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Comparative Study On The Effect Of Temperature On Octane Number Rating Of Reformate From Nigerian Heavy Treated Naphtha Samples.

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Abstract:- The aim of this research paper is to compare and analyze the effect of temperature on the octane number of reformate produced from heavy treated Naphtha of Nigerian crude during catalytic reforming. The continuous catalyst regeneration catalytic reforming process was simulated using Aspen Hysyscatalytic reformer template configured with four beds reactor.Treated heavy Napthene from Bonga Crude and Bonny Crude were used as feed for the process. It was observed that an increase in temperature lead to an increase in the octane number of reformateproduced as the values of Research Octane Number (RON) and Motor Octane Number (MON) were seen to increase from 79 to 94 and 67to 78 respectively. It was observed that the Bonga Crude gave higher octane values at various temperature changes.

Keywords – *Research Octane Number, Motor Octane Number, Bonga Crude, Bonny Crude ,Catalytic eforming, **N**aphthene,Temperature*

I. INTRODUCTION

An octane rating, or octane number, is a standard measure of the performance of an engine or aviation fuel. The higher the octane number, the more compression the fuel can withstand before ignition. In broad terms, fuels with a higher octane rating are used in high performance gasoline engines that require higher compression ratios[1].The quality of various petroleum fuels depends on their composition and types of hydrocarbons present in the mixture. Octane number is one of the characteristics of spark-ignition engine fuels such as gasoline and jet fuel. This number indicates anti-knock characteristic of a fuel and strongly depends on the hydrocarbontype [2].

There are two types of Octane number rating, namely Research Octane Number (RON) and Motor Octane Number (MON). RON correlates best with low speed, mild-knocking conditions, whereas, MON correlates best with high speed and high-temperature knocking conditions. For given petrol, RON is always greater than MON. The difference between the two is called the sensitivity of the petrol (Asian Clean Fuels Association, 2008).

The process for obtaining reformate is through the catalytic reforming process.Catalytic reforming is a strategy that involves transforming low octane components to high octane components with the aid of a catalyst. Catalytic reforming is atype of reforming process that produce high octane ratings reformate, hydrogen and liquefied gases. The end product of catalytic reforming process are iso-paraffin and aromatics which are high-octane gasoline components required to fuel automobiles, raw material for aromatics and other chemical industries [4].

This reforming process usually occurs in three or more fixed-bed reactors in series and operates with a decrease in pressure and temperature within the following operating conditions. Temperature range of 450- 520 °C, total pressure between 10-35 bar and molar hydrogen-to hydrocarbon ratios of between 3- 8 [5].
Bonny Light: Bonny light is a high quality of Nigeriancrude oil with high American Petroleum Institute (API) gravity (low specific gravity). It is mainly gotten in the Niger Delta region of Nigeria and it is named after the city of Bonny in Rivers State [6].Bonga Aromatic: Bonga Aromatic is an average gravity, low sulphur, naphthenic crude. It is similar to Forcados Blend in both quality and yield pattern but relatively heavier [7].

II. SIMULATION

The process was simulated using Aspen Hysys. The temperature for the simulated catalytic reactor was varied within a temperature range of 430 to 540°C to determine its effect on the octane number rating of treated heavy Naphthene sample.The properties of the process feed for the simulation are shown in Tables 1 and 2 below.

Table 1: BONNY LIGHT ASSAY

Crude	Heavy Naphtha
Density at 15^{o}C: 854.8kg/m^3	Density at 15^{o}C: 780.0 kg/m^3
Nitrogrenwt% 0.220	Cut 80-160^{o}C
Sulphur m/m % 0.16	Yield 18.72 Vol.%

API 34	Napthene 50.6 Vol.%
	Paraffin 33.7 Vol.%
	Aromatics 15.7 Vol.%

Source [6]

Table 2: BONGA ASSAY

Crude	Heavy Naphtha
Density at 15°C: 879.5kg/m^3	Density at 15°C: 761kg/m^3
Nitrogen ppm 1219.9	Cut °C 80-160
Sulphur wt% 0.24863	Yield 13.97 Vol.%
API 29.4	Napthene 60.59 Vol.%
	Paraffin 25.53 Vol.%
	Aromatics 13.88 Vol.%

Source [7]

The simulated process flow diagram is shown in Fig. 1 below.

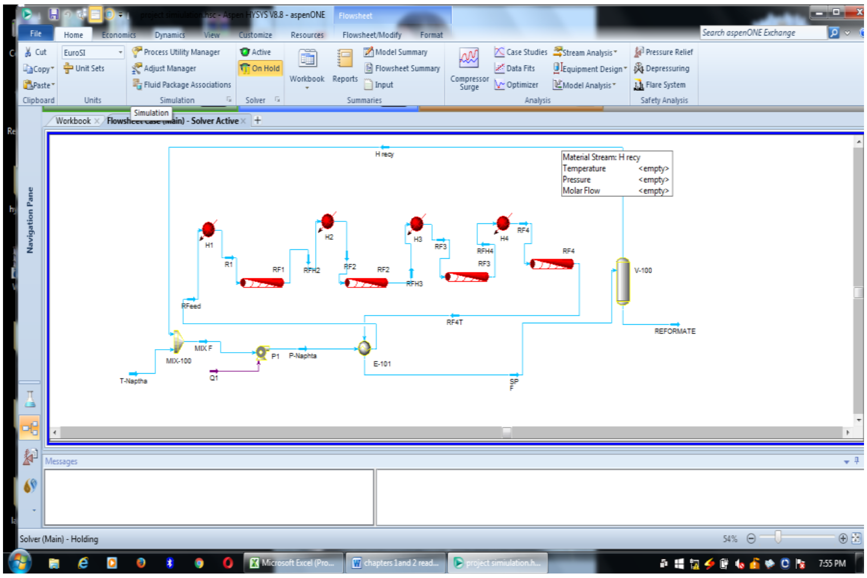

Figure 1: Window showing simulated process

III. KINETIC MODEL

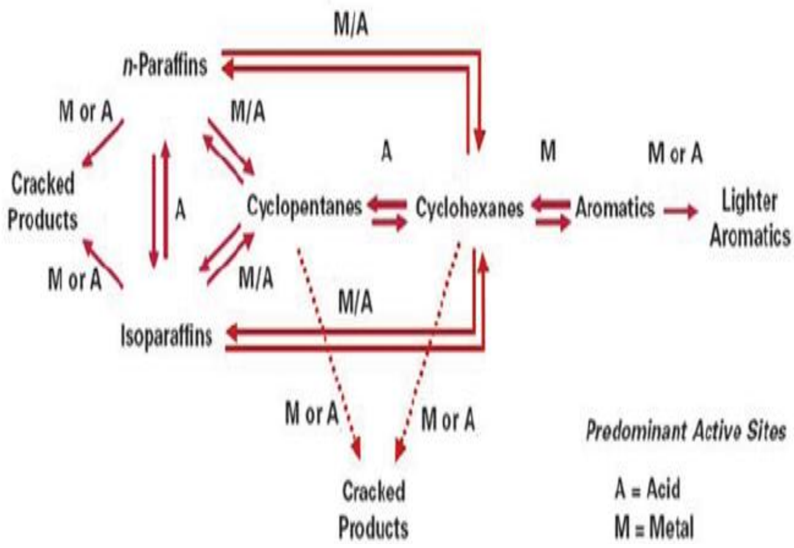

Figure 2: ACH and ACP Kinetic Model [8]

The reforming kinetics of the process as described in [9], written as follows:

$$N \overset{r1}{\Longleftrightarrow} A + 3H_2 \qquad (1)$$

$$P \overset{r2}{\Longleftrightarrow} N + H_2 \qquad (2)$$

$$N + 2H_2 \overset{r3}{\Longleftrightarrow} 2G \qquad (3)$$

$$P + H_2 \overset{r4}{\Longleftrightarrow} 2G \qquad (4)$$

Where N, A, G, H and P; are Naphthenes, Aromatics, Gases, Hydrogen and Paraffin respectively.
The reaction rates are expressed as follows:

$$r1 = k_{f1}pN - k_{r1}pAp^3H_2 \qquad (5)$$

$$r2 = k_{f2}pNpH_2 - k_{r2}pP \qquad (6)$$

$$r3 = k_{f3}pN/p \qquad (7)$$

$$r4 = k_{f4}pP /p \qquad (8)$$

where*p* is the partial pressure of the components and p is the overall pressure of reactor, kf and kr are the forward and reverse rate constants.
The Arrhenius equation of rate expression is assumed during the reaction:

$$k_f = k0fe^{\left(\frac{-Ef}{RT}\right)} \qquad (9)$$

where E the activation energy is depends on the catalyst and k0f is depends on the molarity of the Reactants and R is the universal gas constant [9]. Higher octane ratings correlate to higher activation energies: the amount of applied energy required to initiate combustion. Since higher octane fuels have higher activation energy requirements, it is less likely that a given compression will cause uncontrolled ignition, otherwise known as auto ignition or detonation[10].

IV. RESULTS

The heavy treated Naptha samples were given the nomenclature for easy identification.
Sample 1: Bonny light
Sample 2: Bonga

1.4.1 Research Octane Number (RON)

The values of Research Octane Number for the two samples at various temperature changes are displayed in Table 3.

Table 3: Research Octane Number Result

	SAMPLE 1		SAMPLE 2	
T x 100	**C_5+**	**C_6+**	**C_5+**	**C_6+**
4.3	78.04	79.36	82.97	84.29
4.4	78.90	80.22	83.93	85.25
4.5	79.81	81.13	84.94	86.27
4.6	80.75	82.07	86.00	87.32
4.7	81.73	83.04	87.12	88.44
4.8	82.75	83.04	88.27	89.59
4.9	83.78	84.07	89.43	90.75
5.0	84.86	86.17	90.62	91.94
5.1	86.09	87.39	90.91	92.23
5.2	86.95	88.23	91.67	92.99
5.3	87.94	89.22	92.5	93.81
5.4	89.07	90.34	93.47	94.77

From Table 3 above it is seen that as the temperature increases, the values for the RON of both sample increased. The amount of C_6+ was higher than that for C_5+ for both samples. The composition of the treated heavy naphthene sample also affected the octane number as sample two was seen to have a higher paraffinic composition when compared with sample 1.

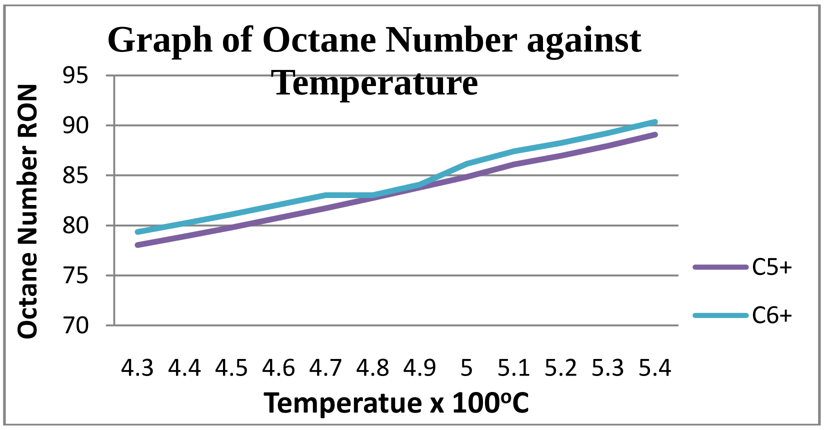

Figure 3: Effect of Temperature on Octane Number (Sample 1)

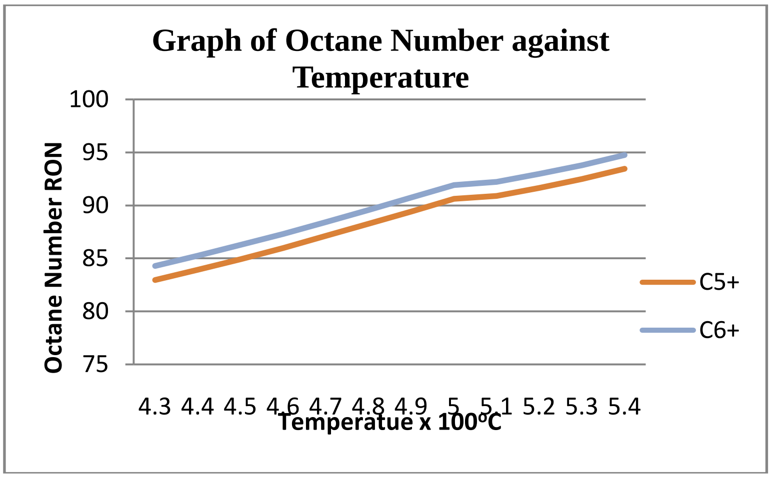

Figure 4: Effect of Temperature on Octane Number (Sample 2)

From Figs. 3 and 4 above, it is seen that as the temperature increases the octane number increases. Also it is seen that C_5 + has a lower value than C_6 + at any temperature change. Sample 2 has the highest octane number value when compared with sample 1, conforming to literature [11]. Also it is seen that there is significant change between C_5+ and C_6+ at any given temperature change for the various samples [12].It seen also seen from above, that there is significant margin between the values of RON in C_5+ and C_6+ for both samples.

4.6.2 Motor Octane Number

The values of the Motor Octane Number rating for the various samples are displayed in the Table 4.

Table 4: Motor Octane Number Result

	SAMPLE 1		SAMPLE 2	
T x 100	C_5+	C_6+	C_5+	C_6+
4.3	67.88	67.86	72.78	72.76
4.4	68.26	68.23	73.19	73.18
4.5	68.65	68.62	73.63	73.61
4.6	69.05	69.02	74.07	74.05
4.7	69.45	69.43	74.54	74.52
4.8	69.88	69.85	75.01	74.99
4.9	70.31	70.28	75.47	75.45
5.0	70.77	70.74	75.9	75.88
5.1	71.33	71.29	75.95	75.93
5.2	71.73	71.29	76.22	76.19
5.3	72.2	72.14	76.52	76.49
5.4	72.76	72.68	76.88	76.85

From Table 4 above it is seen that as the temperature increases, the values for the RON of both sample increased. The amount of C_6+ was higher than that for C_5+ for both samples[12].

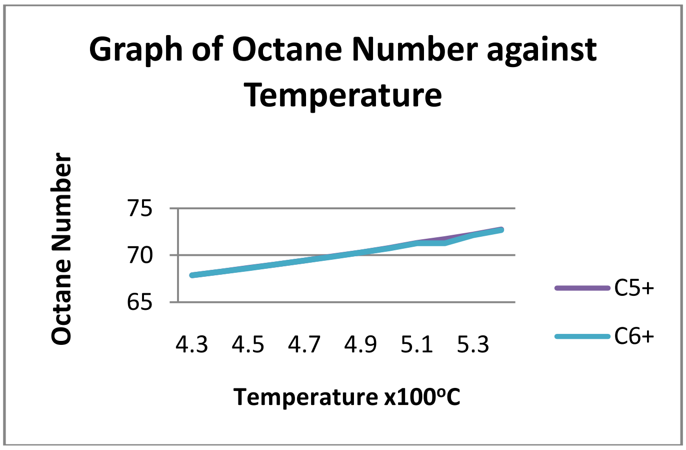

Figure 5: Effect of Temperature on Octane Number (Sample 1)

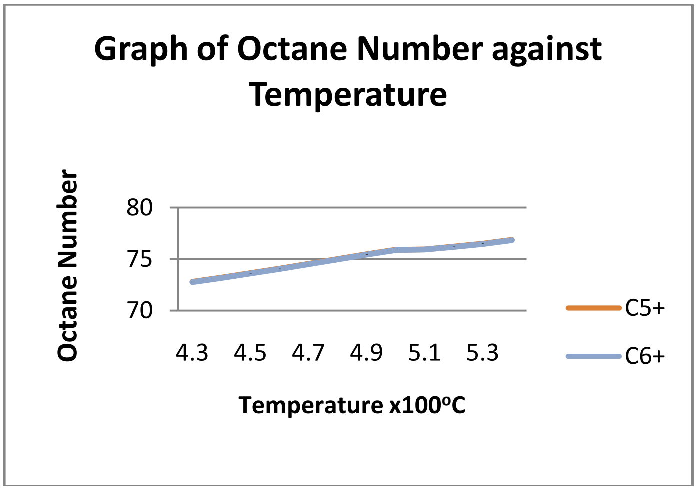

Figure 6: Effect of Temperature on Octane Number (Sample 2)

From Figs. 5 and 6 above, it is seen that as the temperature increases the octane number increases. The trend shows a linear relationship between temperature change and octane number rating. This is because as temperature increases the dehydrocyclisation reaction contributes to octane number increase because of a paraffinic mixture. Sample 2 had the highest octane number value when compared with sample 1, conforming to literature [13]. Also it is seen that there is no significant change between C_5+ and C_6+ at any given temperature for the various samples.Also, it is seen that the margin C_5+ and C_6+ between for the values of MON for both sample is veryvery small as both trend lines were seen to be lying on each other.

V. CONCLUSION

From the results and trend, it is seen that there is a linear relationship between temperature and Octane Number Rating. Therefore to maximize production of reformate with high octane number rating, the temperature of the reactor should be increased and the nature of feed should be a priority. It was seen that the values of RON were greater than MON at any particular temperature change.

REFERENCES

[1] Hassan A. I and Mourhaf A. Correlation between the Octane number of Motor gasoline and its boiling Range. Journal King Saud University,Volume 9, Engineering Sci. (2) PP 311-318 A.H 1417,1997.
[2] Albahri, T. A., Riazi M. R. and Alqattan, A. A.Fuel Chemistry Division Preprints, 2002,47(2), 711,
[3] Asian Clean Fuels Association, A Monthly Publication,Vol. 6 Issue 7 - October 2008

[4] Shuichi Kubo,Analysis of catalytic reforming characteristics of various Hydrocarbons, JSAE Annual congress No. 43-04,2004.

[5] Mohan L.Catalytic Reforming Process Catalysts and Reactors 6th Summer School on Petroleum Refining & Petrochemicals Indian Institute of Petroleum Management Gurgaon, June 6-10, 2011.

[6] Chevron (2016): www.chevronng.com

[7] ExxonMobil (2016): www.exxonmobilng.com

[8] Mohammad, M., Shohreh F., Ali F. Modeling and Simulation of Industrial Continuous Naphtha Catalytic Reformer Accompanied with De-lumping the Naphtha Feed, International Journal of Chemical Reactor Engineering 18 A(1) 2010.

[9] Wordu, A. A. Dynamic Simulation of Industrial Reformer Reactors,International Journal of Engineering and Technology Volume 2 No. 7, July2012, ISSN: 2049-3444 © – IJET Publications UK.

[10] Chang A. F, Kiran P., Y.A. Liu, Integrated Process Modeling and Optimization, Refinery Engineering, (2012) Wiley-VCH VerlagGmBH and Co. KGaA, Boschstr.,12.69469 Weinheim, Germany.

[11] [Zaidoon M. S., Optimization of Al-Doura Catalytic Naphtha Reforming Process Using Genetic Algorithm. Eng. &Tech. Journal Vol. 31,2013Part A, No.7.

[12] [Werner D., Arno R., Andrea S. and Klaus R. (2007): "Automotive Fuels" in Ullmann's Encyclopedia of Industrial Chemistry, Wiley-VCH, Weinheim. doi:10.1002/14356007 .a16_719.pub2

[13] Hu S. and Zhu X.X. Molecular Modeling and Optimization for Catalytic Reforming. Journal of Chemical Engineering Communications, *Vol. 191, No*. 4, 2004, pp 500-512 (13) ,: