International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 4 Issue 8 ǁ August. 2016 ǁ PP. 14-16

Modification of resol phenolic resin by unsaturated polyester for improved mechanical properties

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Abstract: crued phenol formaldehyde resol resin is abrittle material due to an extensive three dimensional structure. formation of microvoids in crued structure result in inferior mechanical properties .in this study , un saturated polyester (UP) is used as a modifier for phenolic resol resin .tensile and impact strengths of the modified resin are compared with that of the neat resin . The SEM pictures of the fractioed surface are used to investigate the morphological changes on modification . The modified resin has fewer voids after crosslinking and possesses superior mechanical properties, especially impact strength.

Keywords: Resin, polyester, modified.

I. INTRODUCTION

Phenol formaldehyde resol resin is a thermoset resin and forms a three dimensional network structure on curing. The methylene bridges formed between the individual phenolic units make it abrittle material .Another drawback of resol resin is the formation of microvoids in the crued resin due to the escape/trapping of condensation byproducts in the material .The normal method of reducing the microvoids is by carrying out the cure process by heat and pressure. Open molding of phenolic resin creates a large number of microvoids even if the cure process is done in a controlled manner. Reinforcements like saw dusts, cotton linters, glass fibers, particular fillers etc. have also been employed for reducing microvoids and improving the properties of phenolic resin . polyols like ethylene glycol, glycerol etc. have been used as modifiers for microvoids and give transparent nature to the crued resin. Dicarboxylic acids with 6-10 carbon atoms can improve the properties of resol phenolic resin introducing these into the network structure.

II. MATERIAL AND METHODS

1,2 propylene glycol , maleic anhydride , phthalic anhydrite , xylene , triphenyl phosphate and glacial acetic acid (solid content ..50%) was obtained from M/S . polyformalin (p) , resol resin was neutralized with glacial acetic acid until the PH reached a va lue of ~7.0. it was then kept overnight for phase separation and the water layer was decanted off the resin was subsequently dried for 12 hours using a vacuum oven to completely remove the water.

Have observed that the optimal procedure for synthesis of UP is to initially react PA with the total stoichiometric amount of PG and subsequently react the product with MA . this procedure has been adopted for the synthesis . Ups with 4different maleic anhydride to phthalic anhydride (MA/PA) ratio (90/10 .70/30,50/50 and 30/70) designated as UP1 ,UP2 ,UP3 ,and UP4 respectively were synthesized (acid value ~26) .

Dried phenolic resol resin (R) was mixed with varying proportions of UP dissolved in methyl ethyl ketone using a mechanical stirrer for 20 minutes . the solvent was then removed by applying vacuum for about 45 minutes . The modified resin were designated as RUP1 , RUP2 ,RUP3 and RUP4 corresponding to each MA/PA ratio. since UP2 corresponding to an MA/PA ratio of 70:30 was observed to give the best properties when blended with phenolic resin , subsequent studies using polyesters of different acid values were limited toUP2 only . RUP2a –d represent various blends containing UP of different acid values namely 93 ,70 ,60 ,and 50 . The dried and degassed samples were then poured into atelfon mold fabricated as per ASTM standards and cured in an air oven according to the following temperature: 60ºC-2hours, 70ºC-15hours, 80ºC-2hours, 90ºC-1 hour, 100ºC-1 hours , 110ºC-1hour and 120ºC-2hours .

III. RESULTS AND DISCUSSION

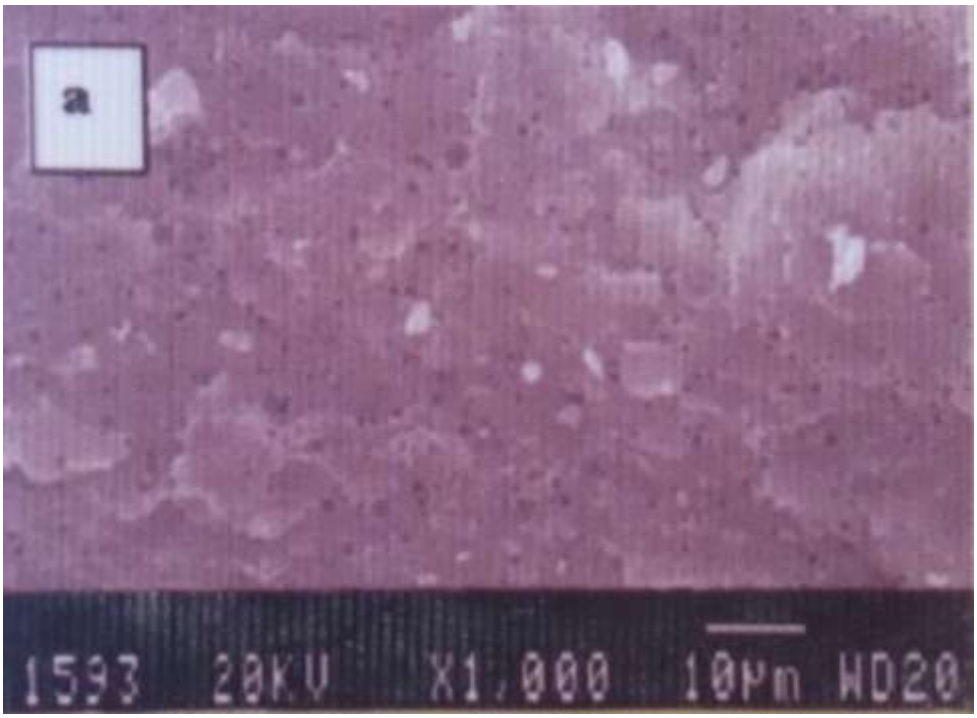
Table 1 Tensile and Impact strength of modified resin by UP with Varying MA/PA ratio

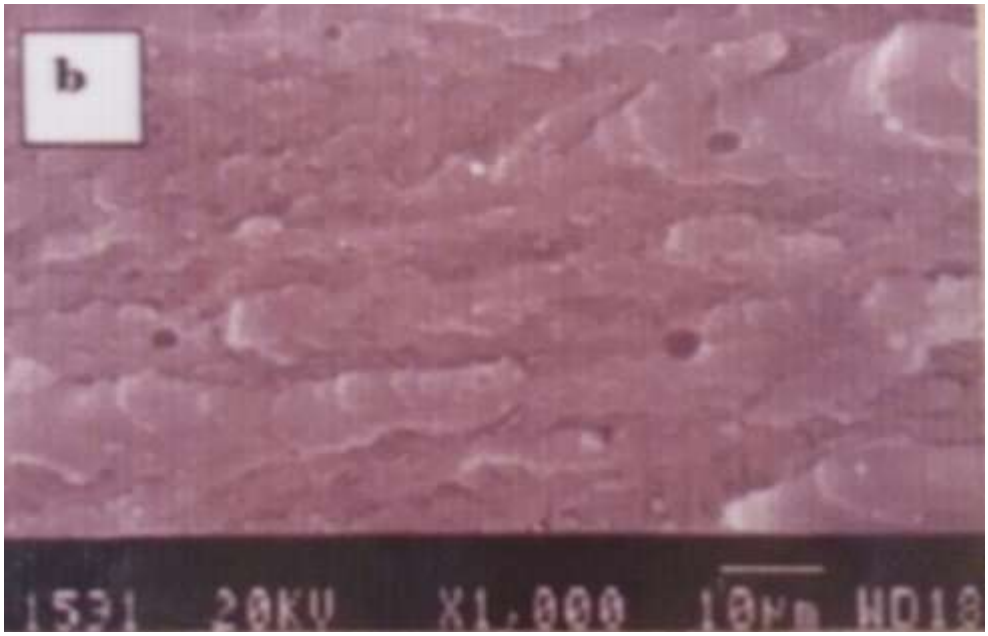
Modifier	Tensile Strength (MPa)					Impact Strength (KJ/m^2)				
	0	2.5	5.0	7.5	10.0	0	2.5	5.0	7.5	10
UP1(90/10)	26.0	29.2	31.8	33.2	29.1	47.4	56.4	75.7	114.4	110.4
UP2(70/30)		28.3	30.9	34.0	31.2		63.5	78.2	117.8	115.3
UP3(50/50)		28.5	30.8	31.8	30.6		60.2	74.8	111.6	109.1
UP4(30/70)		27.0	31.1	29.9	27.2		58.3	68.3	106.2	105.4

Table2 Tensile and Impact strength of modified resin by UP2 with varying acid values

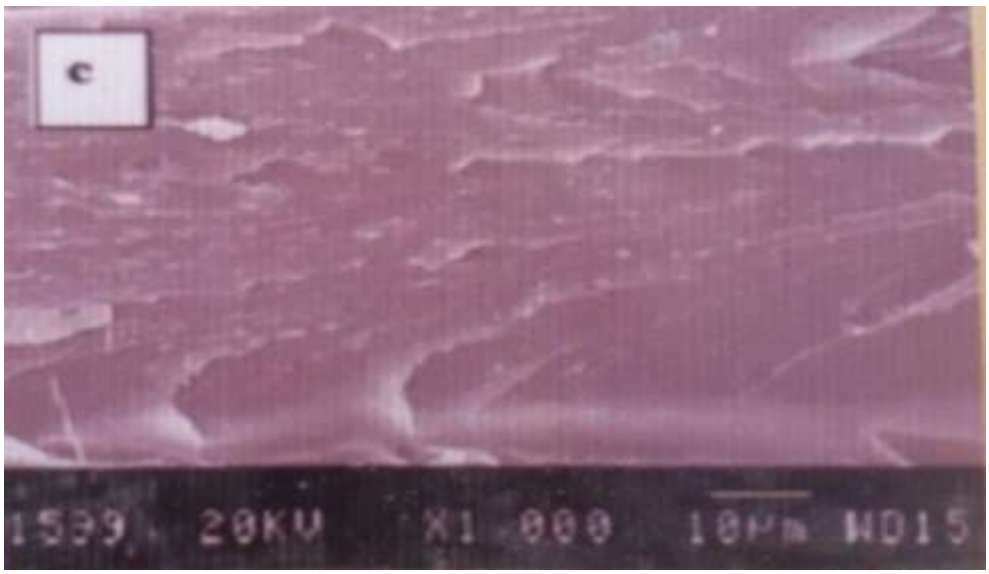
Modifier	Tensile Strength (MPa)					Impact Strength (KJ/m^2)				
	0	2.5	5.0	7.5	10.0	0	2.5	5.0	7.5	10
Up2a(93)	26.0	29.1	32.2	34.1	30.6	47.4	68.5	89.1	118.8	115.1
UP2b(70)		28.1	31.2	34.o	29.0		70.9	91.3	122.0	121.6
UP2c(60)		30.3	32.6	35.3	31.9		69.3	97.8	133.8	125.9
UP2d(50)		29.6	31.4	32.4	27.5		65.2	93.6	120.0	117.9

The variation in tensile strength and impact strength of modified phenolic resin with proportion UP having varying ratios of MA/PA is shown in Table 1 both the tensile strength and impact strength of the resin increased on modification with UP and show a maximum at 7.5% of UP content . Phenolic resin modified with UP2 shows comparatively better properties Higher number of UN saturation in UP may give more flexibility to the cured resin, but the properties show a maximum ratio at 70/30. This may be due to greater compatibility bequeathed by PA to the resin by virtue of more benzene rings in the structure.





UP



UP

IV. CONCLUSIONS

Phenolic resin can be successfully modified by UP resin. UP resin with MA/PA ratio 70:30 shows the best properties. The acid values of UP resin have also an influence in properties. The SEM picture of the fractured surface indicate that the modification leads to reduction in the micro voids as well as greater energy absorption.

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