Results of Thermal Analysis on Fibre Reinforced Plastic Matrix Composite Materials

Nilgün Becenen

***Abstract*---**In this study, two different types of resin as matrix and glass fibers in form of scrap, woven and felt as supplementary material were used in manufacturing plastic matrix composite material supplemented with fiber being used in tractor hood manufacturing. Fiber type and ratio was kept constant in the resulted samples and their situations were examined after they hardened at room temperature. The materials hardened at room temperature and one group was not cured and the other was exposed to post-curing process and then, they were tested on Q 800 TA Dynamic Mechanical Analyzer instrument. HDT values were determined according to ASTM E 2092-04 stand while Tg values were determined according to ASTM E 1640-04 stand. The results were reported after they were interpreted.

***Keywords*----**Composite, fibrere in forced, plastic matrix, thermal analysis.

I. Introduction

THERMAL analysis is a group of technique in which physical variations occurred in a matter during heating or cooling under control are measured and interpreted as a function of temperature [1]**.** Thermal analysis helps us in determining a matter's mass loss, transformation temperatures and energies, size variations and visco-elastic characteristics. T_g at which polymers are vitrified and the crystal melting temperature T_m are two important values determining usability of this matter. To use a partially crystalline polymer as a solid matter, operation temperatures should be kept below T_g and T_m. If the polymer will be used in form of rubber, the temperature should take place above T_g and below T_m. Polymers transform from solid state to liquid state at T_m and from solid state to elastic form at T_g [2], [3]. Differential Scanning Calorimeter (DSC) and thermo- gravimetric analysis (TGA) are the most frequently used techniques among thermal methods.

In this study, inexpensive ortophytalic polyester-base matrix material with sufficiently mechanical strength for tractors [4], [5].andBisphenol–A vinyl ester-base matrix material with higher chemical strength as well as inexpensive glass fiber satisfying the desired specifications as supplementary material were used. HDT and Tg values of the samples built under laboratory conditions were found through Dynamic Mechanical Analyzing Method, which is one of the thermal analyzing methods.

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One way variance analysis (ANOVA) method and Turkey test were applied to the results obtained in the experiments and interpretations were done based on statistical results.

II. Material And Method

A. Material

In this study, two different types of resin as matrix and glass fibers in form of scrap, woven and felt as supplementary material were used in manufacturing composite material. Also, certain chemicals like stiffeners and accelerators, normal drying oven, electronic balance and various test devices were employed in this study. Two different types of matrix resin were used. One of these is ortophytalic polyester being used for general purposes and the other is Bisfenol-A epoxy vinyl ester. A stiffener and an accelerator were used together for making process rapider.

B. Method

The composite samples built under laboratory conditions were manufactured by manually placing method on glass molds. First, ortophytalic-base and Bisfenol–A vinyl ester resins were reinforced with glass felt and prepared in 4 layers. The materials were hardened at room temperature and then, one group was not cured and the other was exposed to post-curing process and then, they were tested on Q800 TA Dynamic Mechanical Analyzer instrument. As a result, their HDT values were determined.

III. Results

Test results are given at Fig. 1., Fig.2., Fig. 3., Fig. 4., Fig. 5., Fig. 6., Fig. 7., Fig. 8. And TABLE I.

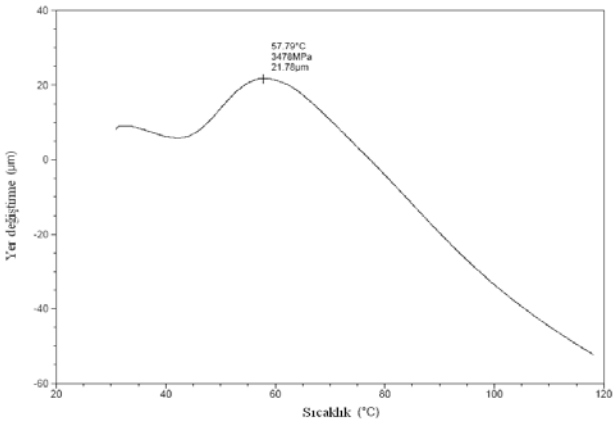

Fig.1 DMA test results of not-cured sample that reinforced with ortophytalic resin glass felt (HDT ^oC)

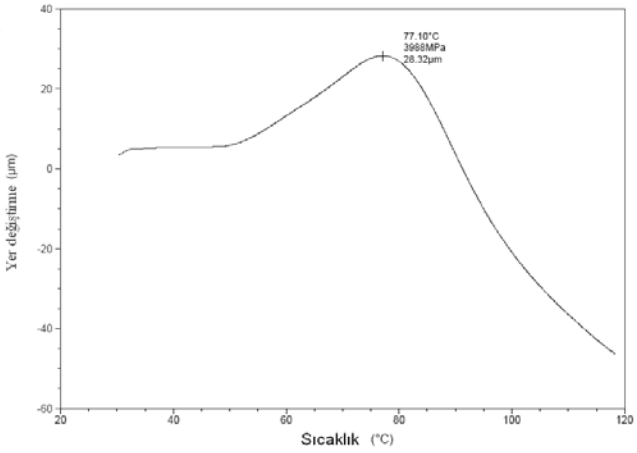

Fig.2 DMA test results of cured sample that reinforced with ortophytalic resin glass felt (HDT oC)

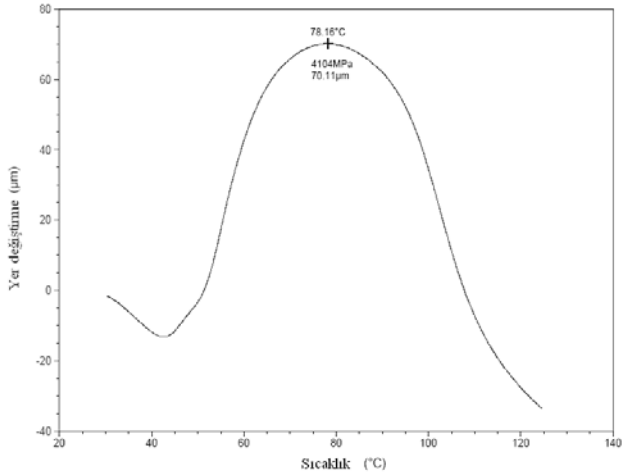

Fig. 3 DMA test results of not-cured sample that reinforced with vinly ester resin glass felt (HDT oC)

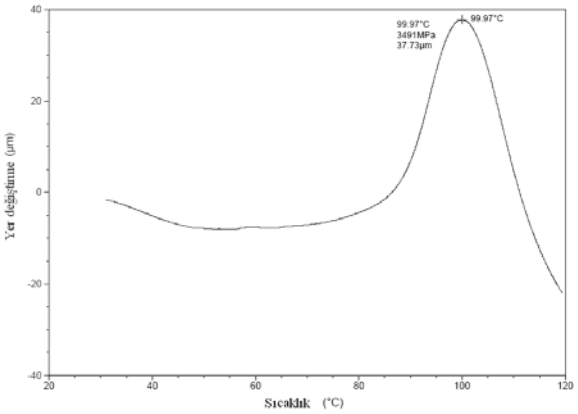

Fig.4 DMA test results of not-cured sample that reinforced with vinly ester resin (HDT ^{o}C)

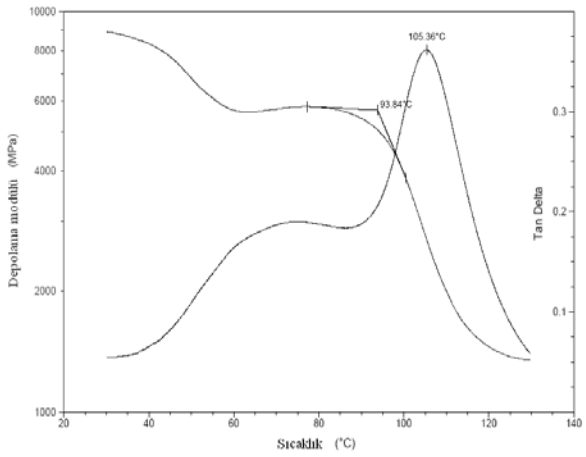

Fig.5 DMA test results of not-cured sample that reinforced with ortophytalic resin glass felt (TgoC)

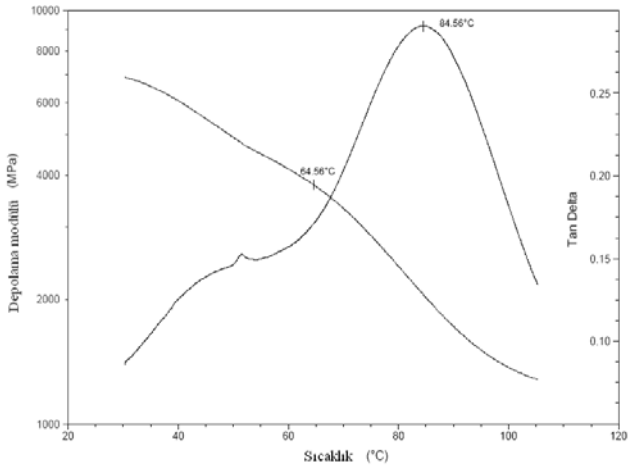

Fig.6 DMA test results of cured sample that reinforced with ortophytalic resin glass felt (TgoC)

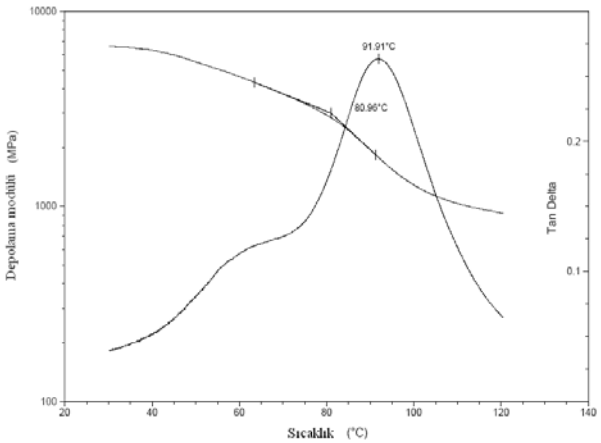

Fig.7 DMA test results of not-cured sample that reinforced with vinly ester resin glass felt (TgoC)

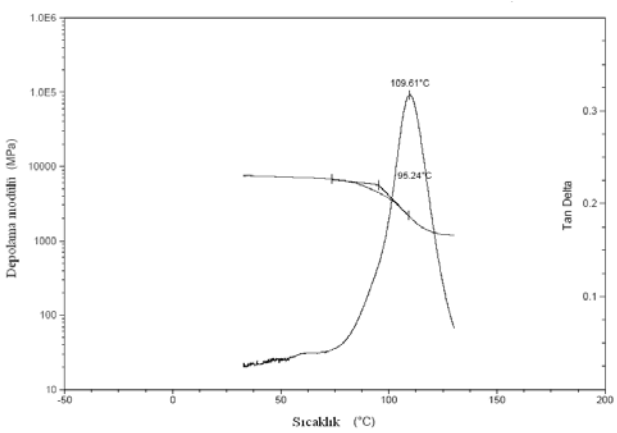

Fig.8 DMA test results of not-cured sample that reinforced with vinly ester resin (TgoC)

According to HDT values, fiber supplement reduced vitrified transition temperature (T_g) of epoxy. This reduction increased as fiber ratio increased even at lower proportions. However, variations in size of fiber did not affect Tg. Also, glass fiber addition increased thermal strength of the epoxy material and this increased as the fiber ratio increased. However, it was not affected by variations in size of fiber.The temperature at which the composite samples to decompose is 84.5 ^{o}C for ortophytalic resin and 109.6 ^{o}C for vinyl ester resin. Assuming operation temperatures of tractors range between 40 and 45 ^{o}C, both of the resins are suitable for tractors. However, considering operation conditions, it was observed that, vinyl ester resin is more suitable matrix for tractor hood parts due to its higher thermal resistance compared with ortophytalic resin.

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TABLE I
HDT AND T_G TEST VALUES

	Ortophytalic – not cured		Ortophytalic –cured		Vinil ester-not cured		Vinil ester- cured	
P (MPa.)	1.8	-	1.8	-	1.8	-	1.8	-
T (mm.)	2	2.1	2.07	2.07	2.05	1.9	2.02	1.98
W (mm.)	13.2	12.6	13.15	13.1	13.21	12.9	13.01	13.0
F (Pre-Load) (N)	1.26	-	1.36	-	1.33	-	1.27	-
D (mm.)	0.2	-	0.2	-	0.2	-	0.2	-
HDT ( )	57.8	-	77	-	78.16	-	100	-
T_g ( )	-	84.5	-	91.9	-	105.3	-	109.6

Nilgün BECENEN was born in Edirne TURKEY. She graduated from Yıldız Teknik University in 1989 and received her Ph.D. at Namık Kemal University in1989. She is a Assistant professor at the Vocational College of Technical Sciences of Trakya University.