An Investigation of Tensile Properties of the Bonded PS Specimens Produced by Bentonite Clay and PS Foam Reaction

Nurşen ÖNTÜRK,Sencer Süreyya KARABEYOĞLU

Abstract: *There are various methods for bonding Polystyrene (PS). PS sheets are able to be bonded with a material that is generated as a result of a chemical reaction between acetone and PS foam. By adding Bentonite clay in the process it is aimed to improve the mechanical properties of final bonded product. In this study PS sheets were bonded as a result of interaction between PS foam and Bentonite clay. Tensile tests were performed by using tensile test specimens produced with this bonding method.*

Key words: *Bentonite Clay, Polystyrene Sheet, Acetone, Bonding, Polystyrene Foam.*

Introduction

Polymer materials are commonly used in industry. Polystsrene, which one of these polymers, has a wide usage from food industry to machinery. Easy to form has made these materials advantages according to conventional materials but resistance to UV light and chemicals is very low [1-2]. PS materials reacting with acetone becomes a melted form. PS material dries and returns to its first solid form with the evaporation of acetone within a certain time. Besides PS forming pulp, as the result of chemical reaction, generates brittle material after drying [3].

Some additives are used for increasing of mechanical and physical properties of polymer materials. Composite materials made with these additives come together with polymer. Materials in the macro dimension[4]. Mineral materials and clays are commonly used within additives. Clays, which are so often come across, in nature take over with their heat and resistance properties besides their low casts. Bentonite clay is one of these. This clay, has swollen properties up to 8-10 fold of its volume in contacting with liquid, is frequently used with polymer materials[5-6].

Conventional methods like plastics extrusion and plastic injection moulding are used in production stages of composite materials[7]. But when laminated composite materials are wished to form, more different production technologies are used instead of these conventional methods[8.] One of these methods is to generate composite material by using adhesive between two or more sheets. Different materials are used here as adhesive element[9-10].

In this study, adhesive material was made with acetone and PS foam by adding different mass ratios of Bentonite clay [11]. The laminated composite was produced form PS sheets with the help of formed adhesive material. Tensile and hardness behaviour of formed laminated composite material were examined.

Material

As the foam material, the material produced fort the aim of insulation material was used. Technical properties of the used material are shown in table 1.

Table 1. Technical properties of the PS foam

Test	Test Method	Value (kPa)
Compressive Strength	EN 826	150-200
Density-Creep Rate	EN 1606	95-150

Technical properties of PS sheets used in the production of the laminated composite material are shown in the table 2.

Table 2. Technical properties of PS sheets

Test	Test Method	Value
Tensile Test	ISO 527	1,78 N/mm^2
Hardness Test	ISO 868	25-26 Shore d

Chemical properties of Bentonite clay used as additive material are given in table 3.

Table 3. Chemical properties of Bentonite clay

Chemical Properties	
SiO_2	61.28 %
$Al2O_3$	17.79 %
Fe_2O_3	3,01%
CaO	4,54%
Na_2O	2.70 %
MgO	2.10 %
K_2O	1.24 %

Method

By reacting PS foam with acetone the was adhesive material made. Mass ratios of test specimens are given in table 4.

Table 4. Mass Ratios of Test Specimens

Test Specimens 1	Test Specimens 2	Test Specimens 3	Test Specimens 4	Test Specimens 5	Test Specimens 6
20g PSF+0 B	20g PSF+3g B	20g PSF+ 5g B	20g PSF+ 7gB	20g PSF+ 9g B	20g PSF+ 11g B

Middle of laminated composite materials were also made by adding different mass ratios of Bentonite additive to this product. Sheet was cut in tensile sample dimensions by taking in to account of ISO 527 standard for preparing tensile test specimens from 3 mm thickness of PS sheets. Bottom and top PS sheets, which will make laminated composite materials, were combined with the adhesive material, obtained by reacting PS foam in acetone. The production stages are shown in figure 1.

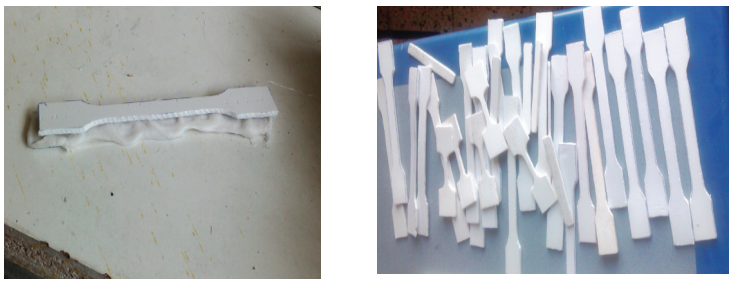

Fig. 1. Stages of Test Specimens

Results

Tensile test results of laminated composite materials generated by adding different ratios of additive materials. Tensile test results are given table 5.

Table 5. Tensile Test results of Specimens

NR	Rm(N/mm^2)	S0(mm^2)	L0(mm)
1	1,78	82,55	50,52
2	2,65	81,28	50,42
3	3,26	78,4	50,34
4	4,59	67,79	50,44
5	4,67	67,94	50,48
6	4,87	68,98	50,49

Hardness measurement values of experiment samples are given table 6.

Table 6. Hardness Test of Test Specimens

	T.S.1	T.S.2	T.S.3	T.S.4	T.S.5	T.S.6
PS Sheets	27,8	27,6	28,4	26,6	26,6	27
PS Foam	38,8	42,7	45,9	49,4	52,66	61,6

Conclusion

It was determined that test specimens, made with Bentonite added adhesive, had high resistance with increasing additive ratios and elongation at break decreased with additive ratios. As the result of hardness increased with increasing Bentonite material ratios. It was concluded that brittleness of middle laminated composite material increased with bentonite additive in experiment specimens.

References

[1] Ş. Uğur, A. Alemdar, Ö. Pekcan"Films formed from polystyrene latex/clay composites: a fluorescence study" J. Coat. Tech. Res., 2 (7) (2005), pp. 565–575.

[2] Miles, D. C., Briston, J. H., "Polymer Technology, Chemical Publishing" Co. Inc., New York, U.S.A, 1996.

[3] E.M. Kampouris, C.D. Papaspyrides, C.N. Lekakou," A model recovery process for scrap polystyrene foam by means of solvent systems" Conservation & Recycling, Volume 10, Issue 4, 1987, Pages 315-319.

[4] Hull, D. "An Introduction to Composite Materials", Cambridge University Press, 1992.

[5] M. Victoria Villar, Antonio Lloret" Influence of dry density and water content on the swelling of a compacted bentonite" Applied Clay Science, vol. 39 Issue 1-2 (2008), pp. 38-49.

[6] Liu, Q. Wu"PP/clay nanocomposites prepared by grafting–melt intercalation" Polymer, 42 (2001), pp. 10013–10019.

[7] Yu Chan, James L. White, Yasushi Oyanagi"Influence of glass fibers on the extrusion and injection molding characteristics of polyethylene and polystyrene melts" Polymer Engineering & Science, vol 18, Issue 4 (1978), pages 268–272.

[8] Shun-ichi Ohta,Hiromoto Nakazawa," Porous clay-organic composites: Potential substitutes for polystyrene foam "Applied Clay Science, vol. 9 Issue 6 (1995), pp. 425-431.

[9] M.Y. Tsai, J. Morton “An investigation into the stresses in double-lap adhesive joints with laminated composite adherends” International Journal of Solids and Structures, Volume 47, Issue 24, 1 December 2010, Pages 3317-3325.

[10] Dahsin Liu, Basavaraju B. Raju, Xinglai Dang “Impact perforation resistance of laminated and assembled composite plates Original Research Article” International Journal of Impact Engineering, Volume 24, Issues 6–7, July 2000, Pages 733-746.

[11] Fujita, T., Sugiyama, H., Adachi, M. and Nakazawa, H., “Strengthening of clay aerogel by use of additives”), Proc. 9th Int. Clay Conf. (1990). pp. 53-61.

For contacts:

Nurşen ÖNTÜRKq Namık Kemal University, Engineering Faculty of ÇORLU, Mechanical Engineering Department, Çorlu/TEKİRDAĞ-TURKEY 59860
Sencer Süreyya KARABEYOĞLU,Namık Kemal University, Engineering Faculty of ÇORLU, Mechanical Engineering Department, Çorlu/TEKİRDAĞ-TURKEY 59860

Докладът е рецензиран