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Transient acoustic wave in self-similar porous material having rigid frame: Low frequency domain

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Highlights

- â€¢ Acoustic of Fractal porous material.
- â€¢ Fractal dimension.
- â€¢ Permeability.
- â€¢ Non-integer dimensional space.
- â€¢ Time domain wave equation.

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Abstract

This study concerns the acoustic wave diffusion in fractional dimensional rigid porous media in the low frequency domain. An equivalent fluid model with a non-integer dimensional space is developed using the Stillingerâ€“Palmerâ€“Stavrinou formalism. A generalized lossy diffusive equation is derived and solved analytically in the time domain. The coefficients of the diffusion equation are not constant and depend on the fractional dimension, static permeability and porosity of the porous material. The dynamic response of the material is obtained using the Laplace transform method. Numerical simulations of a diffusive wave in porous material with a non-integer dimensional space are given, showing the sensitivity of the waveform to the fractional dimension. It is found that the attenuation of the acoustic wave is more important for the highest value of the fractional dimension d. This result is especially true for resistive porous materials (low permeability value) and for large thicknesses.

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Keywords

Fractal porous material; Acoustic propagation; Fractional dimension

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