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Steam Cracking Crude Oil for Petrochemicals: Two-Stage Steam Cracking

Sarthak Suhane[1]
[1]*Student at Institute of Engineering, Jiwaji University, Gwalior*

Abstract: ***Olefins are the key chemical raw material in today's world. Most important of them are Ethylene and Propylene, with production rates of 15 × 10^7 t and 80 × 10^6 t, respectively World Wide. Their demands are increasing very rapidly due to the population boom and rising living standards. Their production can be made more economical by using the Two Stage Steam Cracking of Crude Oil and the crude further sent to the distillation in Vacuum Tower, skipping the Atmospheric Tower. This paper discusses a modern method for producing Olefins more economically.***
Keywords: Cracking Furnace, Flash Drum Separator, Gas Oil Portion, Naphtha Portion, Olefins, Steam Cracking.

I. Introduction

In Two Stage Steam Cracking process, the feed i.e. Crude Oil is directly processed to get the Naphtha and Gas Oil portions from it. In this process the feed is first passed to a Convection section of the Steam Cracking Furnace to vaporize the material (the Naphtha Portion) in the feed which boils below 232.22^o C. The portion of the feed which vaporized is then passed to the separation zone, i.e. Flash Drum Separator to separate the Liquid and Vapor portions. The separated vaporized portion of the feed is mixed with the steam and passed to the Steam Cracking Furnace for short residence time with high temperature cracking conditions. The bottom product from the Flash Drum Separator, i.e. Liquid portion is then passed to the Convection zone of second Steam Cracking Furnace and then with steam it is passed to the second Flash Drum Separator where material (the Gas Oil Portion) which boils between 232.22^{o}C – 593.33^o C gets separated. Again the vaporized portion is passed to the Steam Cracking Furnace, this time there is no need for further addition of steam to vaporized portion for its cracking under Optimum conditions. From there the liquid portion of the feed is directly introduced in the Vacuum tower skipping the Atmospheric tower, also there will be no need for any Naphtha cracking unit. This will eventually make the Olefin production more economical and its effect will be reflected on final price for the consumers.

II. Scope

In next 10 - 15 years the Production capacity and Demand of Propylene will be 160 million metric tons and 140 million metric tons respectively, with 4% increase in demand per year. Currently China tops in the Propylene Production in World, with forecast of increase in Propylene Production rate of 6.9% in next 10 – 15 years. Other major contributors in Propylene Production are US, Middle East and West Europe with production share of 14%, 9% and 13% respectively in year 2016.
Similarly, Production capacity and Demand of Ethylene will be 230 million metric tons and 200 million metric tons respectively, with 3.6% increase in demand per year. Currently US, China, Middle East tops the Ethylene Production in World, with forecast of increase in Ethylene Production rate of 4.5%, 5.7%, 3.4% respectively in next 10 – 15 years.

TABLE I. Propylene Production in India

Company	Location	t/y
Gas Authority of India	Pata, U.P.	300000
Haldia Petrochemicals	Haldia, W.B.	520000
Indian Petrochemical Corp.	Baroda, G.J.	130000
Indian Petrochemical Corp.	Gandhar, G.J.	300000
Indian Petrochemical Corp.	Nagothane	400000
National Organic Chemicals ltd.	Thane, M.H.	75000
Reliance Industries	Hazira, G.J.	790000

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In last ten year India has seen spectacular growth in the Petrochemical and Polymer Industries. India has nominal Ethylene Capacity of 2.5 million tons, which places India on fifth position in Far East. In India per capita consumptions of Polymers are 2.7 kg/y, which is way below than World Average 19 kg/y. Market is growing very fast with 12% increase per annum. This means in India more Plants will be installed, which should be more efficient and economical. India has the potential to become leader in field of Olefin Productions, with most economical production. Presently in India most of the plants are in Western side of India.

Steam Crackers and Fluid Catalytic Crackers produce the majority of Propylene as the by-products. This Two Stage Process for directly steam cracking the Crude oil feed to get the Olefins is more economical and efficient than the traditional method of Olefin production.

III. Process Description

As Shown on figure, The Crude Oil feed is first introduced into the Convection Section of a Cracking Furnace (I) via line 1 to vaporize the feed portion whose boiling point is below 232.22^{o} C. The feed, both vaporized and non vaporized is passed into Flash Drum Separate (I). It operates under 30 to 100 p.s.i.g. pressure to ensure the Phase separation, vaporized phase contains Naphtha Portion and liquid phase contains the portion above 30 weight% of the total feed. Now the Vaporized phase via line 3 admixed with steam through line 4 is passed into the Convection section of Cracking Furnace (I). Here the Cracking of Naphtha portion is carried out in the most optimum conditions, this enables cracking of selective C4 – C6 diolefins like Butadiene and Isoprene. The liquid phase present at the bottom of the Flash

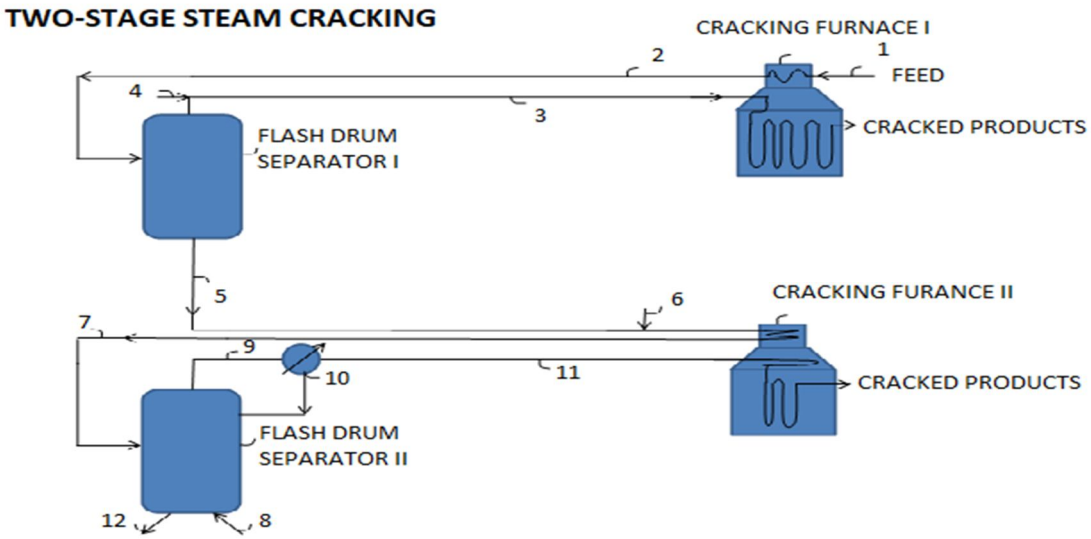

FIGURE I. Two-Stage Steam Cracking

Drum Separator (I) is withdrawn via line 5 and admixed with steam through line 6 is introduced into the Convection Section of Cracking Furnace (II). Temperature of the liquid withdrawn from the Flash Drum Separator (I) is about 232.22^{o} C to 371.11^{o} C, which is raised to about 315.55^{o} C to 482.22^{o} C in Convection Section of Cracking Furnace (II), it vaporizes the feed portion whose boiling is in range of 232.22^{o} C – 593.33^{o} C . The feed, both vaporized and non vaporized from the Cracking Furnace (II) is passed to Flash Drum Separator (II) via line 7 which operates under 30 to 100 p.s.i.g. pressure for phase separation. In Flash Drum Separator (II) steam is introduced via line 8 to reduce the partial pressure of Hydrocarbons to increase its vaporization and for subsequent steam cracking of vapor phase. The vaporized phase is then through line 9 is withdrawn from the Flash Drum Separator (II) and cooled to -6.66^{o} C to 93.3^{o} C to condense some part of it and it is send back to the Flash Drum as a reflux through line 10 to prevent fouling of Steam Cracker coils from condensation of the heavy portion in the vaporized phase. The vaporized portion left after reflux through line 11 is introduced into the Convection Section of Cracking Furnace (II) and then passed into the Radiant Section for Cracking of Gas Oil portion. Liquid Phase left in Flash Drum Separator (II) is then withdrawn through line 12.

Further the Crude oil from separator is now free from the light hydrocarbons or says lighters, which is then further distilled in the Vacuum Tower directly; here Atmospheric Tower for distillation is not needed; since Light Hydrocarbons are already distilled.

Also there is no need for Petrochemical Complex for Olefins; since Naphtha and Gas Oils portion are already Steam Cracked in our Two Stage Steam Cracker. Similarly, ExxonMobil and Saudi Aramco has developed two new steam-cracking processes, which allows petrochemical producers to directly steam crack the Crude Oil to extract the Olefins skipping the refining processes. This process can profit producers with $100 to $200 per metric tons more than that of the traditional naphtha cracking processes.

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IV. Economics and Conclusion

In this process, there is a very limited use of Heat Exchange Apparatus than that of traditional processes to vaporize the Naphtha and Gas Oil portions. Moreover the Two Stage Steam Cracking process operates under optimum conditions to maximize the Cracking and overall yield of Olefins, especially C4 – C6 diolefins like Butadiene, Isopropene, Cyclopentadiene, etc. Also this is to be kept in mind that in this process no Atmospheric Column and Naphtha Cracker are needed for further processing of the Crude Oil.

Here, the describing how the rates of production of steam crackers declined and table, the cost of erecting the Atmospheric tower, which is now not needed in our Two Stage Process. These evidences support the new methods of production.

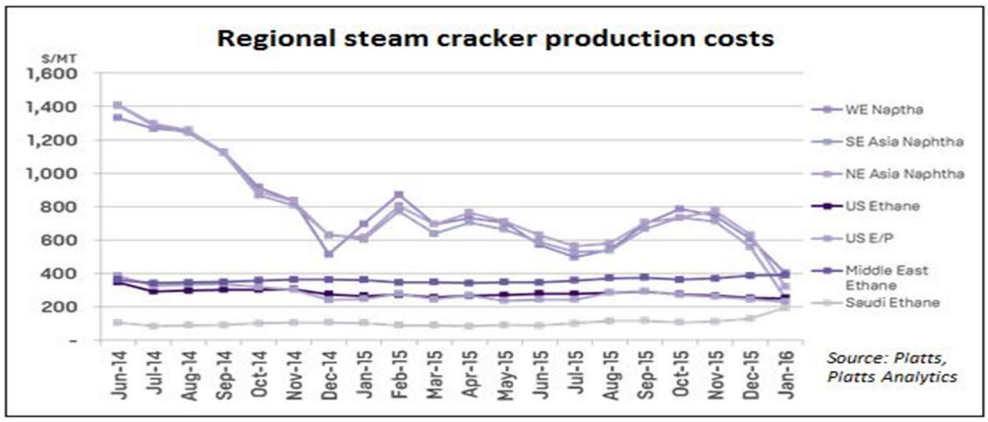

FIGURE II. Steam Cracker Production costs

TABLE II. Cost of Equipments

S. No.	Equipment	Price $
1.	Heater 1	327700
2.	Heater 2	332400
3.	Heater 3	611400
4.	Furnace	1431200
5.	Pre Flash Drum	127300
6.	Pump	277200
*7.	Atmospheric Tower	5798300
Total	8905500	

*Vary with height of Column,

This Paper hereby, concludes that the Two Stage Steam Cracking Process is more economical and efficient way of producing Olefins. By using this process, Atmospheric Distillation and Petrochemical Complexes can be skipped. In India this method can be used to boost the Olefin production, which will boost the exports of Petrochemicals and make the India world leader in Olefin Productions.

REFERENCES

[1] H. Zimmermann, R. Walzl Ethylene Ullmann's encyclopedia of industrial chemistry, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim (2009).
[2] BP plc. BP statistical review of world energy. BP technical report BP plc, London (2013 Jun)
[3] Global Supply and Demand of Petrochemical Products relied on LPG as Feedstock Mitsubishi Chemical Techno-Research 7th March 2017.
[4] Duncan Seddon Petrochemical Economical Technology Selection in a Carbon Constrained World Copyright © 2010 by Imperial College Press.
[5] Guy B. Wirth, Florham Park, Charles E. Jahnig, Rumson, both of NJ FOR STEAM CRACKING CRUDE OIL; U S Patent No. 3617493 Esso Research and Engineering Company; Patented Nov.2, 1971.
[6] New ExxonMobil and Saudi Aramco Technologies Produce Ethylene Directly from Crude Oil, Cutting Refining Costs, HOUSTON (July 6, 2016)IHS Markit
[7] Oludare J. Odejobi Exergy and Economic analyses of Crude Oil Distillation Unit NETJOURNALS 12 August, 2015
[8] blogs.platts.com the-world-is-flat-ethylene-producers-oil-prices-low /2016/02/02/

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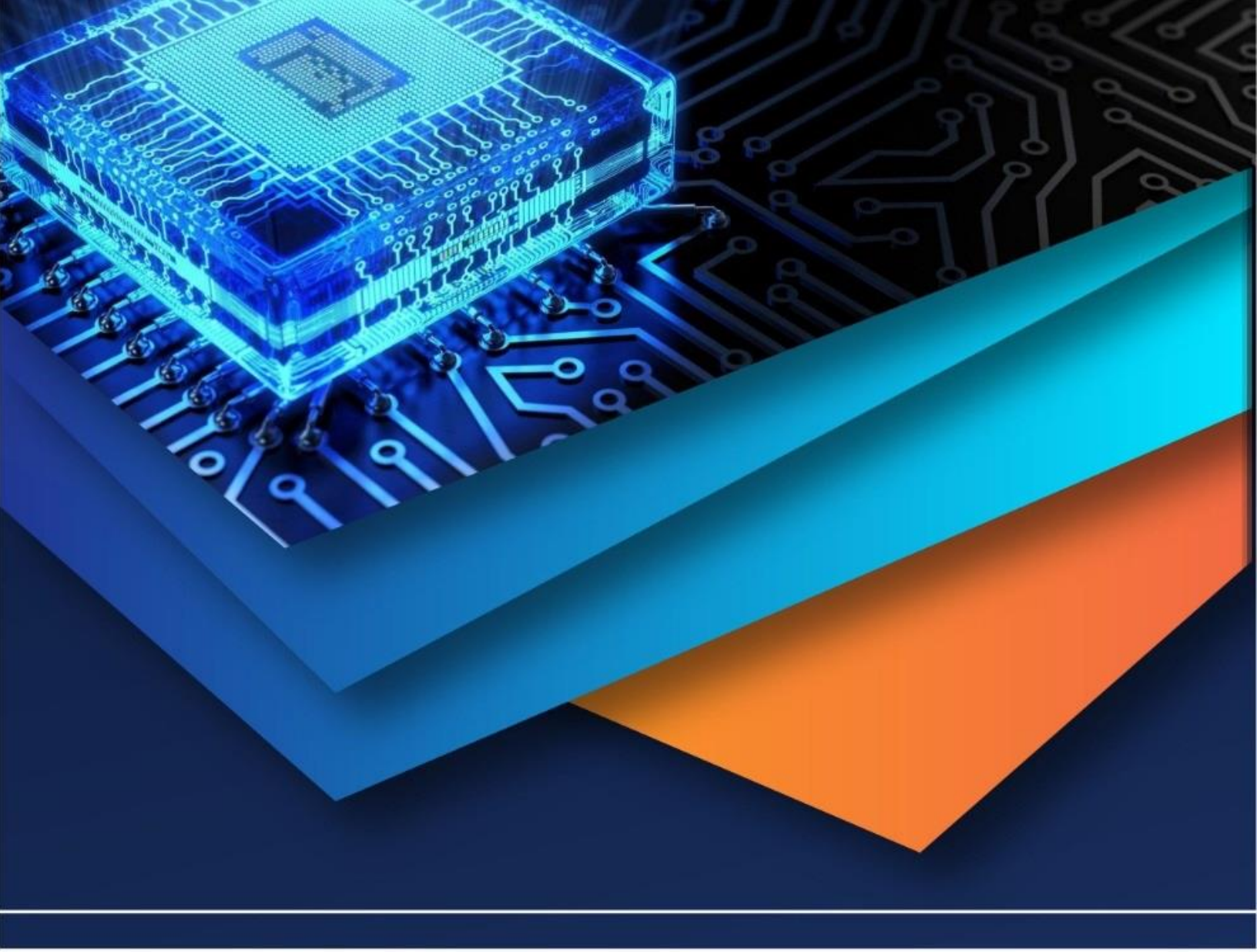

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