



Conversion of used Palm oil using CaCO_3 as a Catalyst

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Abstract

Continuous increasing demand for petroleum fraction and decreasing petroleum recourses catch the importance towards the alternative fuel. In this paper cracking of used palm oil has been tried to obtain alternative fuel. The cracking was carried out in presence of CaCO_3 as a catalyst. Various runs were carried out at different temp and catalyst concentration. The maximum liquid hydrocarbon were obtain in presence of 5% CaCO_3 catalyst

Keywords: Palm oil, cracking, catalyst, pyrolysis etc.

Introduction

The increasing production of waste frying oils from household and industrial sources is a growing problem all around the world. This residue is regularly poured down the drain, resulting in problem for wastewater treatment plants and energy loss, or is integrated into the food chain through animal feeding, thus becoming a potential cause of human health problems¹. There are several end uses for this waste, such as the production of soaps or of energy by anaerobic digestion, thermal cracking, catalytic pyrolysis, etc. Many researchers found that biofuels can be produced from waste oils such as used frying oil². Thus, recycled waste oils offers a significant potential as an alternative low-cost biofuels feedstock. However, used frying oil from restaurants and food industries have a variety of qualities, and possess properties different from that of neat oils. Higher impurities of waste oils make them different from neat vegetable oils in biofuels production. 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 Na_2CO_3 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. Idem, et al. used canola oil⁴ 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.

Prasad Y.S., and Bakshi⁵ 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^oC indicated that acylglycerides initially crack due to protonation occurring on the outside surface of the catalyst. Secondary cracking formed olefins ($\text{C}_2 - \text{C}_4$) which then oligomerize to form aromatic hydrocarbons that wee within the range of components for gasoline.

Katikaneni⁶ 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.

The present work reports the results obtained from conversion of used palm oil to hydrocarbon fuels and chemicals with calcium oxide by using special pyrolysis reactor and effect of the process parameter, i.e., temperature and catalyst concentration. The purpose of the use of packed column is to increase residence time of the primer pyrolysis products which cause additional thermal and catalytic reactions for the increasing of the liquid hydrocarbon content in narrow boiling range.

Material and Methods

In this paper it is tried to report the pyrolysis of used palm oil. Used palm oil is used twice for frying of vegetables obtained from Gokul restaurant. Sodium carbonate of analytical grade, calcium carbonate of laboratory grade and calcium oxide of laboratory grade of Riedel Product Company.

Experimental Setup: For the batch cracking, reactor is loaded with 200 gm of oil. Then the certain quantity of catalyst like calcium carbonate was added for different runs to oil and mixture was stirred to disperse the powder and then packed column, 'Y' joint, condenser, glass trap (100 ml measuring cylinder) connected to the reactor. 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 180 mm long in presence of 1, 3 and 5% calcium carbonate based catalyst. 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

Three necked flask fitted with packed column is used as reactor for cracking of used palm oil. The reactor of 500 ml capacity and the packed column above the reactor functions as a separating unit. Experiments were carried out with catalyst such as calcium carbonate. 200 gm of feed of used palm oil was taken in the reactor and to this required quantities of catalysts were added. The concentration of calcium carbonate catalyst was varied from 5% to 9% with intervals of 1% based on feed stock employed.

Effect of Calcium Carbonate as a catalyst 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. This may be due to increase in lighter fractions with increased in catalyst concentration.

Density: On increasing in the catalyst concentration from 1 wt% to 5 wt% density of the product was varied from 0.84 to 0.82 gm/ml as shown in table-2 and figure 2.

Table-1
Effect of Catalyst Concentration on Viscosity

Sr No.	Catalyst Conc. (wt%)	Viscosity (cSt)
1	1	2.16
2	3	2.061
	5	1.99

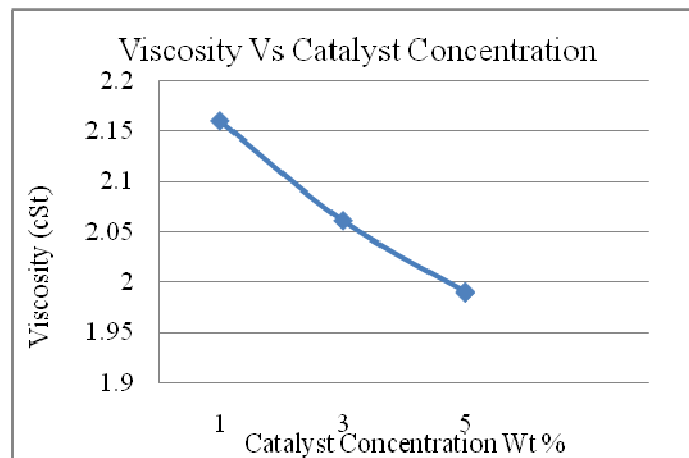


Figure-1
Effect of Catalyst Concentration on Viscosity

Table-2
Effect of Catalyst Concentration on Density

Sr No.	Catalyst Conc.(wt%)	Density (gm/ml)
1	1	0.84
2	3	0.832
3	5	0.82

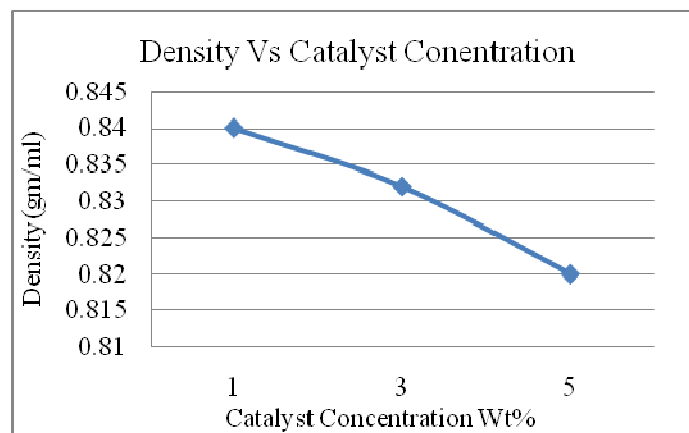


Figure-2
Effect of Catalyst Concentration on Density

Aniline point: Aniline point of hydrocarbon phase was found to be decreased from 49°C to 46°C with increase in the

concentration, after that it became approximately as shown. This may be due to aromatic content of hydrocarbon phase with increase in catalyst concentration.

Table-3
Effect of Catalyst Concentration on Aniline Point

Sr No.	Catalyst Conc. (wt%)	Aniline point (°C)
1	1	49
2	3	47.5
3	5	46

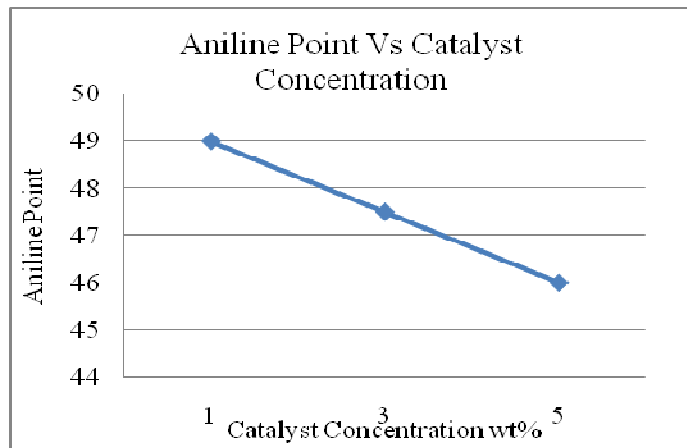


Figure-3
Effect of Catalyst Concentration on Aniline Point

Table-4
Effect of Catalyst Concentration on Bromine No

Sr No.	Catalyst Conc. (wt%)	Bromine number
1	1	4.8
2	3	5.3
3	5	5.36

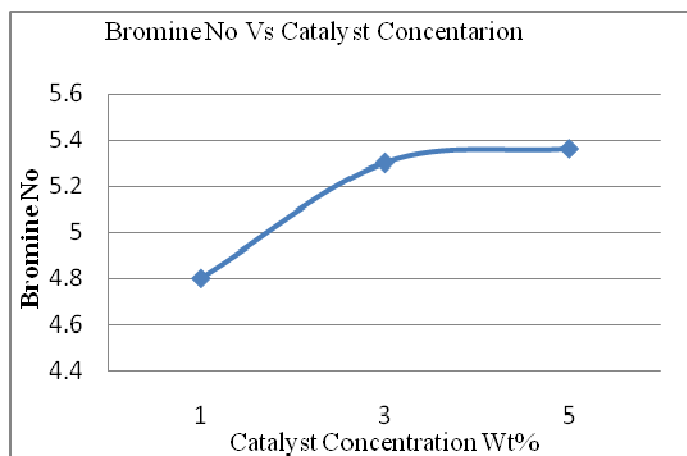


Figure-4
Effect of Catalyst Concentration on Bromine No

Bromine number: On increase in the catalyst concentration from 1% to 5%, Bromine no of the product was found to be increased from 4.8 to 5.38 as shown. From this we can conclude that the unsaturation percent in the hydrocarbon phase is increased with increased in catalyst concentration.

Conclusion

From above discussion we conclude that, used palm oil could be converted into liquid as well as gaseous hydrocarbon. Maximum amount of liquid hydrocarbon were observed using fractionating column of 200 mm in presence of 5% CaCO₃ catalyst. The boiling range obtained with CaCO₃ catalyst were 90°C to 159°C.

References

1. Deshpande D.P.et.al, Petro-Chemical Feed stock from Plastic Waste, *Research Journal of Recent Sciences*, **1(3)**, 63-67 (2012)
2. Deshpande D.P, Haral S.S and Sarode P.B, Hydrocarbon Liquid from Castor Oil, *Research Journal of Chemical Sciences*, **3(7)**, 87-89 (2013)
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. Prasad Y.S. and bakshi, Catalytic Conversion of Canola Oil to Fuels and Chemical Feedstocks Part I. Effect of Process Conditions On the Performance of AZSM-5 Catalyst, *Canadian Journal of Chemical Engineering*, 278-284 (1986)
6. 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)
7. Leng T.Y., Mohamed A.R. and Bhatia S., Catalytic Conversion of Palm Oil to Fuels and Chemi Cals, *Canadian Journal of Chemical Engineering*, **V 77**, N1, 156-162 (1999)
8. Hobson G.D., *Modern Petroleum Technology*, 4th Edition, Applied Science Publishers Ltd., England, P.No. 278-280, (1973)
9. Nelson, W.L., *Petroleum Refinery Engineering*, 4th Edition, New York, Macgraw Hill Book Co. P.No.190, (1958)