Int. J. New. Chem., 2020, Vol. 7, Issue 4, pp 296-302.

International Journal of New Chemistry

Published online 2020 in http://www.ijnc.ir/.

Open Access

Print ISSN: 2645-7237

Online ISSN: 2383-188x

Original Research Article

Optimization the Adhesive Production from Sugar Cane Bagasse

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Received: 2020-02-14 *Accepted: 2020-06-18* *Published: 2020-09-29*

ABSTRACT

The production of adhesive from sugar cane bagasse was performed in this study. The goal of this investigation was optimization of wallpaper adhesive production from sugar cane bagasse cellulose by experiments which were designed by full factorial method and carried out in a lab scale reactor with variations in reaction condition such as temperature, catalyst and feed concentration. The analysis of the results showed that the amount and quality of produced wallpaper adhesive is related to reaction condition. The investigation results showed that the optimum condition for removal of lignin from sugar cane bagasse is occurred at ammonia solution concentration of 30 percent and temperature of 150 centigrade. Production of water soluble carbohydrate was carried out by hydrolysis of deligninificated sugarcane in sulfuric acid solution at concentrations of 72 up to 68 percent and controlled temperatures from 20 to 25 centigrade. The results of quality investigations showed that the optimum glue formulation is occurred at carbohydrate concentration of 3 percent and borax concentration of 0.2 percent.

Keywords: Sugar cane bagasse, Adhesive, Bond strength, Drying time

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Introduction

Sugar cane bagasse is the main byproduct of sugar cane industry [1]. There are many different downstream industries that consume sugar cane bagasse. Producing wall paper adhesive from sugar cane bagasse was not under concern because carbohydrates- based adhesive are mainly produced from starch [2]. Adhesives are substances that are able to adhere or stick together without deformation or failure through a process called adhesion. Adhesives are categorized natural or synthetic. One of the main natural adhesives is based on carbohydrates. The most common carbohydrates adhesives are starch based adhesives. The main advantages of using starch for production of adhesive is its low price, availability and sustainability [3]. Despite these advantages, the cheap structural characteristics, low bond strength and low stability against ageing and fungal attack are some disadvantages of starchy adhesives. Cellulose-based adhesives developed to modify carbohydrates-based adhesive. The main cellulose-based adhesives are methyl cellulose glue. This adhesive has better application properties than starchy glue but it's, low bond strength, higher price and semi-synthetic production process make it undesirable. The aim of this study is the development of an intermediate low price wallpaper adhesive production process that possesses the application characteristics of all paper adhesives comparing with best commercial wallpaper adhesives in the Iranian market.

Experimental

The sugar cane bagasse was provided from Karoon Agro Industry Company which is located in Khuzestan province in south west of Iran [4]. The separation and purification of cellulose is carried out by using common alkaline Kraft process following the successive rinsing and filtering processes [5]. Then the purified cellulose fibber was dried to 10 percentage water content and then hydrolyzed in 72-68 percent concentrated sulfuric acid. The hydrolyzed cellulose was then extracted from the solvent and dried and milled to produce water soluble carbohydrate powder. To determine the optimum process conditions, the adhesive formulations were conducted at different mass of carbohydrate powder, water and the borax by using the experiment design method of full factorial and then stirred continuously until mixture becomes sticky. In these conditions the viscosity of the adhesive solution was around 1400 CP. The adhesives produced were applied on pieces of wallpaper and allowed to air dry and the bond strength was measured with drying time. The bond strength of different glue formulations were

determined according to ASTM method F-904. The viscosity of the suspensions was determined using the Brookfield viscometer [6]. After the optimization of the new adhesive formulation, the effect of drying time on the glue viscosity at optimum concentration and the effects of different glue concentration at the optimum borax to carbohydrate powder ratio on bond strength was investigated. At the last the characteristics of the new adhesive was compared with the characteristics of the two best commercial paper adhesives existing in Iranian market [7-9].

Results and Discussion

The carbohydrate powder produce in hydrolysis experiments was shown in figure1. This powder is completely soluble in water at low concentration and ambient temperature.

Figure1. Carbohydrate powder produced in hydrolysis experiments

The results of optimizing the new adhesive solution formulations were shown in table 1. The effects of adhesive and viscosity enhancer content on the bond strength of wallpaper adhesive can be seen in the table. Results show that the maximum bond strength was achieved at Adhesive concentration of 3 percent and viscosity enhancer of 0.2 percent [10-12].

Table 1. the results of optimizing the new adhesive solution formulations

Powder percent	Borax percent	Time percent	Bond strength(Pa)
2	0.1	3	55
2	0.1	15	670
2	0.2	3	93
2	0.2	15	840
2	0.3	3	97
2	0.3	15	1065
3	0.1	3	84
3	0.1	15	920
3	0.2	3	125
3	0.2	15	1100
3	0.3	3	125
3	0.3	15	1100

At this optimum conditions the bond strength was 1100 pa at drying time 15 minutes. The effects glue concentration on bond strength and the drying time on viscosity were shown in table2 and table. According to the results shown in table 2 and table3 the glue bond strength and the viscosity increases with glue concentration respectively and time. The results show that the increasing rate of bond strength is decreases while the viscosity increasing rate contentiously increases.

Table 2. Bond strength variation with glue concentration

Glue concentration (g/lit)	Bond strength (Pa)
3	1100
5	1400
10	1835
20	2060

Table 3. Viscosity variation with drying time

Viscosity (cp)	Time (min)
80	0
120	5
280	10
730	15
1400	20
2000	40

The results of measuring the application characteristics of two well-known commercial wall paper adhesives existing in Iranian market was shown in table 4. Comparing the quality of these two commercial wallpaper adhesives with the new adhesive shows that the application properties of this new product is in the range of the best standard commercial wallpaper adhesives while it costs around one third of this two commercial products.

Table 4. the test results of two commercial adhesives at their prescribed conditions

Adhesive name	Glue percent	Drying time(min)	Bond strength(Pa)
Sycifix	3	3	55
W&P	3	15	670
Sycifix	3	3	93
W&P	3	15	840

Conclusion

Production of wall paper adhesive from sugar cane bagasse was investigated. The effect of borax and carbohydrate powder concentration on characteristics of wallpaper adhesive was studied. The application properties of two commercial wallpaper adhesives produced by Chinese W&P and German Sycofix Company were measured based on their company directions. Comparing the experiment result the new adhesive produced from sugar cane bagasse possesses the required properties of commercial wallpaper adhesives.

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H**OW TO CITE THIS ARTICLE**

Mohammad Norouzi, Ehsan Darouneh, Tahereh Pirhoushyaran, "**Optimization the Adhesive Production from Sugar Cane Bagasse**" International Journal of New Chemistry., 2020, 7(4), 296-302. DOI: 10.22034/ijnc.2020.43442