Can a perfectly matched layer be mimicked with a porous medium?

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Abstract:

An earlier publication [D. K. Wilson and M. B. Muhlestein, *Proceedings of Meetings on Acoustics* 39, 045004 (2019), https://doi.org/10.1121/2.0001208] discussed the possibility of designing the properties of a porous material to mimic a perfectly matched layer (PML). (A PML is a numerical construct, providing essentially zero reflection and rapid attenuation in space.) The formulation for the acoustical properties of the medium was based on the relaxation model, from which it was shown that setting the ratio of the vorticity and entropy shape factors to $\sqrt{N_{pr}}/(\gamma-1)$, where N_{pr} is the Prandtl number and γ the ratio of specific heats, the impedance becomes real-valued while the medium remains attenuative. However, this pore-shape factor ratio is approximately 2.1 in air, whereas it appears that for typical pore geometries it must be bounded between 0 and 1. Therefore the PML-like condition does not appear to be physically realizable. In this presentation, we summarize the previous derivation and discuss whether extensions to closed-pore geometries are capable of producing the desired pore-shape factor ratios larger than one.