Ultrasonic Evaluation of the Fusion Level of Expanded Polystyrene Foam

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EXTENDED ABSTRACT

The quality of the metal parts produced using the lost foam casting (LFC) process has been shown to be a function of the properties of the expanded polystyrene (EPS) foam used in the process. As much as 90% of the problems associated with the LFC industry are believed to be direct results of problems with the foam used.

An important EPS foam property is its fusion level. This is a measure of how well the polymer chains have intertwined and / or joined at the bead to bead boundaries. Research has shown that fusion level does have a strong effect on mold fill times and thus an effect on the quality of the metal cast.

For the purposes of this research, a thru-transmission, low frequency ultrasonic testing technique was and is being used, though future plans are being made to incorporate a C-scanning, pulse echo apparatus. A correlation between fusion level and ultrasonic velocity in the foam is trying to be established. It is well known that sound velocity is a function of both the medium's stiffness and inertial properties. For solid media the stiffness property is a combination of Young's modulus and Poisson's Ratio and its inertial property is density. It has been shown that the stiffness of polystyrene is strongly dependant upon its fusion level.

Major difficulties in this research have resulted from localized property variations in the polystyrene - especially from variations of density. The presence of a density gradient makes it impossible to independently determine the stiffness of the foam using sound velocity measurements. Further work is being done to produce a test that will allow for the determination of localized density. The present focus of this task is on determining localized acoustical impedance. Once local density is known, local stiffness can then be evaluated.

Testing has shown that ultrasonic velocity can vary significantly across the area of a given foam plate. Typical sound velocities in the foam are on the order of 700 m/s and can vary 20-30% across a given plate. The target resolution for velocity and general property variation evaluation is 1 cm^2 but will be ultimately determined by the ultrasonic transducers available.