Journal of Engineering in Industrial Research

Journal Homepage: http://www.jeires.com

Original Research

Investigation the Input Temperature of Catalytic Conversion Unit Reactors Efficiency on Octane Number

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ARTICLE INFO

Article history

Submitted: 25 July 2020
Revised: 14 September 2020
Accepted: 12 December 2020
Published: 29 December 2020
Manuscript ID: JEIRES-2101-1015

KEYWORDS

Gasoline
Heptane
Hydrocarbons
Octane Number
Paraffinic

ABSTRACT

One of the most important properties and quality features of a high quality gasoline product is also low levels of pollutants such as sulfur, benzene, and aromatic compounds such as sulfur, benzene, and aromatic compounds and lead and manganese particles from environmental standards, octane number of the fuel. The higher the octane number is, the fuel is more resistant to combustion, pressure and heat. Basically, the octane number is a measure to indicate the gasoline resistance to the heat, push and start of spontaneous combustion. The octane number is a fully conventional quantity of terms that have assumed the normal octane number of heptane, zero and the iso-octane 95, and the rest of the compounds have been calculated to these two. In the case of hydrocarbons, they are paraffinic the higher the number of branches increases, the higher the octane number increases. Being cyclic and aromatic also increases the octane number. Regarding the mentioned cases, it is obvious that the conversion of normal paraffin hydrocarbons to iso paraffin's, naphthenes and aromatics leads to an increase in the octane number.

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G R A P H I C A L A B S T R A C T

Introduction

The importance of the gasoline octane number parameter is that one way to increase the engine power and output is to increase their concentration ratio, but this is achieved only by increasing the strength of the gasoline resistance to spontaneous combustion, which is the same concept of the octane number.

Another important characteristic of gasoline is the amount of benzene present in it. The maximum allowable limits of benzene conform to the 2005 European standard in gasoline is 1 volume percent. In the United States, however, it has been announced recently that the amount of benzene in the country would be reduced to 0.62% by 2015 [1-5]. Therefore, in optimization of gasoline product, effective parameters on benzene reduction are also considered.

Naphtha's catalytic conversion unit is a continuous revival with the commercial name Octanizer of refinery with a capacity of 30,000 b/day with the aim of increasing the octane number of the refined heavy naphtha flow to 95 [6-9].

However, reaching the conditions and specifications of the product due to forced changes in unit capacity, composition of food and fluctuations of control variables and different operational conditions need to know practical solutions and meet the optimal values of each process parameters related to each specific operational conditions [10-15].

Process Description

Naphtha feed to an Octanizing unit typically contains C_6 to C_{11} paraffin's, naphthenes and aromatics. The purpose of this reforming process is to produce high octane aromatics from paraffin's and naphthenes either for use as a high octane blending component as in this case or as a source of specific aromatic compounds. Naphthenes convert rapidly and efficiently to aromatics. Paraffin's do not, requiring higher severity conditions and even then conversion is slow and inefficient. In this process conversion is achieved by passing the naphtha over a slow moving bimetallic catalyst bed in three adiabatic reactors, in the presence of hydrogen at relatively high temperature and low pressure. Operating under these conditions of low pressure and high temperature, the rate of coke lay down on the catalyst is relatively high [16-20]. A semi regenerative type process is impractical in this case, a continuous catalytic regeneration unit is necessary. In this process, catalyst is withdrawn from the reaction section at a fixed rate, regenerated in the continuous catalytic regeneration unit and returned fresh to the reaction section. The rate of catalyst withdrawal and regeneration ensures a consistently highly active catalyst with a low carbon content and controlled chloride/water content. This maximizes yields of both reformate and high quality hydrogen off-gas [21].

Fundamental Reactions

The fundamental reforming reactions can be split into two parts:

(1) Positive reactions i.e. reactions which lead to an aromatic content increase, these are the reactions you wish to promote.

(2) Negative reactions i.e. reactions which not only lead to an octane decrease but to a loss of reformate yield. These reactions are obviously the ones you wish to avoid [22-25].

Examination the Effect of Capacity Change of Naphtha Catalytic Conversion Unit on the Gasoline Octane Number and the Amount of Coke Formed on the Catalyst

This scenario has been investigated in terms of constant input temperature to the reactors at 525 °C and the constant rate of mass gas flow of 22 ton/hr with 90 % purity and the constant mass flow of catalyst for 800 kg/hr. Before starting, the gas returned flow must be regulated and recorded with the definition of logical function (ADJ) 22 ton/hr in all conditions. In this trial, the heavy purificated Naphtha mass flow of catalytic conversion unit input feed with continuous revival has been considered as an independent variable for the unit capacity that will be changed in the range of 90000 to 170000 kg/hr. The amount of produced gasoline octane number and the amount of coke formed percentage on the catalyst surface are also independent variables. It should be noted that the amount of coke formed percentage allowed range on the catalyst surface is based on the capacity of coke unit of catalyst resuscitation ranging from 3-7%. This range is a constraining factor in the operational condition for the amount of coke allowed [26-30].

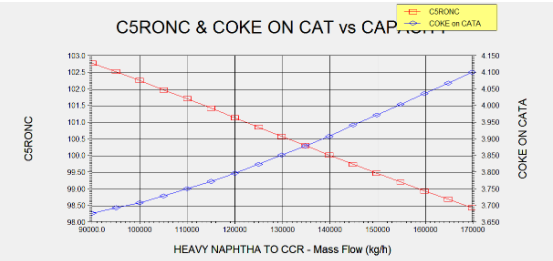

Figure 1. Effect of the catalytic conversion unit capacity changes on gasoline octane number and the amount of coke formed percentage on catalyst

As can be seen, by increasing the catalyst conversion unit capacity, the gasoline octane number conversion unit will be decreased and the amount of coke formed percentage on catalyst surface unit will be increased. But, in this variation of unit capacity, the percentage of coke formed is within the permitted range

Investigation the Input Temperature of Catalytic Conversion Unit Reactors Efficiency on Octane Number and the amount of Coke Formed on the Catalyst

Due to the importance of the input temperature to the reactors in the catalyst conversion process, sensitivity analysis was performed on changing the input temperature to the reactors on the octane number and the amount of coke production. This state is examined at a constant capacity 150000 kg/hr equivalent to 34000 barrels per day of purificated heavy Naphtha feed, which is the catalytic conversion unit of Naphtha nominal capacity and a constant mass flow rate of 22 ton/hr of hydrogen gas, and the mass constant flow of catalyst equivalent to 800 kg/hr. The reactors input temperature as a most important factors on octane number has been considered as an independent variable and also, gasoline product octane number and the amount of coke formed percentage on the catalyst surface as the dependent variable [31-34].

One of the important results of above figure is that the maximum permitted temperature of reactors input is 550 °C. At warmer temperatures, positive dehydrogenation reactions tend to be more likely to negative hydrocracking reactions and their octane number not only changes but also decreases. As it is clear, the gasoline octane number will be increased by increasing the reactors temperature and the amount of coke formed, too. The slope of this coke formation increases dramatically at 520 °C, which is problematic, and is the limiting factor for temperature rise. The main desirable and effective reactions on octane number rise are endothermic process such as dehydrogenation of naphthenes, isomerization of paraffin's and naphthenes and carbonization of paraffin's by dehydrogenation and will be intensify by temperature increasing and pressure decreasing. Also, velocity of these reactions will kinematic be increased by temperature increasing. As shown in figure 10, the activation energy of the reactions is related to the gradient of the diagram. The greater the gradient of the graph, the higher the activation energy and consequently, the increase in temperature will have a greater impact on the speed of the reaction such as carbonization of paraffin's which have high activation energy (about 35 kg/mole) then temperature will increase this reaction rate. Hydrocracking reactions and coke formation have higher

activation energy (35 and 45 kg/mole). The velocity of these undesirable reactions is noticeable by temperature rise. According to the literature, the steep slope of coke increasing seems to be logical as the temperature rises. According to the obtained results and maximum allowed coke and desirable octane number in this study, the optimal input temperature of the catalytic conversion reactors at these conditions and capacity is obtained 150000 kg/hr and in the range of 525-530 °C [35-38].

The Reactor Input Temperature and Catalyst Velocity Flow in Different Capacities must be how the Octane Number will be a Constant Rate 99 and the amount of Coke Formation in all Conditions 3.5%

One of the most functional and practical issues that is required for using of catalytic conversion unit of continuous resuscitation is this scenario. It is mainly due to various reasons and conditions that the unit operating in different capacities will have to produce gasoline with the required octane number. On the other hand, due to the settings and limitations of the coke and catalyst reduction, the percentage of coke formed should also be fixed and specified. The results of this study can play an effective role in controlling and right and proper regulating of mentioned operational unit. The fixed condition of this scenario is the coke formed percentage equivalent to 3.5 percent and product gasoline octane number 99 and the rate of returned hydrogen gas mass flow with a purity of 90 percent has been considered 22 ton per hour. In this study the purificated heavy Naphtha mass flow input feed of catalytic conversion unit with continuous resuscitation has been considered as an independent variable for unit capacity which is changed in a range from 90000 to 170000 kg/hr. The finding values of dependent variables which are the main purpose of this issue to regulate and control the operational unit, are reactors input temperature and rate of catalyst mass flow. The amount of coke formed percentage depends on different parameters and factors such as unit capacity, reactors input temperature, velocity of catalyst circulation flow, purity of returned hydrogen gas, portion of hydrogen to hydrocarbons and input reactors pressure. Among the mentioned factors, the most effective factor in this scenario can be applied to regulate and stabilize the coke formed percentage by changing on it, is the velocity of continuous catalytic conversion unit. The variable compliance of coke formation rate is an inverse ratio in relation to the parameter catalyst circulation flow. The higher the catalyst circulation flow rate, the lower the percentage of formed coke but due to increasing the velocity of the catalyst circulation flow, the possibility of the erosion and decrease of the useful life of the catalyst will be decreased by erosion increasing. By defining a flow as input values of the fluctuating flow of a catalyst and moving it to a spreadsheet and using the ADJ logical operator in different conditions, after the effects of the reactor and reactor gas intake and input temperature variations and the

returning hydrogen gas, with a mass flow regulation of the catalyst It can be used to stabilize 3.5% of the coke formed on the catalyst surface. It should be noted that the design capacity of the catalytic resuscitation system is 58 kg of coke at an hour with a catalyst flow rate of 820 kg per hour. According to the results, it is shown that in capacities above 145000 kg/hr the required flow of catalyst to stabilize 3.5% of the coke will be higher than the optimal design, The shape of the desire to operate in the optimal design conditions range with changing other process conditions, such as increasing the percentage of coke production to reduce the catalyst flow, or increasing the purity of the reversed hydrogen gas or increasing the amount of hydrogen gas returned can be brought into optimal conditions. Of course, in the information gathered from the unit control values, floods above 1200 kg/hr can also be seen for the amount of catalyst flow [39].

Investigation the Effect of Catalytic Flow Fluctuation Changes on the Percentage of Coke Composition Formed on the Catalyst

Considering the importance of controlling the amount of coke formed at a nominal capacity of 150,000 kg/hr (mainly the capacity of the continuous catalytic conversion unit of the gasification complex of the refinery is being exploited in this capacity), and in order to complete the information required in the previous scenario, the need for review the effect of the catalyst flow on the amount of coke formed in this capacity and in terms of the amount of returnable hydrogen gas equivalent to 22 ton/hr with a purity of 90% and a constant temperature of 525 °C input reactors seemed essential. The proper flow rate of the catalyst is 600 to 1200 kilograms per hour. Higher fluxes result in more erosion and reduced useful life of the catalyst [40]. In this study, the independent variable is a mass flow rate of a catalyst, defined by the definition of a current and its mass flow rate as the input of this test, and the percentage of coke as dependent variable [40].

Optimization of Energy Consumption with the Aim of stabilizing Octane Number 95 at the Nominal Capacity of the Catalytic Conversion Unit of Continuous Reduction

Initially, the effects of the reactor pressure changes on energy consumption were calculated for increasing octane number, which would not be favorable for improving energy consumption. As reactor pressure increased, despite the reduction of coke formed on the catalyst surface, no significant change was observed in terms of reducing energy consumption. In addition, the unit pressure increase is not cost-effective, and will result in more energy being consumed by the return gas compressor and other equipment that overwhelms the cost-effectiveness of the design. As reactor pressure decreases, as the octane number increases, the energy consumption increases. In the nominal capacity of the catalytic converting unit with a flow rate of 22 ton per hour, a flow of gas and a flow rate of 800 kg/hr of catalyst and a concentration of 1.1 catalyst chloride weight percentage, the compressor gas output

pressure was reduced to 3.5 relative bar, but produce gasoline with octane 95, 111,000 kw of heat needed by the furnaces, which is about 5,200 kw more than the initial one. The reactor pressure changes are not a good option for optimizing energy consumption.

Conclusion

Subsequent studies on how to optimize the energy consumption of the specified conditions, with a capacity of 30,000 b/day, aiming at reaching the octane number 95, has led to changes in the catalyst chloride concentration and its effects on energy consumption. Finally, the result of these studies was that increasing the catalyst chloride concentration has a beneficial effect on reducing energy consumption to increase octane number. Of course, this concentration increase due to the increase in the formation of coke and the reduction of purity of circulating gas is limited. The maximum possible effect of increasing the chloride concentration in a catalyst is 1.5% weight, after which the increase at 525 °C, which is reduced to 5 °C before, and results in an octane number of 95 °C with the consumption of 103600 kw energy for the furnaces thermal bar. As a result of this refinement, 2200 kW energy used to produce gasoline with an octane number 95 for a capacity of 30,000 b/day is reduced and the heat demand for furnaces is optimized. It should be noted that rising chloride concentration above 1.5% not only does not have an effect on reducing energy consumption but also increases the production of coke and reduces the purity of the hydrogen return gas and reduces the percentage of yield. Then, the effect of fluctuating gas changes on energy consumption for producing gasoline with octane 95 was investigated. The result of these experiments is the beneficial effect of fluctuating gas on energy consumption. One of the positive aspects of fluctuating gas flow has been its increased purity of hydrogen, which was reduced due to an increase in chloride concentration in the previous stage. The most effective flow of the circulating gas is improvement the energy consumption of 18 ton per hour, with hydrogen purity reaching 89 percent. As a result of this modification in the gas flow, to achieve the octane number 95 for a nominal capacity of 150 t/h at an input temperature of 525 °C consumption of 102500 kw of energy, which, compared with the initial conditions of 3300 kw, reduced furnace thermal bar required shows. In the following, the effect of the catalytic circulation flux was studied, which results in the desired effect of reducing the flow of catalyst on energy consumption.

According to the coke limiting factor, the optimum amount of 600 kg/hr fluctuation of the catalyst is achieved at an inlet temperature of 525 °C for a nominal capacity of 150 ton/hr. With this change, the 300 KW reduction is achieved from the previous stage. Finally, in this optimization process, after affecting all of the above mentioned operational parameters, the energy consumption of 10,222 kw will be achieved to produce gasoline with an octane number 95 for a nominal capacity of 150

ton/hr, which, compared with the initial state, reduces energy consumption by 3600 kilowatts it shows.

To ensure the non-deviation of other operating parameters of the catalytic converter unit as a result of the optimization process performed in the modified condition, 1.5% weight of the catalyst chloride concentration and the flux of 18 ton/hr of return gas with a purity of 89% hydrogen and 600 kg per hour catalytic circulation at a nominal capacity of 150 ton/h, the rate of coke formed on the catalyst has been checked at an input temperature of 525 °C to produce gasoline with an octane number 95 equal with 4.7% which is acceptable and within the permissible range of formation coke.

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How to Cite This Manuscript: Masood Amiri Koshkeki*. Investigation the Input Temperature of Catalytic Conversion Unit Reactors Efficiency on Octane Number, *Journal of Engineering in Industrial Research*, (*J. Eng. Indu. Res.*), 2020, 1(2), 170-178.

DOI: 10.22034/jeires.2021.265411.1015