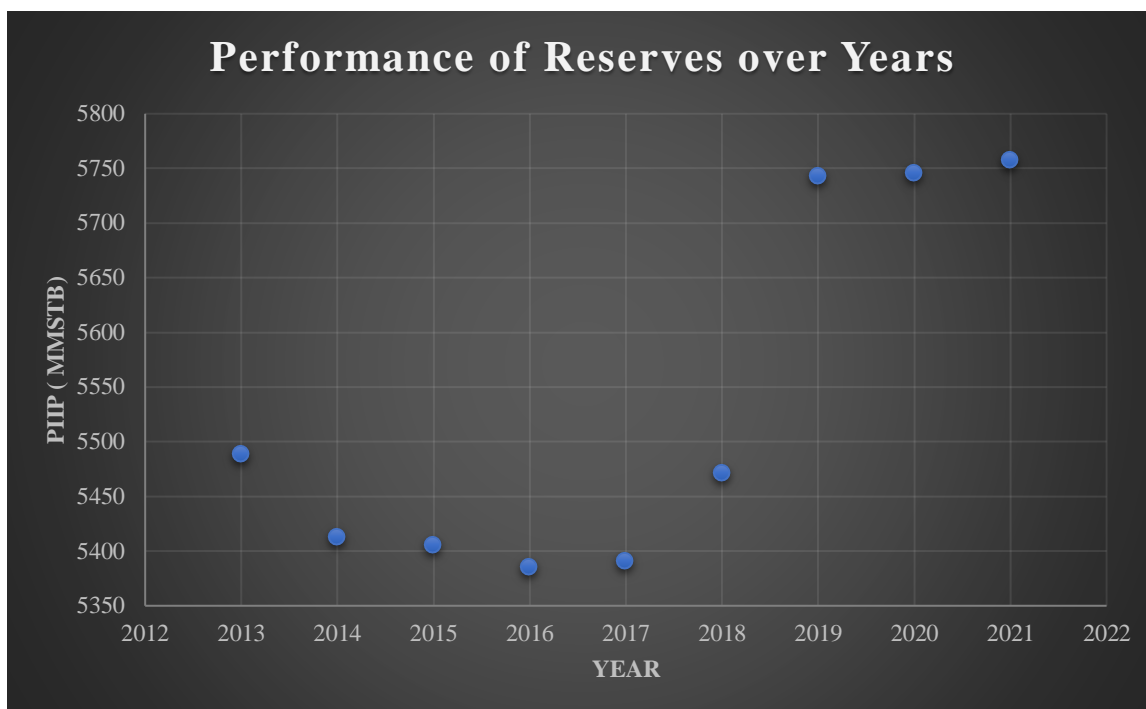


Chart 1: The performance of Petroleum initially in place (PIIP)

From the chart (1) above, it is clear that; after the review of studies earlier used for the assessment of the petroleum initially in place in block 3& 7 some additional reserves were added amounting statistically to the variance between the biggest reserve figure and the smallest reserve figure (5756.88 in 2021)) – (5385.41 in 2016) = 371.47 MMstb

which is quite significant and considering the minimum recovery factor the recoverable amount would be at tune of (0.22x 371.47)= 81.7234 MMstb enough to run south Sudan at the rate of about two years at the rate of 111,949.8 bpd for (24 months) based on the current level of production in block 3& 7 of Dar Petroleum Operating Company.

B. Petroleum Estimated Recovery (EUR) in DPOC Block 3& & over the years

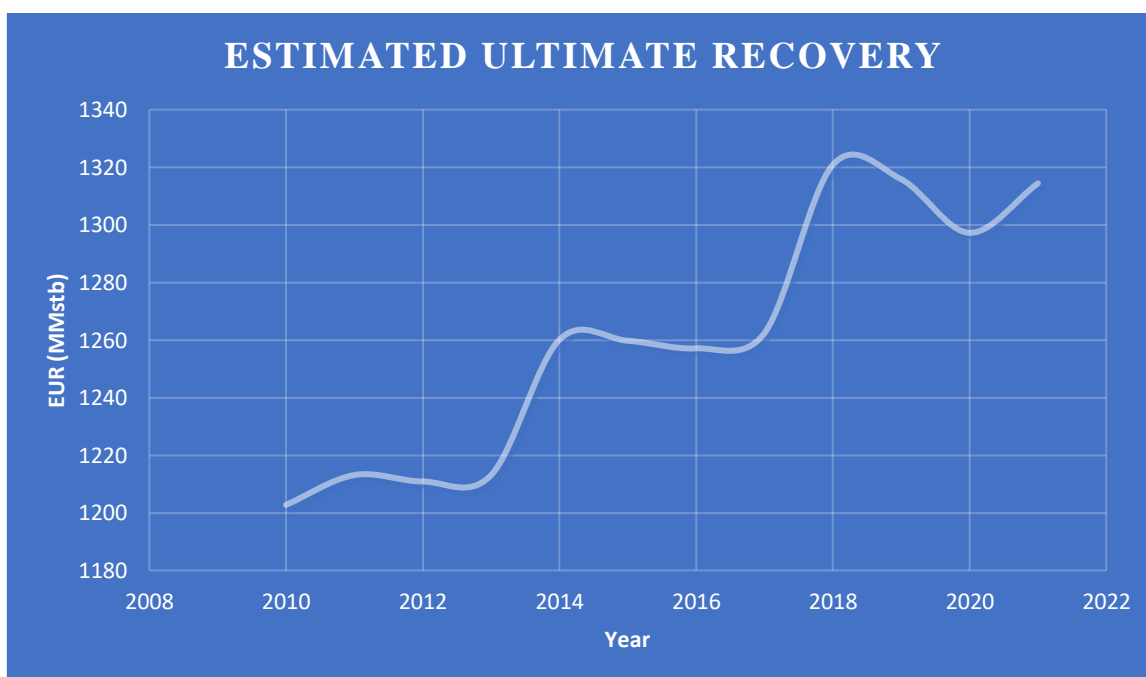


Chart 2: Estimated Ultimate Recovery performance in DPOC

The above chart (2) shows how the Estimated Ultimate Recovery EUR behaved when displayed in 2010 before the

independence the rate was low and increase gradually from 2011 indicating improvement

VII. PETROLEUM RESERVES DECLINE

The Stock Tank Oil initially in Place (STOIP) or Petroleum Initially in Place (PIIP); was reported to be a total of 10,666.08 MMbbls in all the three concession areas in The Republic of South Sudan, while the proven reserve was standing at 3,573.00 MMbbls. Out of this DPOC consortium accounts to 5,756.88 MMstb; more than 52% of Petroleum Initially in place (PIIP) discovered in the country, while the recoverable resources from these fields are estimated to be more than 60% from the total country production.

The drop in the oil reserves since then; followed the following patten from 2011 to 2021.

The reserve decline is followed by decline in the production as shown in the following chart (5); and influenced by a number of factors:

- Natural decline resulting from Petroleum resources depletion; as always being reported by the DPOC to be around 20% decline annually.

A. Petroleum Remaining Reserves:

- Challenges related to Reservoirs Management; resulting from lack of clear understanding of the opportunities and limitations.
- Lack of deployment of Enhanced and Improved Oil Recovery technologies
- Deferment of Production as a result of crisis connected to; shut – down of production, workers strike, war & insecurity, annual flooding and challenges of logistics of Petroleum Critical materials through Sudan to Republic of South Sudan Oilfields.

The decline curve of the remaining petroleum reserve over the years as a result of natural decline. This study covered the decline from 2006 when the commercial production started, to show the overall performance, however, the interest remains in the period from 2011 to 2021, indicated in the scope of the paper.

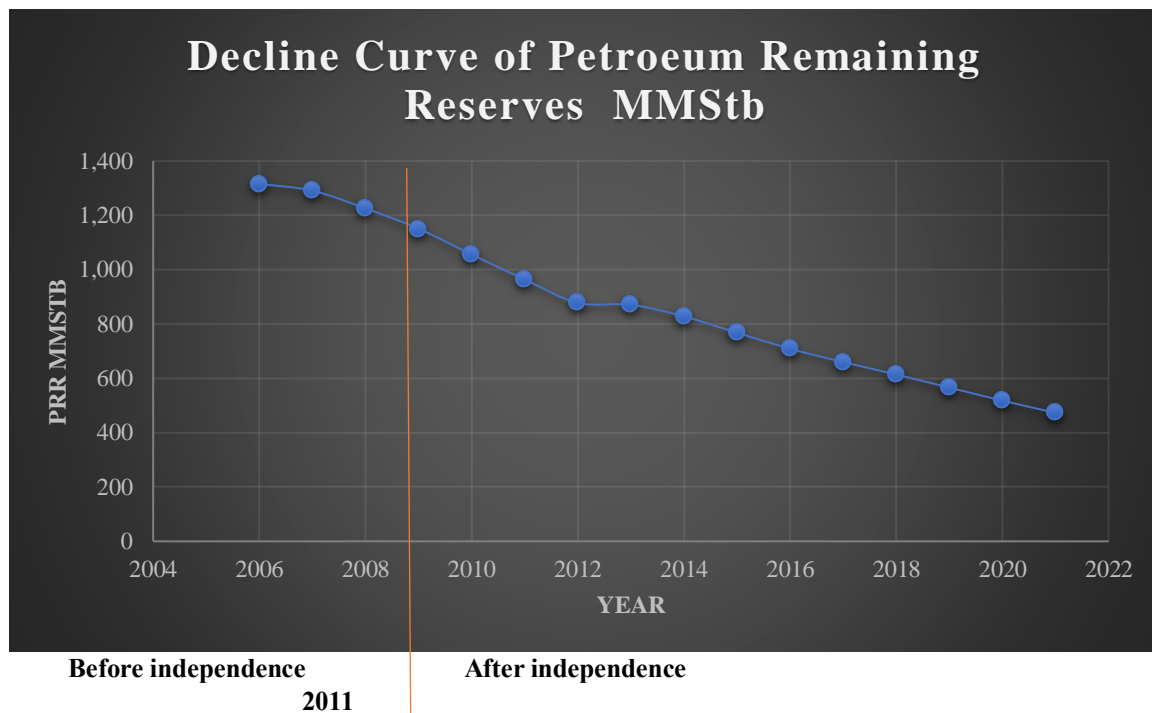


Chart 3: Petroleum Remaining Reserves in DPOC

From chart (3) the curve it is evident that the decline curve is rapidly taking place, and if nothing is done, it will hit the horizontal line in a matter of few years. if the production is assumed to be at the current rate.

VIII. PRODUCTION TRENDS

A. Recovery of Oil

Dar Petroleum Operating Company is a consortium that produces an output volume of estimated to be more than 62% of South Sudan total Petroleum output as of May 2023. Oil production follows in sequence a primary depletion, secondary and tertiary recovery processes (Alkafeef & Zaid ,

2007; Pal, et al., 2016). Therefore, any oilfield; as a rule of thumb passes through those steps, South Sudan has long gone past those processes when primary depletion was experience at the very early life of the oilfields, secondary recovery is what is still being used today with some insignificant attempt of introducing production optimization, while the tertiary recovery processes are yet to be deployed fully to recover more oil from the formations. After the oil production phase has gone through both primary and secondary recovery stages, the Original Oil in place (OOIP) left is expected to be two thirds in the reservoir (Gbadamosi, et al., 2018; Agi, et al., 2019). While this is supposed to happen in DPOC oilfields, just below a quarter (< 25%) of PIIP is always being

recovered, which means; DPOC could still use the best production technologies to help recover at least one third of the PIIP. Primary oil depletion is driven by reservoir natural pressure, to sweep the oil in the formation which is characterized as a porous media that could achieve production volume of 20% OOIP. When the reservoir energy is depleted, attempts of injecting water or gas follow; to recover 40% OOIP in a secondary recovery method, (Mansour, et al., 2019). Nevertheless, the oil remains trapped; held by other forces; of capillary, wettability of rocks, interfacial tension, reservoir heterogeneities, viscosity, all these forces combined; cause difficulties in recovery of the remaining 60% OOIP in the reservoir, and it is time to deploy tertiary recovery methods of Enhanced Oil Recovery (EOR), (Pothula, et al., 2023). In block 3 & 7 of Dar petroleum operating company (DPOC) the recovery factor of Petroleum is below 25% compared to Block 1,2 & 4 of Grater Pioneer Operating company (GPOC) oilfields in the Republic of South Sudan. While recovery factor of DPOC is more or less about 23%, GPOC has had over year a recovery factor (RF) of 34%, apparently higher than DPOC. If by any chance; the recovery factor RF of DPOC is assumed increased to around 34%; just equal to that of GPOC, then the production would be at a tune of 156,695 Bpd; an increase from the current production of 106,000 Bpd as of June, 2023. Therefore, the need to work on recovery factor is what will help in recovering additional crude oil volumes; and realize an optimal recovery from the discovered volumes of PIIP and improve the recoverable resources.

B. Petroleum Production

Analysis of production volumes and resources available and projection are presented with scenario of the status quo to show how quick the improved recovery factor should be introduced; to guide DPOC in achieving the intended objectives of maintaining a continuous business. Petroleum is still a major source of energy for most countries, and it is estimated that the daily petroleum consumption in the world will increase from 85 million barrels in 2006 to 106.6 million barrels by 2030. (Igunnu & Chen, 2014), this trend requires the overall volume to be produced to gradually increase until then; to be at that tune; in order to meet the daily global consumption projections. The production of crude oil remains one of the leading driving forces of the world economy, as it continues to contribute to the highest percentage of the world energy mix require to catalyze development, thus; has made it one commodity of the biggest interest to all. South Sudan is to the world primary energy needs, while the contribution is marginal, it adds significant value to the economy of the nation; making it above 90% of its revenues. Since; the quick development of the South Sudan depends on crude oil production, the industry development and progress being international nature, makes it is imperative to share knowledge, in order to provide information to industry experts, who would help in finding solutions to some of challenges and open up avenues for opportunities. South Sudan produces oil from three contract areas; Operated by mainly a consortium of multinational Asian companies – Petronas of Malaysia, CNPC and SINOPEC of China and ONGC of India, Tri-Ocean from Egypt; in addition to the National Oil company of South Sudan (Nile Petroleum Corporation). The production is from six blocks as shown in the table below:

Table 2: South Sudan Petroleum Concession holders

Block	Operator	Contractor		Location of active oilfields in RSS
		Company	Country of Origin	
3 & 7	Dar Petroleum Operating Company (DPOC)	CNPC	China	Upper Nile State
		Petronas	Malaysia	
		Nilepet *	South Sudan	
		Sinopec	China	
		Tri-Ocean	Egypt	
1,2 & 4	Greater Pioneer Operating Company (GPOC)	CNPC	China	Ruweng Administrative Area & Unity State
		Petronas	Malaysia	
		ONGC	India	
		Nilepet		
5A	Sudd Petroleum Operating Company (SPOC)	Petronas	Malaysia	Unity State
		ONGC	India	
		Nilepet	South Sudan	

*Nilepet is an abbreviation of Nile Petroleum Corporation, the National Oil Company of the Republic of South Sudan (RSS)

Table 3: Production profile of Dar Petroleum Operating Company

Year	Yearly production (MMstb)	Volume Change Percent (P _{dr}) (%)	Remaining Reserves (MMstb)	Remarks
2006	25	-	1,316	Start of commercial production in Sudan
2007	65	+01.6	1,291	//
2008	75	+15.38	1,226	//
2009	95	+26.67	1,151	//
2010	92	-03.14	1,056	Just Before independence
2011	86	-06.52	964	
2012	7	-91.86	878	RSS Independence; July 9th 2011 onwards
2013	43	+514.29	871	Shutdown of Production by the government
2014	60	+39.53	828	
2015	59	-01.67	768	
2016	49	-16.95	709	
2017	46	-06.12	660	
2018	48	+04.35	614	
2019	48	00.00	566	
2020	45	-06.25	518	
2021			473	

$$Pdr = [(P(i+1) - P(i)) / P(i)] \times 100\%$$

Where:

P(i) = Production in year (i)

P(i+1) = Production in Year (i+1)

Pdr = Production Change Percent (%)

Cumulative Production (CP) MMstb

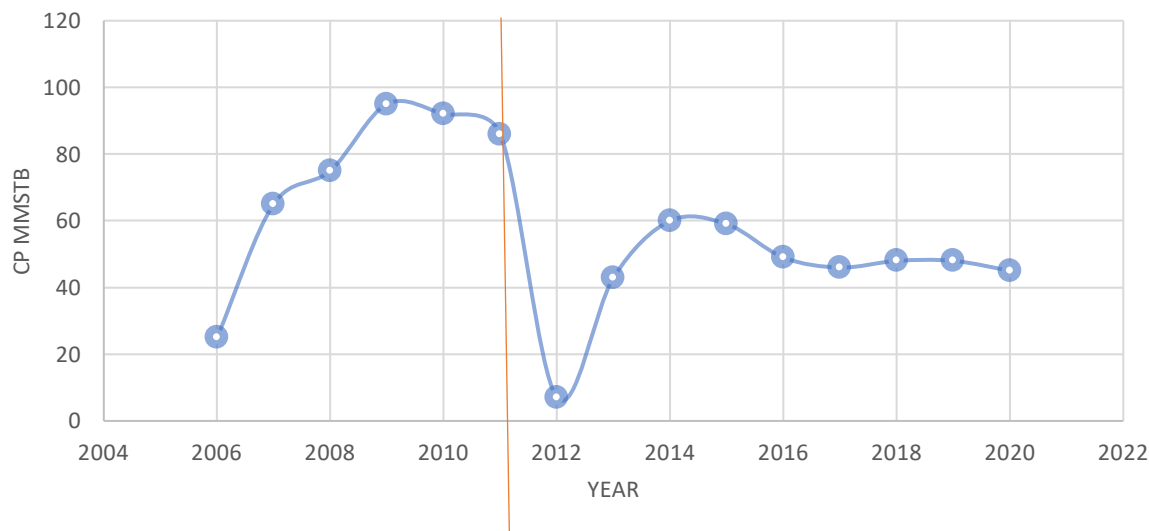


Chart 4: Production Performance in DPOC, Block 3 & 7 Independence 2011

From chart (4), Petroleum production performance has shown upward and downward profile, reasons for that could be summarized in six points; (1) year 2011 with the highest production was because it was part of the production peak that started around year 2009, (2) while 2012 has shown the lowest production ever that was because the production was shut-down as ordered by the government of RSS as a result

of row on transit, processing and transportation fees imposed by Sudan, (3) year 2013 is the year when the resumption of oil started, (4) year 2015 mark the beginning of natural decline that the oilfields are experiencing until today and (5) the production started to be flat from 2017 – 2020. (6) again, the effects of flooding have affected the production until it fell below threshold of 100Kpd from about 130Kpd in 2020.

C. Production Profile Volume Change

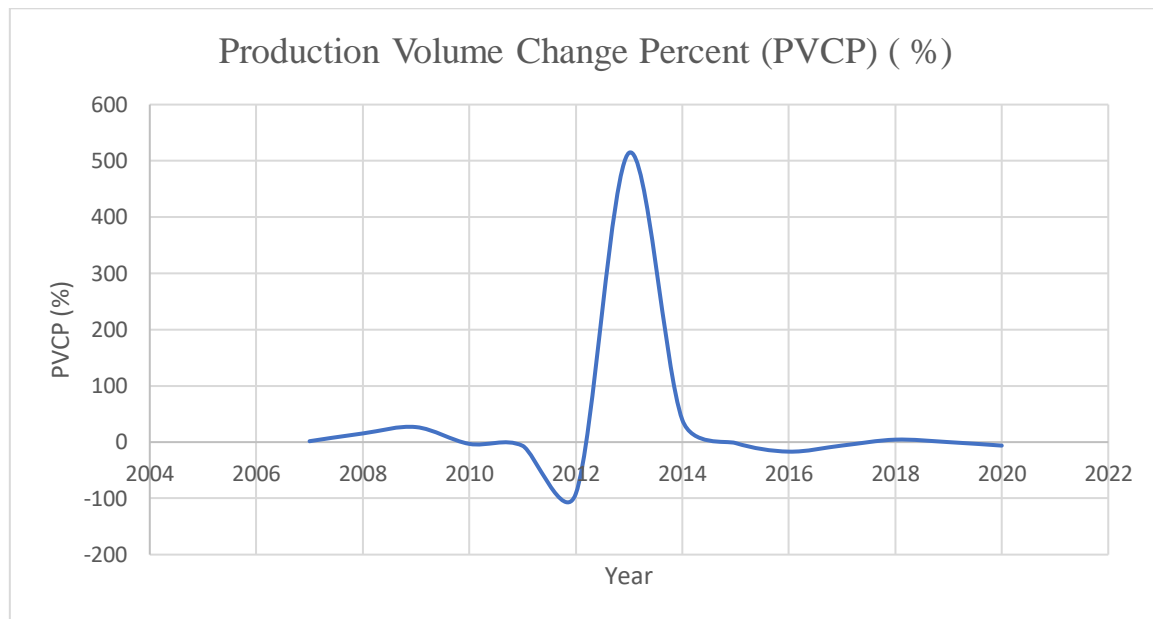


Chart 5: Production Volume Change Percent

The above chart (5) shows, how the production volume is changing from year to year, this tells the exact change, whether it is a positive change or a negative change or there is no change at all, starting from year 2011 the change in the following year 2012 became a negative change because production was ordered to shut-down, and in 2013 the change shot up; because the rate of change from almost no production to resumption, has made it extremely a big change. In 2016 the production change again dropped to below zero line to be flat in 2017/2018.

IX. CHALLENGES OF SOUTH SUDAN PETROLEUM RESERVES

South Sudan is rapidly running-out of petroleum reserves, since the country is relying heavily on Petroleum resources; it is becoming a big challenge to the country's economy, the reserve replenishment has its own challenges; slowing down the phase of balancing the production output with the remaining reserves in order to keep the production stable for a long time. One of the key challenges; was identified to be the natural decline the oilfields are going through, and needs to be addressed by deploying production enhancing technologies. According to (Patey, 2017), Investments in Enhanced Oil Recovery EOR in South Sudan has a potential to improve production; if Chemical and Gas injection technologies are employed, and further stated that; one Norwegian study estimated the increase from 23% to 30%. This, however; requires hundreds of millions in

investments. Huge investment flow to the country became and challenge in the environment of fluctuating oil prices, energy transition, political stability among others. Nevertheless, other avenue to revive South Sudan's production would be; through exploration and new oil discoveries. Therefore, continuous replenishment of reserves by oil companies needs to be strongly hinged to the business policy to safeguard the company's future (Nadjakovic, et al., 1996), host countries would be the first beneficiaries of the company's positive business policy that is supposed to be guided by the state petroleum authorities for the common interest of investors and host country. While policies guiding Petroleum sector have been developed, South Sudan is still suffering from lack of sufficient exploration activities to add hydrocarbon reserves to the depleting oilfields, because; exploration activities have long been halted by the operating companies, awaiting extensions of their terms of Production Sharing Agreements PSAs.

X. PRODUCTION FORECAST

Based on the remaining Petroleum Reserves, the oil is likely to hit the horizontal axis by year 2032, if nothing is done to replenish the reserves in DPOC, the recovery factor remains the same and production is maintained at the current levels of 2023, then the following is likely to occur and by the time the world is reaching NetZero by year 2050, DPOC will be short of (- 787 MMstb), Assuming we maintain the production until that time.

Year	Remaining reserves MMStb	Cumulative Production MMStb
2022	473	45
2023	428	45
2024	383	45
2025	338	45
2026	293	45
2027	248	45
2028	203	45
2029	158	45
2030	113	45
2031	68	45
2032	23	45
2033	-22	45
2034	-67	45
2035	-112	45
2036	-157	45
2037	-202	45
2038	-247	45
2039	-292	45
2040	-337	45
2041	-382	45
2042	-427	45
2043	-472	45
2044	-517	45
2045	-562	45
2046	-607	45
2047	-652	45
2048	-697	45
2049	-742	45
2050	-787	45

XI. CONCLUSION

In conclusion, this paper has highlighted the production profile from 2011 to 2021, and beyond, showing how the reserves depletion has affected the production.

The oil initially in place and its profile and how it was changing over years and showed how an additional gained reserve volumes of about 81 MMStb was added, enough to extend the field life by two years based on the current standards of production in DPOC. Projection of production forecast was made to show the quick decline of production as a result of reserves decline. Rate of reserves decline was established and its future projected; to understand the need to replenish the current reserves needed to balance the production. Production deviation profile reflecting the change in cumulative production was shown to understand that pattern of production decline for known and unknown reasons.

The limitation of this paper is in finding more data about thematic areas of this paper to further analyze and come with a more elaborate argument that would support the petroleum resources management for fairly before NetZero target of year 2050.

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