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To Study Furfural Extraction From Bagasse

Ms. S. P. Nilapwar[1], Ms. S. S. Itankar[2], Mr. S.U. Patil[3], Mrs. V. S. Ghoderao[4]

[1] *UG Student, Chemical Engineering , J.D.I.E.T. Yavatmal, Maharashtra, India ,**shreyunilapwar@gmail.com***
[2] *UG Student, Chemical Engineering , J.D.I.E.T. Yavatmal, Maharashtra, India ,**shwetaitankar26@gmail.com***
[3] *UG Student, Chemical Engineering, J.D.I.E.T. Yavatmal, Maharashtra, India **shubhampatil2897@gmail.com***
[4] *Assistant Professor, Chemical Engineering , J.D.I.E.T. Yavatmal, Maharashtra, India, **vaishali_ghoderao@jdiet.ac.in***

Abstract

Bagasse could be stuff from the sugar trade that is sometimes used as energy supply in manufactory at the moment. However, the quantity of bagasse left continues to be high enough for additional added product for instance furfuraldehyde. Bagasse could be a sensible supply of pentosan and containing concerning twenty five to twenty seventh. The most objective of the analysis was to supply furfuraldehyde from pulp. The most staple for the assembly furfuraldehyde was pulp and a few chemicals/ingredients were used (H_2SO_4, water, NaCl). Furfuraldehyde is a vital organic chemical, created from agro industrial wastes and residues containing carbohydrates referred to as Pentosans. It's a basic chemical, which may be used during a form of industries like industry, purification refining industry, food trade and agricultural trade. In its pure state, it's a colourless or yellow oily liquid with the odour of almonds, however upon exposure to air it quickly becomes yellow then brown and at last black ,it is normally referred to as plant product.

***Keywords**: Bagasse, Furfural, plant product, and Pentosans*

I. INTRODUCTION

1.1. Furfural

The interest for manufacturing chemicals from renewable resources has redoubled within the last decade in direct reference to the declining reserves and increasing costs of fossil fuels. Bagasse is a waste product from the sugar industry, which is usually used as energy source in factory at present. However, the amount of bagasse left is still high enough for more value-added products. It also used as forage and raw material for production of pulp, paper making and particleboard. It has been reported that bagasse contains pentosan with concentration of 250-270 g/kg of the original bagasse, which mainly consists of arabinoxylan. Furfural is an important organic chemical, produced from agro industrial wastes and residues containing carbohydrates known as Pentosans. It is a basic chemical, which can be utilized in a variety of industries such as chemical industry, refining oil industry, food industry and agricultural industry.

It’s an organic compound of pyromucic acid. The world marketplace for furfuraldehyde is anticipated to achieve regarding USD 1200.9 million by 2020. The present value for furfuraldehyde is around USD 1,500 per weight unit. furfuraldehyde is very important as a result of it's a selective solvent for separating saturated from unsaturated compounds in crude refinement, gas, oil and diesel oil and for the high demand of its derivatives, particularly furfuraldehyde alcohol, that is employed as a basic element for organic compound resins. Furfuraldehyde (FF) may be a solvent created from plant pentosan (xylene, arabinan and polyuronids), the complicated carbohydrates contained within the polysaccharide of plant tissues. The merchandise has attracted some interest as a result of it helps within the practicability of changing the comparatively easy provides of lingo-cellulose feedstock (that is, the materials used for transformation in processing) into fermentation alcohol and higher-valued co-product chemicals. Fermentation of alcohol has faced viability issues with fluctuations in oil costs and sometimes terribly low oil costs particularly. Furfuraldehyde and its derivatives have attracted interest as a result of their higher-valued co-products that would build an fermentation alcohol plant viable Common sources of pentosans are corn/maize cobs (the main source), bagasse, paper-pulp residue, bamboo, kenaf, grain hulls, wheat and rice straw, nut shells, oilseed and wood (soft and hardwood). Feedstock for furfuraldehyde production are those with high pentosans content; potential furfuraldehyde yields for typical feedstock, expressed in kilogram of furfuraldehyde per ton of dry biomass, a 220 for corncobs, one hundred seventy for pulp, a hundred sixty five for cornstalks, a hundred and sixty for helianthus hulls, one hundred twenty for rice hulls and around 150–170 for hardwoods.

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Furfural could also be obtained by the acid catalyzed dehydration of 5-carbon sugars (pentose), significantly saccharide. These sugars could also be obtained from hemicellulose gift in lignocellulose biomass (plant matter) and in and of itself furfuraldehyde could also be thought of an inexperienced chemical. This synthesis is comparable to the assembly of hydroxymethylfurfural by the acid catalyzed dehydration of 6-carbon sugars (hexoses)

$C_5H_{10}O_5 \rightarrow C_5H_4O_2 + 3H_2O$

For crop residue feed stocks, between third and 100% of the mass of the initial plant matter are often recovered as furfuraldehyde, looking on the kind of feedstock. Furfuraldehyde and water evaporate along from the reaction mixture, and separate upon condensation. The world production capability is regarding 800,000 tons as of 2012. China is that the biggest provider of furfuraldehyde, and accounts for the larger a part of world capability. The opposite 2 major industrial producers Illovo Sugar within the Republic of African country and Central Romana within the state.

In the laboratory, synthesis of furfuraldehyde from corn cobs takes place by reflux with dilute acid. The lignocellulose residue that continues to be when the removal of the furfuraldehyde is employed to get all the steam needs of the furfuraldehyde plant. Newer and additional energy economical plants have excess residue, that is or are often used for co-generation of electricity, cows feed, atomic number 6, mulch/fertilizer, etc. It conjointly has been used as a glue extender within the North yank board trade

Recently, furfuraldehyde has been utilized in the food trade for flavorings purpose too. This paper offer data to extract and establish furfuraldehyde obtained from native helianthus hulls. It's typically referred to as ‘green chemistry within the sense that production of a chemical is achieved with a biomass. There a numeral of biomass resources, that embody wood and wood waste, agricultural crops and their waste merchandise, municipal waste merchandise, municipal solid waste, animal waste, waste from food process and aquatic plants and protoctist. Among these biomass sources, agricultural residue and energy crops a known nearly as good precursors for the assembly of biogas, bio-oil and bio-char fuels .Sunflower hulls by-product left when vegetable oil has been extracted from the seed. Helianthushulls supply various opportunities for bio-fuel analysis, significantly in bio-oil and biochar production. The target of changing biomass material to biochar or biochemical for varied application.

1.2. Properties

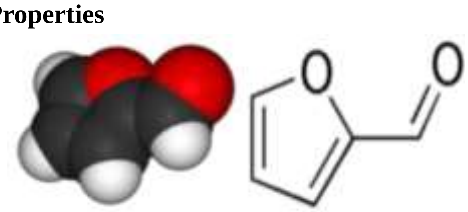

Fig.No.1 Molecular Formula of $C_5H_4O_2$

Furfural Physical Properties

1. Molecular Weight 96.08
2. Boiling Point(^{0}C) 161.7
3. Freezing Point(^{0}C) 36.5
4. Density at 25^{0}C 1.16
5. Refraction Index at 25^{0}C 1.5235
6. Critical Pressure (MPa) 5.502
7. Critical Temperature (^{0}C) 397
8. Solubility in water at 250C (%peso) 8.3
9. Dielectric Constant at 200C 41.9
10. Vaporization Heat (kJ/mol) 42.8
11. Viscosity at 250^{o}C (MPa) 1.49
12. Combustion Heat at 250^{o}C (kJ/mol) 234.4
13. Formation Enthalpy (kJ/mol) 151
14. Surface Tension at 29.90^{o}C (mN/m) 40.7
15. Auto-ignition temperature (^{o}C) 315

Furfural dissolves promptly in most polar organic solvents, but is simply slightly soluble in either water or alkanes. Chemically, plant product participates inside a similar styles of reactions as completely different completely different} aldehydes and different aromatic compounds. Indicating its diminished aromaticity relative to benzene, plant product is instantly modify to the corresponding characid hydro chemical compound derivatives.

When heated higher than 250°C, plant product decomposes into furfuran and monoxide, typically explosively. When heated within the presence of acids, plant product irreversibly solidifies into a tough thermosetting compositions.

Raw Materials	Pentosan Content (in %)	Furfural Yield in Industrial Operation (%)
Corn cobs	30-40	10
Bagasse	25-27	8-9
Cotton Hulls	27	8-9
Hardwoods	21-24	6-8
Beech bark	19-21	5-6
Rice Hulls	16-18	6
Sunflower Hulls	25	8-9

Table no.1 Furfural yield of raw material

3. Applications of Furfural and Its Derivatives

Furfural comes from monosaccharide, additional exactly from saccharide, through dehydration in acid medium. During this method, at the same time it obtained its alkyl group by-product 5-hydroxymethyl furfuraldehyde, in smaller quantity, and these compounds will be separated through distillation. This "impurity" from furfuraldehyde production will be used as a flavor agent in fine industry. Furfuraldehyde has many applications like antacids, fertilizers, plastics, inks, fungicides, nematicides, adhesives and seasoner compounds.

One amongst the various applications of furfuraldehyde is on hydrocarbons purification technology of C_4 and C_5 that was developed throughout the II war for hydrocarbon fabrication within the United States for synthetic rubber production. Through extractive distillation with furfuraldehyde, butadiene will be separated from different hydrocarbons and C_4 and C_5 severally.

TableNo.2. Furfural Main Derivatives

Derivatives	Production	Utilization
Furfuryl Alcohol	Fufural catalytical hydrogenation	Production of resins and tetrahydrofufuryl alcohol;intermediate in fragrances production, lysine and vitamin C
Furan	Furfural catalytic decarbonylation	Production of tetrahydrofuran and acetylfuran
2-methylfuran	Furfural and 5-methylfurfural decarbonylation	Solvent and monomer
Tetrahydrofuran	Furan hydrogenation	Industrial solvent, polymers, adhesives, pharmaceuticals products
Furfurylamine	Furfural reductive amination	Production of substances pharmacological with and pesticide activities
Furoic acid	Furfural oxidation	Synthesis of medication and perfumes
Levulinic acid	Acid hydrolysis of furfuryl alcohol, hydrolysis of acetyl succinate ester	Production of succinic acid and α-aminolevulinic acid
Succinic acid	Alcoholic fermentation	Food additive and synthesis of pharmaceuticals products

II.MATERIALS AND METHODS

2.1. Raw Materials :

1. Distilled water
2. Bagasse
3. Chemicals-

Hydrochloric acid (HCl)
Sodium Chloride (NaCl)
Chloroform ($CHCl_3$)
Hexane (C_6H_{14})
Sulphuric acid (H_2SO_4)

2.2. Raw Material Analysis

Before taking the run we performed some analysis on the feedstock-bagasse. i .e ash content and moisture content .In moisture content, moisture present in the feedstock would be determined. An oven was used for moisture content analysis at 100-200^{0}C. In ash content, the amount of metallic constituent present in the feedstock would be determined. A muffle furnace is used for ash content analysis at about 500^{0}C. The following table shows further analysis.

Table No.3: Raw Material Analysis

Sr. No.	Particulars	Amount (in %)
1.	Moisture Content	50

Size of feedstock: 300-600 µ

2.3. Procedure:

1

Hydrolysis of Bagasse With Sulphuric Acid (H_2SO_4)

Fig No.2: Experimental Setup

Fifty grams of dried bagasse(dried in the oven temperature of 100^{0}C for one to two hours) grind into minute particles of size 1 millimeter, 24.5ml of 1M binary compound H_2SO_4, and 75gm NaCl were introduced into a three-neck round bottom flask.

A fractionating column and a condenser were connected and the reaction mixture was heated and stirred with a stirrer. Distillation was ascertained when quarter-hour at the distilling temperature of 110^{0}C

The liquid was set to flow into a extraction flask containing 250ml chloroform. Two layers were fashioned with chloroform-furfural containing layer at the top and therefore the binary compound layer at the lowest of the flask.

The bottom binary compound layer was charged into reaction flask by a cone tube connected to the one in all the neck.

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Fig No.3: Furfural Oil

The high chloroform -furfural layer was subjected to the easy distillation unit to get rid of chloroform and a transparent yellow liquid remained.

Purification by distillation

Furfural can be freshly distilled and is best purified by simple distillation.

Fig No.4: Simple Distillation Setup

Procedure:

As we tend to obtain the extract layer of Furfural- chloroform from the chemical reaction method is subjected to the easy distillation.

During unit operation we've got to keep up the temperature at 61.2^{0}C that is the boiling point of chloroform .Because the low boiling purpose ether get filter out by condensation And the remaining one is our product i.e. Furfural.

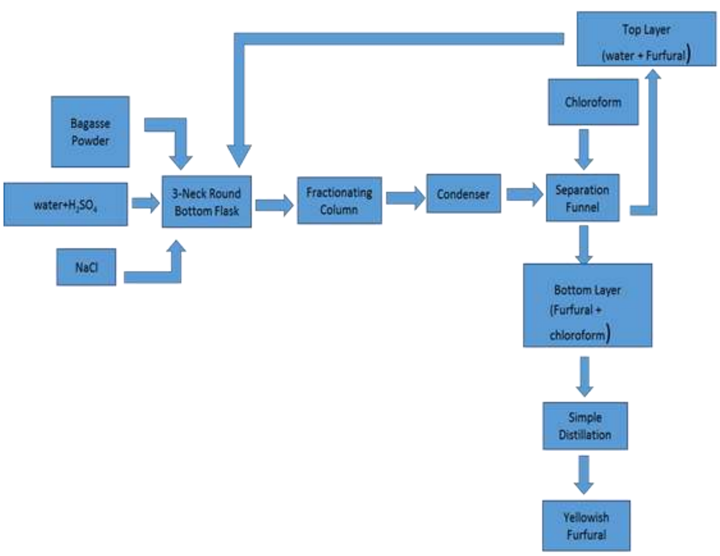


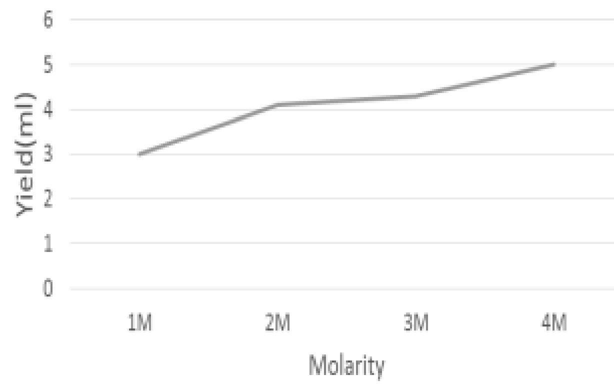
Fig No.5: Process Line Diagram

III. RESULTS AND DISCUSSION

The hydrolysis of bagasse with $H_2SO_4$and HCl was also performed with different concentrations of acid, with the method described above.

Table No.4: Effect of Acid concentration on Product Yield

Concentration(M)	Product yield (ml)
1M (HCl)	2
2M(HCl)	4.1
1M(H_2SO_4)	3.9
2M(H_2SO_4)	5



Graph:-Effect of Molarity on Yield

The chemical reaction of pulp was dole out victimization acid (HCl) and acid (H_2SO_4) of various concentrations. Results indicate that the load petrochemical of crude aldehyde isn't abundant affected once completely different acid concentrations were utilized. However, there was a small increase within the aldehyde production once oil of vitriol of 1M concentration was used. We have a tendency to compare the speed of chemical reaction of the various concentrations acid on the pulp. Therefore within the chemical reaction method, a shorter latency is achieved with used as catalyst. The optimum yield of aldehyde at 2M concentration of H_2SO_4 was found to be 5ml. Yield of aldehyde rely on the temperature, quantity of salt and time. Determined hydrogen ion concentration of the merchandise that is one in all the measured characteristics of aldehyde.

IV.CONCLUSION

The study was aimed at synthesis of furfural from bagasse. We find the alternative method for extraction of furfural by using hydrochloric acid and sulphuric acid. Yield of furfural depends on the temperature, amount of salt and time. As the molarity goes increases then the production of furfural oil increases. The optimum %yield of furfural at 2M molarity of HCl was found to be 4.1ml, The optimum %yield of furfural at 2M molarity of H2SO4 was found to be 5ml. Hence we concluded when increase the temperature, yield is increased. We observed that the colour was yellow which indicate the one of the characteristics of the furfural with almond odor. Also we observed pH of the product which is one of the measured characteristics of furfural therefore, the pH of the product that was measured in the laboratory was 1.26.

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