



Short Communication

Hydrocarbon Liquid from Castor Oil

Deshpande D.P.¹, Haral S.S.² and Sarode P.B.²

¹Dept of Chemical Engineering, TKIET, Warananagar, MS, INDIA

²Dept. of Chemical Engineering, Govt. Polytechnic, Jalna, MS, INDIA

Available online at: www.isca.in

Received 15th February 2013, revised 14th April 2013, accepted 15th June 2013

Abstract

Alternative renewable fuels have received increasing attention for future utilization because of limited supply of fossil fuel. In this respect, fermentation, transesterification and pyrolysis of biomass, industrial and domestic wastes have been proposed as alternative solutions for the increasing of energy demand and environmental awareness. In order to meet this challenge, in this paper it is tried to obtain hydrocarbon liquid from castor oil. It is planned to study effect of reaction temp on various properties of hydrocarbon liquid obtained after thermal cracking of castor oil. The properties chosen for study are Viscosity, density, Aniline point and bromine no.

Keywords: Thermal cracking, hydrocarbon liquid, castor oil.

Introduction

The majority of the world's energy is supplied by petroleum derived fuels and petroleum based distillates are used in a wide range of industrial applications. Petrochemicals serve as raw materials for the chemical industry in the production of solvents, lubricants, paints, and lacquers. The oil crisis in the 1970s, depleting reserves, national scarcity issues, price uncertainty, and growing environmental concern over the combustion of fossil fuels highlight major issues associated with the extensive use of petroleum in our society¹. As a result, there has been renewed interest in the discovery of non-petroleum or "green" fuels and chemicals. Studies of pyrolysis carried out in the absence of a catalyst were done using oil from Canola Pequi, Palm tree, Soybean, Macauba and Babassu as rawmaterial. In these works, the characterization of pyrolysis gas and liquid products were reported and some reactions pathways were proposed. The formation of linear and cyclic paraffins and olefins, aldehydes, ketones, and carboxylic acids were observed during thermal decomposition². The pyrolysis products of plant oils highly dependent on the composition of oil and nature and amount of the catalyst used.

Levent Dandik and A.K. Aksoy³ have shown that the catalytic conversion of used sun flower oil to fuels and chemicals carried out with Na₂CO₃ catalyst at atmospheric pressure, a temperature range of 400^oC to 420^oC by using the fractionating column of different length yields organic liquid product, light hydrocarbon gases and water as a major product. The catalyst used yielded the highest amount of organic liquid product of 83 mass % at 3h⁻¹ and 420^oC which consist of 87% liquid hydrocarbon product. In this paper we are trying to report pyrolysis of castor oil. Idem⁴, et al. used canola oil as a model to determine the effect of different catalytic properties such as acidity, basicity, crystalline structure and pore size on cracking reactions. They

determined that the important factors for producing a high yield from catalytic cracking of canola oil to liquid product were the catalyst crystalline structure and catalyst shape selectivity. Crystalline catalyst offer more surface area in which active acid sites initiate the cracking of the molecule. Shape selective characteristics, such as that of HZMS-5, allow for minor cracking. Minor cracking results in large production of organic liquid products (OLP) and small productions of gaseous products. Also, catalysts with basic centers, such as calcium oxide and magnesium oxide, impede the decomposition of long chain oxygenated hydrocarbons. It was shown that reactions using basic catalyst yielded similar products as thermal cracking (i.e., long chain hydrocarbons and oxygenated hydrocarbons), but secondary cracking required for the formation of aromatic compounds could not be formed from the basic catalysts. The pyrolysis products of plant oils highly dependent on the composition of oil and nature and amount of the catalyst used.

Katikaneni⁵ et al. have shown that the catalytic conversion of canola oil to fuels and chemicals carried out with HZSM-5 at atmospheric pressure, a temperature range of 375 to 500^oC and weight hourly space velocity of 1.8 to 3.6 h⁻¹ in fixed bed micro reactor yields an organic liquid product, light hydrocarbon gases and water as major products. HZSM-5 yielded the highest amount of organic liquid product of 63 mass % at 1.8 h and 400^oC which consisted of 83.8% hydrocarbons.

Trancy John Benson⁶ investigated the cracking chemistry as model lipids were reacted over a catalyst, HZSM-5, and two industrially used catalyst, faujasite and silica-alumina. Initial work began with a homogeneous system in which oleic acid, an unsaturated free fatty acid, and triflic acid, a Bronsted super acid, were reacted at low temperatures. Results indicated that protonation began at the double bond with cracking occurring in the direction away from the carboxylic end and producing a

multiplicity of branched saturated fatty acids. Heterogeneous cracking on H-ZMS-5 at 400°C indicated that acylglycerides initially crack due to protonation occurring on the outside surface of the catalyst. Secondary cracking formed olefins (C₂–C₄) which then oligomerize to form aromatic hydrocarbons that were within the range of components for gasoline. D.P.Deshpande⁷ et al has studied effect of sodium hydroxide as catalyst for converting used palm oil to hydrocarbon liquid. They have reported that aniline point viscosity and density of hydrocarbon liquid decreases as catalyst concentration increases.

Material and Methods

In this paper it is tried to report the pyrolysis of castor oil. The castor plant grows in the wild in large quantities in most tropical and sub-tropical countries. It is available at low cost and the plant is known to tolerate varying weather conditions. Castor oil used in the experiments was obtained from nearby oil extracting mill of miraj.

Experimental Setup: For the batch cracking, reactor is loaded with 200 gm of oil. The mixture is heated to the temperature, with heating rate 8°C/min. Temperature kept constant during the reaction. The reaction products leaving the fractionating column are separated in to the liquid and gases fractions. The liquid product is collected in to the glass trap. For the effluent cooling, the cold water is circulated through the condenser. The reactions are conducted using the packed column of 160 mm long in absence of air. The reaction time changed between 160 to 270 min. at the end of the run, the reactor was left to cool at ambient temperature. The liquid product consisted of aqueous phase and organic phase. The aqueous phase is separated from the organic phase in a separating funnel and discarded.

Results and Discussion

Cracking of Castor oil was carried out in a reactor (Three necked flask) fitted with a packed column. The reactor of 500 ml capacity and the packed column above the reactor functions as a separating unit. 200 gm of feed of Castor Oil was taken in the reactor. The Reaction temp was varied from 350°C to 450°C with intervals of 1% based on feed stock employed.

Effect of temp on the Viscosity of hydrocarbon Liquid:

Viscosity: During the course of experiment it is observed that viscosity of hydrocarbon layers decrease from 2.16cSt to 1.99 cSt with increase in catalyst concentration from 1 wt% to 5wt% as shown in table-1 and figure-1. This may be due to increase in lighter fractions with increased in catalyst concentration.

Density: On increasing in the Temp from 350°C to 450°C density of the product was varied from 0.84 to 0.82 gm/ml as shown in table-2 and figure-2.

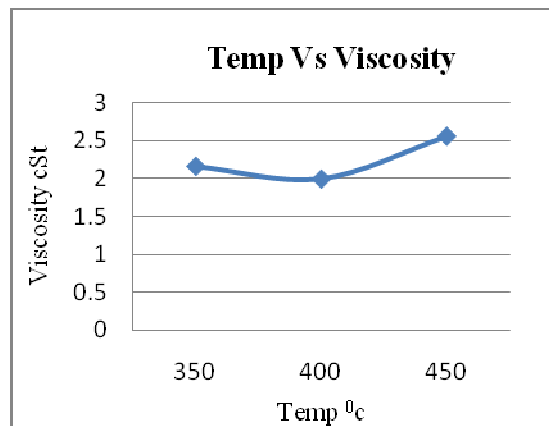


Figure-1
Variation of Viscosity with Reaction Temp

Table-1
Variation of Viscosity with Reaction Temp

Sr No.	Temp	Viscosity (cSt)
1	350	2.16
2	400	1.99
3	450	2.56

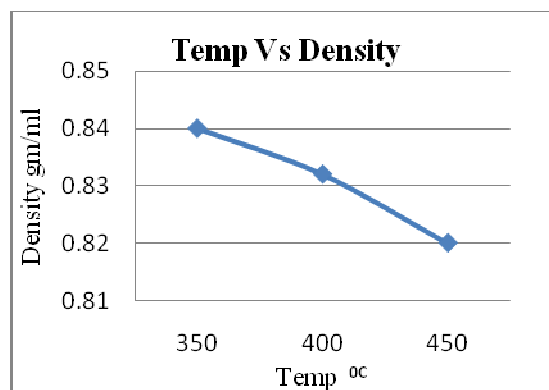


Figure-2
Variation of Density with Reaction Temp

Table-2
Variation of Viscosity with Reaction Temp

Sr No.	Temp	Density (gm/ml)
1	350	0.84
2	400	0.832
3	450	0.82

Aniline point: Aniline point of hydrocarbon phase was found to be decreased from 49°C to 46°C with increase in the Temp, after that it became approximately as shown in table 3 and figure 3. This may be due to aromatic content of hydrocarbon phase with increase in catalyst concentration.

Bromine number: On increase in reaction temp from 350°C to 450°C, Bromine no of the product was found to be increased from 4.8 to 5.38 as shown in Table 4 and figure 4. From this we

can conclude that the unsaturation percent in the hydrocarbon phase is increased with increased in reaction temp.

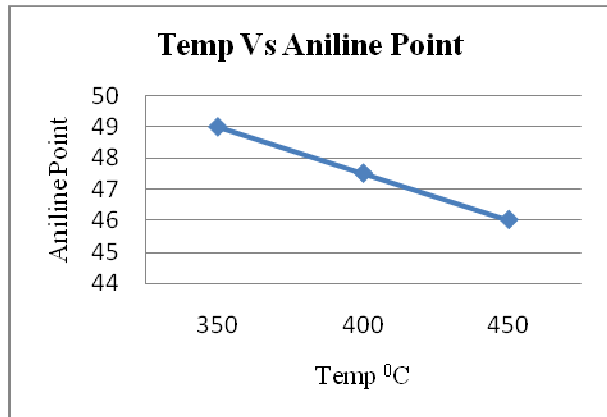


Figure-3
Variation of Aniline point with Reaction Temp

Table-3
Variation of Aniline point with Reaction Temp

Sr No.	Temp	Aniline point (°C)
1	350	49
2	400	47.5
3	450	46

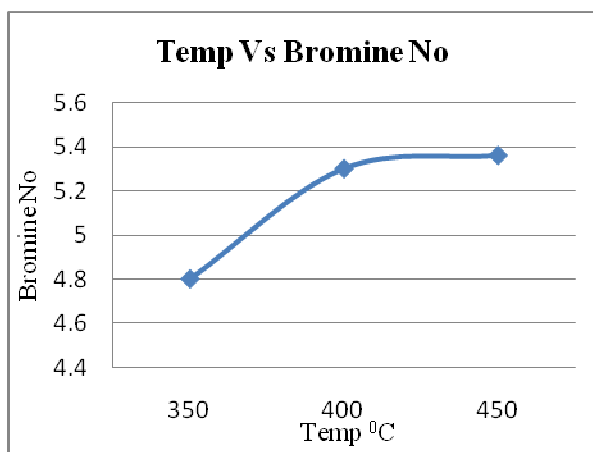


Figure-4
Variation of Bromine no with Reaction Temp

Table-4
Variation of Bromine no with Reaction Temp

Sr No.	Temp	Bromine number
1	350	4.8
2	400	5.3
3	450	5.36

Conclusion

In above discussion it is found that castor can be converted into petrochemical feed stock by using thermal energy i.e by doing

thermal cracking. During the course of experiment it is found that temp plays a vital role in converting castor oil to petrochemical feed stock. In this experiment effect of reaction temp on Viscosity, density, aniline point and bromine no of product is studied. It is observed that density and aniline point of product decreases with increasing temp while, Viscosity and bromine no of product decreases with increasing reaction temp. So castor oil will be one of the promising raw material for production of petrochemical feed stock.

References

1. Maher K.D. and Bressler D.C., Pyrolysis of triglyceride materials for the production of renewable fuels and chemicals, *Bioresource Technology*, **98**, 2351–2368 (2007)
2. Daniela G. Lima et.al, Diesel-like fuel obtained by pyrolysis of vegetable oils, *J. Anal. Appl. Pyrolysis*, **71**, 987–996 (2004)
3. Dandik L. and Aksoy H.A., Conversion of Used Oils to Obtain Fuels And Chemical Feed Stocks By Using Fractionating Pyrolysis Reactor World Conference And Exhibition On Oil Seeds And Edible Oils Processing – Istanbul, *Inform*, **7**, 920-923 (1996)
4. Idem R.O., Katikaneni S.P.R. and Bakshi N.N., Catalytic conversion of canola oil to fuels and chemicals: roles of catalyst, acidity, basicity, and shape selectivity on product distribution, *Fuel Processing Tech.*, **51**, 101-125 (1997)
5. Katikaneni S.P.R., Ajaye J.D. and Bakshi N.N., Studies on the catalytic Conversion of canola oil to hydrocarbons: Influence of Hybrid Catalysts and Steam, *Energy and Fuels*, **9**, 599-609 (1995)
6. Benson T.J., Aromatics Formation from lipids conversion on H-ZMS-5 Zeolite: Mechanism and Intermediate Species, *Catalysis by Zeolites*, **46**, 29-37 (1980)
7. Deshpande D.P., Aneker S.V. and Kanse N.G., Catalytic cracking of used palm oils, *International Journal of Biotechnology, Chemical & Environmental Engineering (IJBCEE)*, **1(1)**, (2012)
8. Nerín C., Domeño C., Moliner R., Lázaro M.J., Suelves I., Valderrama J., *J. Anal. Appl. Pyrolysis*, **55**, 171 (2000)
9. Vitolo S., Bresci B., Seggiani M., Gallo M.G., **80**, 17 (2001)
10. Deshpande D.P., Haral S.S., Gandhi S.S. and Ganvir V.N., Transesterification of Castor oil, *ISCA Journal of Engineering Sciences*, **1(1)**, 2-7, (2012)
11. Deshpande D.P., Urunkar Y.D. and Thakare P.D., Production of Biodiesel from Castor Oil using acid and Base catalysts, *Research Journal of Chemical Sciences*, **2(8)**, 1-5 (2012)