International Journal of Advance Research in Engineering, Science & Technology(IJAREST),
ISSN(O):2393-9877, ISSN(P): 2394-2444,
Volume 2,Issue 5, May- 2015 , Impact Factor:2.125

Production of Furan from Xylan by using solid Catalyst

Jitesh Joshi[1], *Dr. Sachin P. Parikh*[2], *Priyank Khirasariya*[3]

[1].*PG Student (Chemical department), . V.V.P. Engineering college Jitesh1122@gmail.com*

[2]*Proffesor and Principal, V.V.P. Engineering college. sachinparikh@hotmail.com*

[3]*Leacturar, V.V.P. Engineering college 12mchc10@nirmauni.ac.rin*

Abstract

With the aim to develop an ecologically viable catalytic pathway for furfural and furanproduction without the use of inorganic acids. Furfural is a key derivative used in the manufacturing of a wide range of important chemicals. Furan has the ability to substitute fossil compounds on a large scale for polymers, solvents, fine chemicals and finally fuels. It is exclusively produced from lignocellulosic biomass by acidic hydrolysis of the hemicellulose, and the second step of dehydration is comparatively slower than that of acid hydrolysis. There is no synthetic route available for the production of furan. The project is related to convert the xylan into furan which is viable option for the replacement of fossil fuel. The xylan hydrolyzed and produced the xylose and further the hydrolysis gives the xylose and furfural and furan under the microwave irradiation which provide the proper heating to the chemical reaction with the solid catalyst $H_3PW_{12}O_{40}$*(phosphotungestic acid) yieldis furan 71.97% and ZSM-5 yields32.89%.*

Introduction

The increase in global population and a surge in the automobile industry have resulted in a rapid increase on the dependence on fossil fuels. At present 86% of energy and 96% of the chemicals worldwide are produced from petroleum resources. Due to this dependence mankind is facing two related challenges: impending depletion of hydrocarbon fuel resources aggravated by an ever-increasing demand for energy, and the gloomy prospects of a global climate change associated with enormous volumes of fossil-derived CO_2 emissions. The wellacknowledged needto reduce the dependence of human prosperity on fossil sources is triggered by political, economicand ecological motives.

Our natural resources are limited and their wast and also over use is create the environmental problem and also instability to it. The background of this work arises from the interests in the resulting climate effects of the new potential biofuel based on furfural and furan compound.

The climate system and it‘s sensitivity to changes is briefly explained and the chemical compounds called furan are presented with focus on their properties as a fuel and an atmospheric constituent. In the end some goals are set up for this work with a focus on atmospheric chemistry involving furan.

Conversion of furan from xylan by using solid catalyst

Furans are volatile organic compounds (VOCs) that are highly flammable both in liquid and gaseous phase. Because of its properties it has been proposed as a new type of biofuel in combustion processes. It might then be possible to produce some furan derivatives from fructose through catalytic processes, but the technique has so far only been performed on a small scale. The furans that have a higher energy density than ethanol are the most attractive when searching for new biofuels.

The goals are set up for this work with a focus on atmospheric chemistry involving furans. The project object is to optimize and also find the atmospheric process parameter, temperature and residence time. Comparison of results of the techniques of microwave irradiation with available literature. There are different catalyst is used to convert the xylan in to the veryuseful component of furan, in this work includs Comparison of efficiency and effect of solidcatalystPhosphotungstic Acid ($H_3PW_{12}O_{40}$) and ZSM-5.

Experimental procedure

Impetus and food segment xylan is dried at room temperature. This response was done of microwave illumination technique, in Anton standard monowave-300 microwave reactor. Microwave warming has the capacity warm the concoction mixes without warming the whole heater or oil shower, that demonstrates the sparing of time and vitality which is extremely temperate. It is additionally ready to warmth slender protests all through their volume, with legitimate uniform warming. Then again, because of the outline of most microwave reactors and to uneven assimilation by the article being warmed, the microwave reactors field is normally non-uniform and confined superheating happens. taking after procedur is followed amid the response:

1) Take required quantity of xylan and H2O/ 1-butenol solution.
2) Heated it under ambiant temperature and at a atmospheric pressure and stired it until the clear solution is formed.
3) The soluiton is filtered to remove the excess solid particles.
4) At that point suitable measure of impetus is added to the arrangement.
5) The reaction system is then trasfered to the microwave reactor subjected to Microwave Irradiation.
6) At specifidetemperaturs and specified time as per DOE the reaciton is carred out..
7) Samples were withdrawn after reaching the specified time and temperature. The cooling is provided also in microwave reactor, and cooled at atmospheric temperature.
8) Samples were analysed using HPLC.
9) After completion of reaction, microwave reactor was switched off.
10) All parts of reactor were cleaned thoroughly to remove all catalyst and reaction contents from vessel and other parts of the reactor.

The reaction vessel is containing 38 mg of xylan, 20 ml of (H2O/1-butenol) catalyst of specified dosages were added and then followed by MI at desired time and temperature. at first stage feed component is stired in reaction vessel untill the clear solution is formed. then the reaction vessel is put into the microwave reactor.

Microwave is an electromagnetic wave that has a frequency between 0.3 GHz and 300 GHz, shorter than that of a normal radio wave but longer than those of infrared radiation. It is used for heating in microwave ovens and in various industrial processes. Microwave heating is able to heat the chemical compounds without heating the entire furnace or oil bath, that indicates the saving of time and energy which is very economical. It is also able to heat very thin objects throughout their volume with proper uniform heating.

Experiments and results.

For samples, an HPLC method was employed, the samples were analyzed by HPLC (Agilent 1200) using an Agilent Eclipse xdb-C-18 column at the temperatutre 30 ºC. The samples were infused with a 20-μl circle and recognized with an UV Detector at 280 nm. The portable stage was acetonitrile/water (15/85 v/v) at a flow rate of 1 ml/m.

The effect of phosphotungestic acid the reaction the behavior like,as the temperature increases the conversion is also increases. The yield is higher at the higher temperature and as increase in the temperature the furan yield is also increases. The furan yield obtained from xylan increased with increasing temperature from 120º C to 180 ºC.also production is increased with increase in resedance time and catalyst to feed stock ratio increases also the furan yield is increase.

Exp. No.	Temp.(°C)	Time (min)	C/F ratio (mg/ml)	Yield%
1.	**120**	**4**	**1**	**29.63**
2	**180**	**4**	**1**	**36.21**
3	**120**	**10**	**1**	**32.53**
4	**180**	**10**	**1**	**56.77**
5	**120**	**4**	**9**	**44.5**
6	**180**	**4**	**9**	**61.72**
7	**120**	**10**	**9**	**59.92**
8	**180**	**10**	**9**	**71.97**
9	**150**	**7**	**5**	**54.32**

Tabel 1: Experiment table for reaction carried out with presence of phosphotungestic acid catalyst.

Exp.No.	Temp.(°C)	Time (min)	C/F ratio (mg/ml)	Yield%
1.	**120**	**4**	**1**	**20.19**
2	**180**	**4**	**1**	**24.70**
3	**120**	**10**	**1**	**23.58**
4	**180**	**10**	**1**	**24.95**
5	**120**	**4**	**9**	**29.84**
6	**180**	**4**	**9**	**30.3**
7	**120**	**10**	**9**	**31.63**
8	**180**	**10**	**9**	**32.89**
9	**150**	**7**	**5**	**27.8**

Tabel 1: Experiment table for reaction carried out with presence of phosphotungestic acid catalyst.

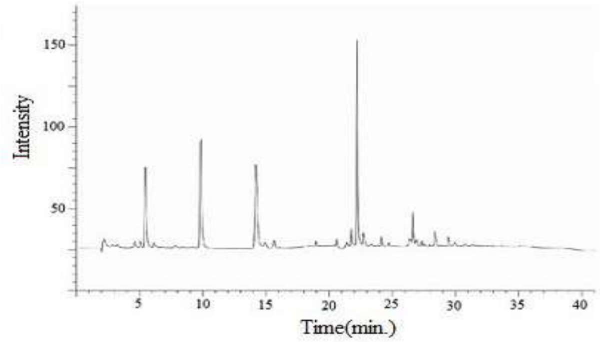

Fig 1: HPLC spectrograph of experiment no.8, Temp-180°C, residence time - 10 min, C/F ratio – 9 mg/ml.

Depolymerisation of xylan can be initiated in the presence of acid, alkali or enzyme catalyst at low temperatures (<140˚C), or in pure water conditions above 180°C. Xylan liquefies at relatively lower temperatures (180˚C-200˚C) compared to cellulose degradation which takes place at higher temperatures ~260˚C.

The duration to achieve 100% liquefaction of xylan varies in a wide range, from a few minutes between 190˚C-280˚C, to several hours for milder conditions between 150˚C- 170˚C. Therefore, by varying reaction conditions, different product compositions can be obtained.

Fig. 2: HPLC spectrograph of experiment no.8, Temp -180°C, residence time - 4 min, C/F ratio – 9 mg/ml.

This image cannot currently be displayed.

Fig. 3: Furan Yield Form Phosphotungestic acid and ZSM-5.

Conclusion

The difficulties connected with creating furan in an ecofriendly pathway keep on being of incredible significance for the reasonable development of biofuels. Upgrades in business procedures of furan generation can be achieved just when mineral corrosive impetuses are supplanted by more efficient and ecological benevolent impetus. The traditional processes for the production of furan were based on homogeneous acid catalysts such as HCOOH, CH3COOH, HCl, H2SO4, HNO3 and H3PO4 in aqueous solution. The production of furan from xylan with the help of H2O/1-butenol solvent, under microwave irradiation the phosphotungestic acid (H3PW12O40) catalyst performed a furan yield up to 71.97% and with ZSM-5 it is 32%.

References

1. Lacrimioara Senila, Mirela Miclean, Marin Senila, Marius Roman, Cecilia Roman, “New analysis method of furfural obtained from wood applying an autohydrolysis pretreatment”, Romanian Biotechnological Letters, Vol. 18, No.1, 2013.
2. David Martin Alonso, Jesse Q. Bond, James A. Dumesic, “Catalytic conversion of biomass to biofuels”, Green Chemistry,10.1039/c004654j 14th July 2010
3. Ying Zha, Peter J. Punt, “Exometabolomics Approaches in Studying the Application of Lignocellulosic Biomass as Fermentation Feedstock”, Metabolites, Metabolites 2013, 3, 119-143; doi:10.3390/metabo3010119.
4. Zehui Zhang, Zongbao K. Zhao, “Microwave-assisted conversion of lignocellulosic biomass into furans in ionic liquid”, Elsevier, Bioresource Technology,101 (2010) 1111–1114.
5. Luxin Zhang, Hongbing Yu , Pan Wang, “Solid acids as catalysts for the conversion of D-xylose, xylan and lignocellulosics into furfural in ionic liquid”, Elsevier, Bioresource Technology, 136 (2013) 515–521.
6. Badal Saha, “Hemicellulose bioconversion”, Society for Industrial Microbiology 2003, 30: 279-291
7. Venkatesh Chaturvedi, Pradeep Verma, “An overview of key pretreatment processes employed for bioconversion of lignocellulosic

biomass into biofuels", and value added products", 3 Biotech(2013) 3: 415-431

8. Lei Hu, Geng Zhao, Weiwei Hao, Xing Tang, Yong Sun, Lu Lin, Shijie Liu, "Catalytic conversion of biomass-derived carbohydrates into fuels and chemicals via furanic aldehyde diagram", RSC Advances, 2012, 2, 11184–11206
9. Talebnia, F., Karakashev, D. , Angelidaki, I. "Production of bioethanol from wheat straw: an overview on pretreatment, hydrolysis and fermentatiom", Bioresour. Technolgy: 101(2009), 4744–4753
10. Dhepe, P.L., Sahu, R. "A solid-acid-based process for the conversion of the hemicelluloses.", Green Chem. 12, 2153–2156.
11. Forstner, J., Unkelbach, G., Pindel, E., Schweppe, R. "Heterogeneously catalyzed production of furfural from xylose.", Chem. Ing. Tech, 84(2012) 503–508.
12. Lessard, J., Morin, J., Wehrung, J., Magnin, D., Chornet, E. "High yield conversion of residual pentoses into furfural via zeolite catalysis and catalytic hydrogenation of furfural to 2-methylfuran.", Bioresource Technology 2010, 56, (3), 52-67
13. Laser, M.; Schulman, D.; Allen, S. G.; Lichwa, J.; Antal Jr, M. J.; Lynd, L. R., "A comparison of liquid hot water and steam pretreatments of sugar cane bagasse for bioconversion to ethanol.", Bioresource Technology 2002, 81, (1), 33-44.
14. Singh, A.; Das, K.; Sharma, D. K., "Integrated process for production of xylose, furfural, and glucose from bagasse by two-step acid hydrolysis.", Industrial & Engineering Chemistry Product Research and Development 1984, 23, (2), 257-262.
15. Olsson, L.; Hahn-Hägerdal, B., "Fermentation of lignocellulosic hydrolysates for ethanol production.", Enzyme and Microbial Technology 1996, 18, (5), 312-331.
16. Root, D. F.; Saeman, J. F.; Harris, J. F.; Neill, W. K., "Kinetics of the Acid -- Catalyzed Conversion of Xylose to Furfural.", Forest Products Journal 1959, 9, 158- 165.
17. Kanetaka, J.; Asano, T.; Masamune, S., "New Process for Production of Tetrahydrofuran." Industrial & Engineering Chemistry 1970, 62, (4), 24-32
18. Lejemble, P.; Gaset, A.; Kalck, P., "Biomass to furan through decarbonylation of furfural under mild conditions". Biomass 1984, 4, (4), 263-274.
19. Kemp, J. L. C.; Hamilton, G. B.; Gross, H. H., "Furfural as a Selective Solvent in Petroleum Refining.", Industrial & Engineering Chemistry 1948, 40, (2), 220-227.
20. Palmqvist, E.; Hahn-Hägerdal, B., "Fermentation of lignocellulosic hydrolysates. II: inhibitors and mechanisms of inhibition.", Bioresource Technology 2000, 74, (1), 25-33.
21. Weingarten, R.; Cho, J.; Conner, J., W.C.; Huber, G. W., "Kinetics of furfural production by dehydration of xylose in a biphasic reactor with microwave heating." Green Chemistry 2010, 12, (8), 1423- 1429.

All Rights Reserved, @IJAREST-2015