The Frits Riddle
or
How to Measure Fluid Thermal Conductivity at Vanishing Convection

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Motivated by rather obscure experimental results on the thermal conductivity of saturated sandstone, we tried to elucidate these findings by performing comparative runs on a model porous-medium but with the same fluids. These investigations on glass sieves, so-called frits, reconfirm the initial results but also made the situation more involved. While trying to solve what we call 'The Frits Riddle', we indirectly determined the thermal conductivity of the fluids at vanishing convection, by means of a frit. Our results on sandstone and those from at least one other group [1], reveal that the thermal conductivity is higher when the stone is saturated with a liquid instead of a gas though both fillers are of similar thermal conductivities. So far, there are many conjectures for this artifact but none really convinces. Frits are of a much simpler pore structure than sandstone. They are available in various porosities and pore sizes. The transient hot-bridge (THB-) sensor that we used for the investigations offers short testing times, a constant thermal penetration depth and small temperature rises. The latter fact reduces radiative heat transfer while the small pores of the frits impede convection of the filler. We tested five different frits of pore sizes between 500 µm and 1 µm and with four different porosities (32%, 40%, 42%, 50%). Each frit was successively saturated with six liquids and five gases. At pore sizes below 40 µm, the above mentioned findings on sandstone were confirmed. However, at larger sizes, the exact opposite results were obtained, i.e., within the overlap region, the thermal conductivity of the gas-saturated frits now is higher.

[1] W. Woodside and J. H. Messmer, *J. Geophys. Res.* **65**:3481 (1960).