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Optimization of Steam Cracking Process

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Abstract—*In petrochemical industries ethylene and other short chain olefins are formed by thermal cracking of hydrocarbon oil fractions in cracking furnaces. The effectiveness of these reactors depends on the resistance to the formation of coke, deposit over the internal walls in contact with the hydrocarbons to be cracked. Furthermore, the red oil formation in the caustic tower present downstream to the cracking furnace along the transfer line reduces the efficiency of the overall process. In the present communication, various issues pertaining ethylene production, viz. challenges, technical aspects, economic aspects, commercial development, operational aspects, and environmental aspects have been dealt with in detail.*

1. INTRODUCTION

Ethylene & propylene are some of the most important compound formed by thermal cracking of hydrocarbons. Ethane and propane are separately cracked in the cracking furnace at very temperatures (780 ℃-900 ℃)results in formation of ethylene & propylene along with various side product such as methane, hydrogen, sulphur dioxide, carbon dioxide, carbonyl compounds and various acidic gases which are due to the side reactions. The acidic gases such as SO_2 and H_2S are removed from the cracked feed in caustic tower by using NAOH(11% by weight) and rest of the feed in passed through various distillation column's to get ethylene& propylene having high purity. Red oil formation takes place in caustic tower due to aldol reaction taking place between the various carbonyl compounds formation in the cracking furnace. Rest of the cracking feed is passed through various distillation columns so that we can get ethylene & propylene having high purity.

In the formation of ethylene & propylene, the cracking of ethane & propane take place in the cracking furnace. Heavy molecular weight particles accumulate over the walls of furnace and formation of coke takes place. Huge amount of coke results in choking of furnace and henceforth creating hindrance in cracking of the gas substantially.

2. CONCEPT

2.1 Theory

The basic concept behind the formation of coke is accumulation of heavy molecular weight compounds over the walls of furnace. Due to the formation of coke, the choking of the furnace takes place which decreases the run time of the furnace .The amount of coking takes place depends upon the reaction time which is about .25sec. So if we are able to decrease the reaction time, then less side reactions occur & less accumulation of heavy hydrocarbons occur over the walls of furnace and for the red oil formed in the caustic tower, we have to stop the aldol reaction. So basically we are placing a SIC reactor before the caustic tower in which we are injecting hydrazine in liquid form & basic medium is provided such that Wolff kishner reduction reaction takes place in it and by this reaction the carbonyl compounds present in the cracked feed in converted in saturated hydrocarbons and we get water & nitrogen as by-products. Hydrocarbons can be separated in distillation columns further in the plant and nitrogen along with hydrogen & methane is separated in demethaniser .So we are injecting these gases along with dilute steam in the furnace so that net increase in volume results in decrease in pressure and according to le chatelier's principal, endothermic reaction moves in forward direction if we decrease the pressure. So the reactions in the furnace move in forward direction results in decreasing reaction time. So basically in this paper we are trying to reduce the reaction time as well as ensure the reduction in red oil formation.

2.2 Design

The design has been made to facilitate the process in as simple a manner as possible. The system cannot afford to be bulky or else this will hamper the dynamics of the exploration. Special arrangement has been made to reduce extra financial load on the process and decrease consumption of fuel. Basically we are comparing our process with already run process in the given fig.

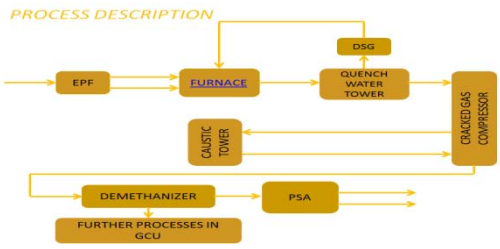

Fig. 1

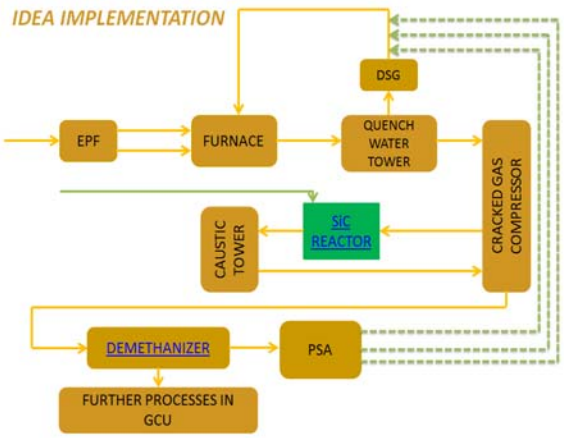

Fig. 2

2.3 Economy

a) In our process we have shown a major economic success of our idea. Adding a reactor in the present running plant won't require a separate plant. By adding the inert gases in the furnace increases the net volume & by le-chattier principle for the endothermic reaction, the reaction proceeds in forward direction & hence reduces the reaction time and increases the run time of furnace by 1.5 to 2.5 times and hence the loss of carores of rupees during the decoking periods can be saved . Low fuel consumption is occurred now by reducing coking. The red oil which is formed in the caustic tower is now reduced up to high extent and its choking can be saved. The excess N_2 is can be used in the formation of ammonia which can be sold out while CH_4 & H_2 can be used as fuel gas for heating up furnace.

2.4 Commercial development

2.4 Commercial Development

a) By-products of Wolff kishner reduction reaction are saturated hydrocarbons, nitrogen & water. Hydrocarbon like methane, ethane and propane can be separated in distillation columns and can be reused for feed in fur-nace. Nitrogen is used in the furnace as well as it is used in making various product like ammonia, urea etc. Meth-ane and Hydrogen are used as fuel gas for heating up furnace. Hydrogen, Methane and Nitrogen are used as inert gases for increasing volume which leads reaction in forward direction. Water can be separated in the dehyd-rator and futher used in heat exchanger process. The by-products of Wolff krishner reaction are environment friendly generating only nitrogen & water as by-products.

The hydrazine used in the reactor is in liquid form so that its toxic nature can be removed.

3. CONCLUSION

A new method of optimising steam gas process in a more economical. The problem which caused due to formation of coke due to the accumulation of heavy molecular weight particle which results in coking of furnace and choking of caustic tower due to red oil can be dealt over now with the help of proposed idea. The idea proposed is very simple and do not contain any complexity in any of its step. Application of Le chatelier's principle and & Wolff kishner reaction. The situation is very simple, in furnace where average temperature is 700-800 ◦C, there is formation of coke in the furnace & red oil is formed in the caustic tower due to aldol condensation. While cracking of hydrocarbons take place whenever we come across this coking of furnace, so a lot of fuel consumption is there and the run time of furnace decreases, so we have to shut down the furnace for its decoking. Now this problem is overcome by increasing the volume inside the furnace by adding inert gases with dilute steam and the reduction in red oil formation can be done by allow Wolff krishner reaction to occur inside a SIC vessel. The extra utility required is a reactor & hydrazine that don't cost too much. After all the mathematical calculations, research and experiments along with simulation work this method will have a bright future and would surely enhance the process of STEAM CRACKING.

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