Wave Speed Propagation Measurements on Highly Attenuative Wax at Elevated Temperatures

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Ultrasonic stress wave amplitude and time-of-flight values change drastically as a media is heated. The measurement of relatively small variations in velocity and material attenuation can detect and quantify significant variations within a material microstructure. This paper discusses experimental setups, ultrasonic wave speed tracking methods and signal analysis algorithms that document the changes within highly attenuative wax material as it is either being heated or cooled from 25˚C to 90˚C. The experimental set-up utilizes ultrasonic probes in a pulse-echo and through-transmission configuration. The ultrasonic waveforms are recorded and analyzed during long duration thermal experiments. To complement the ultrasonic data, a Discontinuous-Galerkin Model (DGM) was also created which uses unstructured meshes to determine how waves travel in these anisotropic media. This numerical method solves particle motion travel using partial differential equations and outputs a wave trace per unit time. Both experimental and analytical data is compared and presented. Finally, the paper describes a series of additional experiments that are currently under investigation which will aid code development to adjust for density variations.

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