



EFFECT OF WALL THICKNESS OF CENOSPHERES ON THE COMPRESSIVE PROPERTIES OF SYNTACTIC FOAMS

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ABSTRACT

Cenospheres are incorporated in polymeric materials to obtain composites of low density and high compressive strength, known as syntactic foams. Some studies on the modeling and experimental behavior of such composites are available in the literature [1-14]. However, no comprehensive studies could be found which characterize the behavior of syntactic foams with respect to various parameters like cenosphere wall thickness (density) and size distribution.

This experimental work investigates the effect of wall thickness of cenospheres on the compressive properties of syntactic foams. As the matrix material D.E.R. 331, a di-epoxy resin, manufactured by DOW Chemical Company was selected. This resin is called diglycidyl ether of bisphenol A (DGEBA). To lower the viscosity of the resin a diluent is added to it. It is difficult to mix large volume of cenospheres in the epoxy resin if the viscosity is very high. Adding 5% of diluent, C12-C14 aliphatic glycidyl ether, brings down the viscosity of the resin from about 9000 cps at 20°C to about 2000 cps at the same temperature. Average equivalent epoxide weight (EEW) of the diluent is 285. For a 95 wt% resin and 5 wt% diluent mixture the EEW is 177.5. A polyfunctional aliphatic amine, which is triethylene tetramine (TETA), C₆H₁₈N₄, is used as curing agent. This chemical is commercially known as D.E.H. 24 and manufactured by DOW Chemical Company. Molecular weight of this hardener is 146.4 and weight per active hydrogen is 24.4. Phr (parts per hundred parts of resin) of amine hardener for 95-5 resin-diluent mix was calculated to be 13.74. Stainless steel molds having inner dimensions of 9×9×0.5 in³ are used to cast the syntactic foams. Four different types of cenospheres were used for the fabrication of syntactic foam specimens. These microballoons were manufactured and supplied by 3M. Specimen size used for the test was 12.7×12.7×25.4 mm³. Compression test was conducted at constant crosshead movement rate of 0.5 mm/min. Minimums of five specimens of each type of syntactic foam were tested. Stress-strain curves for each type

of specimens are presented here [Figs. 2-5]. Trends of peak stress [Fig. 6] and modulus [Fig. 7] of the specimens with respect to cenosphere density are also presented.

FIGURES AND TABLES

Table 1. Particle size distribution of microballoons.

Ceno-sphere type	Average Particle Size (μm)	Top Size (μm)	Cenosphere density (g/cc)	Syntactic foam density (kg/m ³)
S22	35	75	205	493
S32	40	80	320	545
K37	40	85	380	575
K46	40	80	460	650



Fig.1. Compressive fracture behavior of syntactic foam.

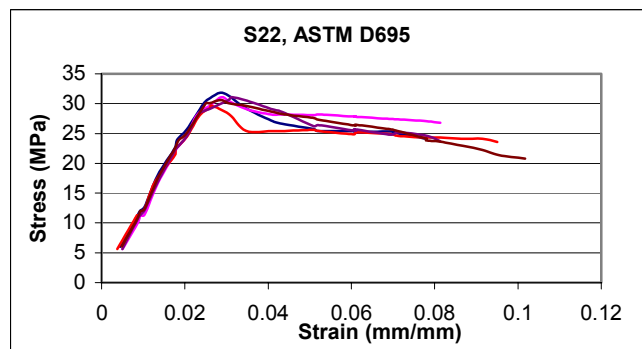


Fig. 2. Compression test results of S22 type syntactic foam.

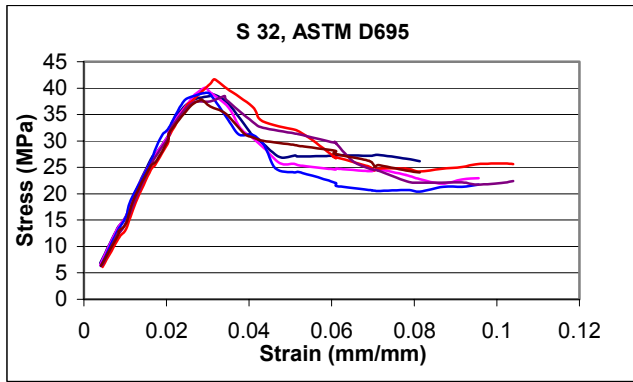


Fig. 3. Compression test results of S32 type syntactic foam.

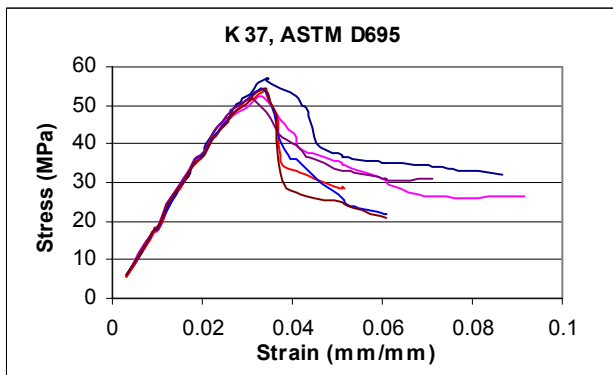


Fig. 4. Compression test results of K37 type syntactic foam.

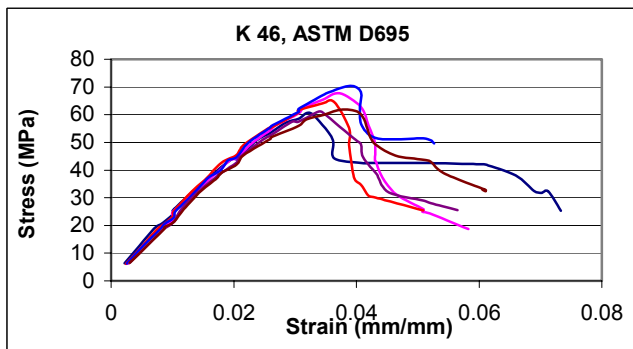


Fig. 5. Compression test results of K46 type syntactic foam.

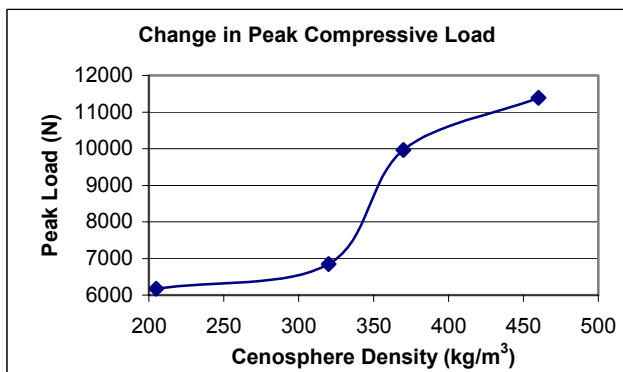


Fig. 6. Dependence of Peak strength of syntactic foam on cenosphere density.

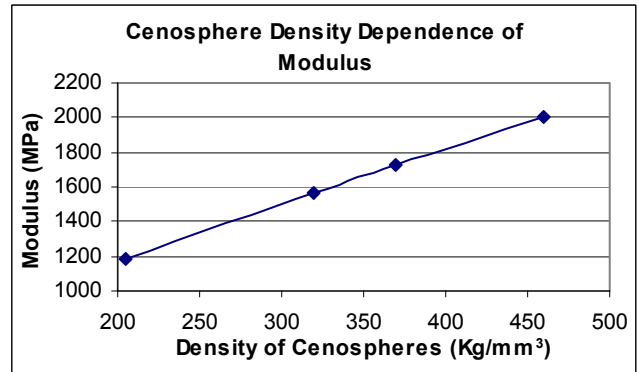


Fig. 7. Dependence of Modulus of syntactic foam on cenosphere density.

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