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SYNTHESIS AND CHARACTERISTICS OF PVAC RESIN WITH PLASTICIZER FOR WOOD PRODUCTS

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ABSTRACT

The Adhesives industry is one of the most importance of PVAc Resin, especially wood product manufacturer .it has many advantages low cost, easy in appilication, minimal harmful in environment effects. However, The PVAc resin also having the disadvantages that it's bonding and viscosity was dependent the work condition get worse at the low temperature. For that phthalate-based plasticizer is used to complement these disadvantages, Bond strength and heat-resistance is weakened by without adding the plasticizer and in the low temperature. The plasticizer quantity should be increased. The properties rising viscosity, curing time reduced and the storage stability, water resistant was increased In addition to these the phthalate-based plasticizer to the PVAc resin. In this study has eliminated the disadvantages of PVAc resin emulsion and also adhesive use where the bond strength more and less for timber so that economy for carpenters .The synthesized PVAc resin for timber adhesion that is excellent in woodwork, thermal resistance, minimum film forming temperature, bond strength performance and storage stability.

INTRODUCTION

The industrial production of polyvinyl acetate homo polymer lattices began in Germany around 1935 and has continued to the present. Poly vinyl acetate emulsions are milk-white liquids contain 40-50% polymer solids, the balance being water and small amounts of emulsifiers, protective colloids, and other additives. Homo polymer lattices prepared with poly vinyl alcohol stabilizers are still among the main products of the adhesives industry. due to its excellent viscosity as a forming material since its glass transition temperature is about the room temperature (Yildrim Erbil, 2000) . PVAc monomer becomes a colorless transparent resin by polymerization if heated by adding a small quantity of benzoyl peroxide. On the other hand, if it is polymerized under the water, The monomer is emulsified from an aid of a surface active agent and polymerized by catalyst and heat. This emulsified and polymerized material appears to be milky white and is generally referred to as emulsion (Skeist, 1190; Pizzi, 1983). The properties of emulsion adhesives are not only determined by the polymerized monomers and also greatly affected by various plasticizers, fillers, protective colloids and additives that are added according to the type quantity and use of necessary surface active agent, and catalyst. Especially, the type and quantity of plasticizer greatly effects on the viscosity of adhesives. In addition to the adhesive woodworks such as for the assembly, boards of furniture, book binding, wood handicrafts and toys, they are also used for cloth and non-woven fabric. Also those copolymerized with acryl ate are available at low cost and have good durability properties. Emulsions copolymers of PVAc have found increasing use in more sophisticated adhesives, exterior and interior paints, carpet baking, adhesives for paper, and numerous other applications (Pizzi and Mittal, 2003; Kim, 2005).

Table 1 is shown advantages and disadvantages of with plasticizer and without plasticizer PVAc resin-based emulsion adhesive. the phthalate-based plasticizer to the PVAc resin. it's using environmental hormones is currently restricted in the advanced countries for its amount of use and also in the domestic market. So in this situation its necessary to prepare. This study has eliminated the disadvantages of PVAc resin emulsion and also adhesive use where the bond strength more and less for timber so that economy for carpenters. The synthesized PVAc resin for timber adhesion that is excellent in woodwork, thermal resistance, water resistance, minimum film forming temperature, bond strength performance and storage stability.

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Experimental

Material

Poly vinyl alcohol industrial grade has used partially hydrolyzed of 84%product Gh-17 r (Japan),Emulsifier used sodium laurel sulfate(Diachi karkaria ltd,India),vinyl acetate monomer(Aldrich)and sodium Bicarbonate (tata chemicals ltd),potassium per sulfate as a catalyst(Merck).and the Plasticizer was obtained from k l j polymers pvt ltd (India).

Synthesis of PVAC adhesives with plasticizer. Sample a sample B and sample C.

The emulsions were prepared by redox initiated free radical polymerization. The polymerization was carried out in a 1000 ml four necked round bottom flask immersed in a constant temperature water bath at 85^0c, equipped with reflux condenser, stirrer, dropping funnel and a nitrogen inlet. Deionized water, pva gh 17 r initially charge apply heat up to85^0c then agitate for 2 hours for hydrolyzed. Emulsifiers and buffer were initially charge and maintain under a constant agitation 90 rpm. Then approximately 25% of the initiators (dissolved separately in deionized water) were added and followed by the delayed addition of 5% the total monomer. The initiation occurred after 10 min with appearance of a light blue color. Then 75% of the monomer was added drop wise over a period of 4 hours. The balance initiator was added in eight equal parts during the reaction at regular intervals the temperature of the bath was then increased to 90^0c and stirring was continued for another 1 hour. The residual trace of mixture, if any, was removed by blowing nitrogen gas over the emulsion. all samples followed same method for sample B and Sample C. After completely checking the reaction, cool the contents down to the temperature of 50^OC or below and then add plasticizer of DBP.

Synthesis without plasticizer PVAc adhesives sample D, sample E, and Sample F

After synthesizing in the same way as A, B, C. and checking the reaction, cool the contents down to the room temperature no further addition .All samples A, B, C, D, E, and F. recipe are given in table 2. Solid content (%) has been kept within 30%-50% to adjust to the test condition of adhesive strength

Characteristic Tests

Physical Properties

Brookfield DV-E viscometer has been used for the viscosity and the measurement temperature has been set to 25degrees.For the solid content (%) W/W it has been dried at the temperature of 120 degrees for 1 and half hour. And the amount has been measured .The particle size has been measured by the dynamic Light Scattering particle size analyzer.

Test Sample Preparation for Bond Strength

For the test sample material, a wood –wood piece with the size of 25 mm×30 mm that has been dried up to the moisture percentage of 10% has been used. Affix together by applying about 150 g/m2 adhesive well-mixed in advance on both sides of adhesion and clamped the sample for load apply 10 kg/cm2. After removing the pressure, it has been left alone for 24 hours and tested for the Bond Strength wood- wood for all samples Measured by using a Steriline tensile tester Test Machine. Bond strength obtained in kg/cm2.

Minimum Film Forming Temperature (MFFT)

White glue After applying widely on the test plate (0-140c) on in the MFFT instrument, make a uniform membrane with a

Table 1. Advantages with plasticizer disadvantages wit out plasticizer of PvAc resin-based emulsion adhesive (Kim and Kim, 2006; Verma and Bisarya, 1986)

With plasticizer Advantages	The undiluted solution can be directly used while it requires joining time and cure. Its use is broad since various materials can be bonded. The poly vinyl acetate emulsion by adding plasticizer becomes flexible and spreadable. (4) it appears colorless and transparent after drying, no contamination is made on the material such as timber. (5) It can be easily mixed with plasticizer (DBP) and the drying film holds plasticity.
Without plasticizer Disadvantages	(1) Since it is thermo-plastic, it loses adhesive strength at a high temperature of 75oC or higher due to its nature of losing heat-resistance. (2) The speed of adhesion is slow on the paper (printing paper) with low absorptive property. (3) It cannot be used in outdoor due to its limited water-resisting qualities. (4) Since it cannot hold a heavy load for a long period of time, it is not suitable for a structural use.

Table 2. Composition of polyvinyl acetate emulsions (PBW)

Material	Sample A	Sample B	Sample C	Sample D	Sample E	Sample F
Water	420	360	282	420	360	282
P v a	18	18	18	18	18	18
VAM (Vinyl acetate monomer)	162	222	282	162	222	282
D.B.P (Dibutyl Phthalate)	5	7.5	9	0	0	0
Total Solids (%)	30.8	41	51	30	40	50

Table 3. Propertice of synthesized adhesives

Characteristics	Sample A	Sample B	Sample C	Sample D	Sample E	Sample F
Viscosity (cp)	26,000	32,000	48,000	25,000	30,000	46,000
Solids content (%)	30.8	41	51	30	40	50
Particle Size (µm)	5.22	5.31	6.39	5.27	5.41	5.52

thickness of approximately 0.3 mm by drying it while maintaining at the specific temperature and humidity. Check it visually whether the dried object is a uniform continuous membrane and the film was whitened.

chains. Plasticizer molecules being relatively small in size compared to polymer molecules penetrate into the polymer matrix and polar attractive forces between it and the chain segments.

Table 4. Minimum film forming temperatures of synthesized adhesives

	Sample A	Sample B	Sample C	Sample D	Sample E	Sample F
MFFT^0 (C)	>5	>4		>2	>6	>5	>5

Glass Transition Temperature (T_g)

Tg of the adhesives was determined by a DSC with TA Instrument Q-1000, with a scan rate of 10oC–1 over a temperature range of -50 to 100oC.

Particle Size

The particle size of adhesives was determined by using dynamic light Scattering particle size analyzer. Samples for particle size analysis were prepared by diluting adhesives obtained in de-ionize water. After dilution, the latex samples were then injected into the instrument.

Fourier-transform Infrared Spectroscopy (FTIR)

The FTIR spectra were recorded on a Nicolet 940 Fourier transform IR spectrometer about 0.5 gr sample is dissolved in chloroform of HPLC grade and made into a thin film transparent film and subjected to IR measurements at 400 to 4000 cm-1. The attenuated total reflection infrared spectroscopy was employed.

RESULTS AND CONSIDERATION

Physical Properties

The viscosity shown in the table 3 synthesized adhesives are more in case of Sample C and less in sample D. due to the plasticizer content adding to adhesives. Viscosity may differ in part from the type and use amount of Vam and generally, the final synthesized product comes out to be high in viscosity when a highly viscous relatively larger amount of Vam is used in the case of C. it has used more of a highly viscous so that hydrogen cohesion can be generated more between A and B, leading to high in viscosity. The non-plasticized synthetic resins sample D, E and F although they have used more Vam in comparison to A and B are synthesized in a similar viscosity within the range of 25,000~30,000 cps due to the influence of Plasticizer that is low in viscosity.

Glass transition temperature

The glass transition temperatures (T_g) of each synthesis resins are shown in Fig. 1. Plasticizers are low molecular weight non-volatile substances, which when added to a polymer improve its flexibility, processibilty and, hence utility. The plasticizer substantially reduces the brittleness of many polymers because its addition even in small quantities markedly reduces the Tg of the polymer. This effect is due to a reduction in cohesive forces of attraction between polymer

These attractive forces reduce the cohesive forces between the polymer chains and increase segmental mobility there by reducing the Tg value. While the T_g of polyvinyl acetate was not added a plasticizer generally appears to the 32^0-36^0C in case of D,E,andF.The addition of plasticizer A,B and C. makes a low T_g of 20^0C that is suitable to use by applying DBP, Although it is known to the make the resin with lower T_g as DBP added.

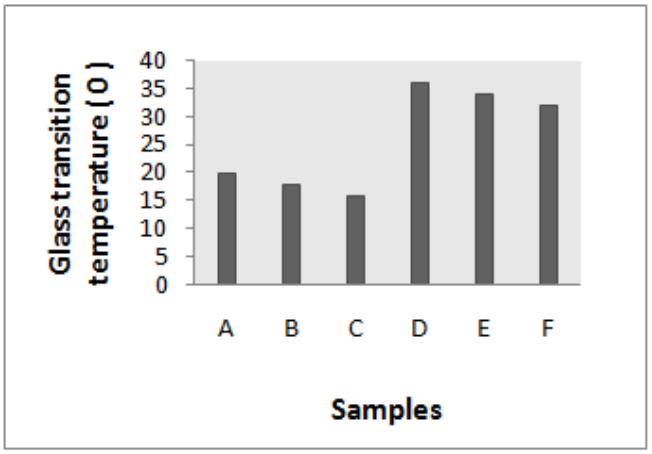


Fig. 1. Glass transition temperature of synthesized adhesives

Minimum Film Forming Temperature (MFFT)

The adhesive bond strength has to be bonded to the adherence by a forming a film as water volatilized .when we using the adhesives in the low temperature winter season the water is not volatilized and caught the film .the strength of the adhesive close relationship with temperatures. so that water starts to freeze is known to be the limit of using water-based adhesives. and the polymer to water inter molecular forces reduced by adding plasticizer MFFT becomes an important criterion whether water-based adhesive can demonstrate its adhesive strength by forming a film up to a certain degree of low temperature. As shown on the Table 4, the more plasticizer (DBP) is used, the better the lower-temperature MFFT property has come out; when using DBP .the low temperature MFFT property is more influenced by plasticizer.. It corresponds to the result of showing better lower-temperature MFFT property.

Bond Strength

Fig 2 shows the result bond strength shown in case of sample C more and less in sample D .the Plasticizer (DBP) is required to improve the physical resin properties as its amount of use

increases and this comes out to be a advantage in the perspective of adhesive strength. As shown sample A, B, and C that uses plasticizer appears to be lacking in the perspective of adhesive strength case of plasticizer, it is known to cause a property change in the adhesive strength because Inter molecular forces reduce between water and PVAc polymer.

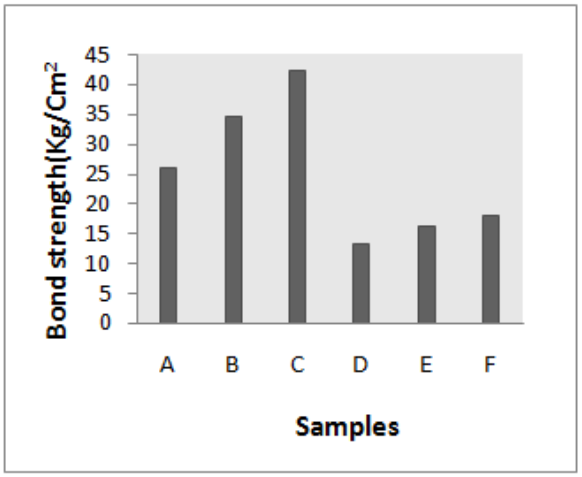


Fig. 2. Bond strength of synthesized adhesives

Storage Stability

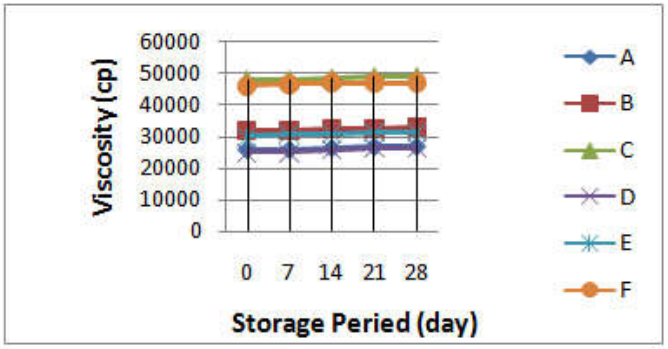


Fig. 3. Storage Stability of synthesized adhesives at room temperature

The non-plasticized synthetic resins D and E and f show relatively low adhesive strength in comparison to the synthetic products. All show the numbers of exceeding the limit that damages adhered. In the cases of D, E and F. For storage stability all synthesized adhesives keeping at room temperature for 1 month. This all resins were shown no significant different during storage period of 1 month at room temperature this resins showed good storage stability. The viscosity found by Brookfield viscometer there was light increased viscosity as shown by Fig 3.

FTIR Spectroscopy

The FTIR spectrum of synthesized adhesives obtained is shown sample A, sample B, and sample C PVAc with plasticizer. IR spectrums in fig 4, 5, 6.The band at 2950 cm-2940cm-1and 2875cm-1 were due to c-H strong bonding and Vinyl Acetate polymer were characterized. And the absorption peak 990cm-1and 1000cm-1 showed wave number of vinyl group. The appearance of peak wave number at 1240 cm-1 was phthalate groups resulted by adding DBP. The peak at 1065cm-1 showed primary alcohol bonding vinyl in it back bone structure. And the peak at 1740 cm-1 were acetate and ester functional groups are present.

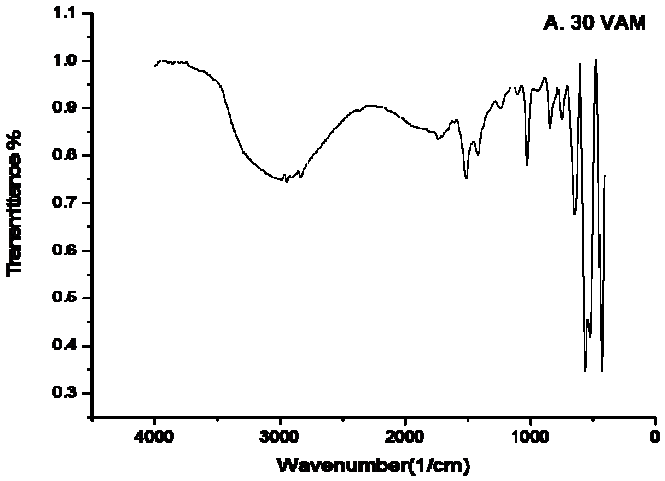
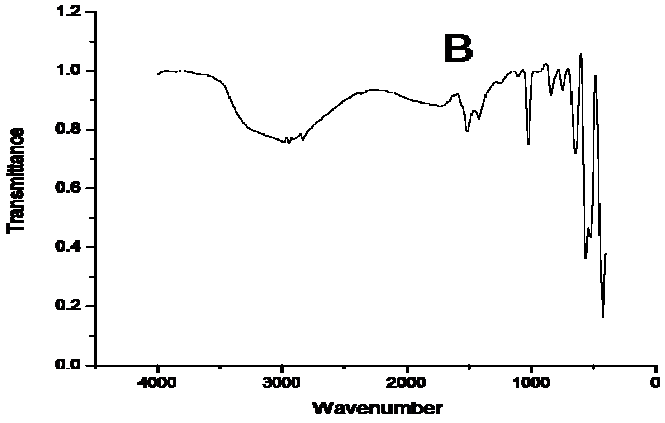


Fig. 4. FTIR spectrum of Sample A



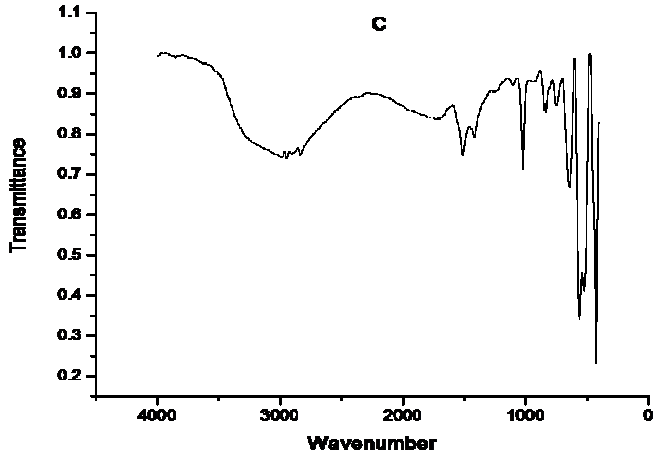


Fig. 6. FTIR Spectrum of Sample C

Conclusion

In this experiment, results obtained different solid content grades of adhesives with plasticizer and without plasticizer. Especially, the Bond strength can be greatly improved with high solid content and high plasticizer. We synthesized the PVAc resin adhesive of Tg below 20 0C and the physically flexible and brittle in appearence. The minimum film forming

temperature up to20c by adding DBP.and also carpenters can be used where the bond strength require priority for timber (wood veneer, finger joint, declaim). Its area of application bond strength is expected to get larger in the domestic market.

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