Manuscript PF#POF22-AR-04097:

Referee Comments:

Referee #1 (Comments to Both Author and Editor):

This manuscript discusses the experimental determination of the permeability of porous media and attempts to identify and minimise sources of error. Experimental results are compared with numerical permeability values obtained from flow simulations based on detailed representations of the porous specimens. The agreement between experimental and numerical values is generally good.

The characterization of flow of viscous fluids in porous media is an important problem in a number of engineering disciplines. The accuracy of experimental methods for permeability measurement is a topic of ongoing discussion in the composites community, where the impregnation of fibrous reinforcement materials with liquid polymer resins is a problem of high practical relevance in the manufacture of lightweight components. A series of papers on issues related to the reproducibility of permeability measurements has been published in the last 10 years (e.g. Yong et al. 2021).

The scope of this study is limited, as only permeability measurement in uni-directional flow is considered. There are more advanced experimental methods which allow the permeability tensor of (anisotropic) porous media to be determined in a single experiment. <- Well, if porous media is isotropic, then uni-directional flow measurements are sufficient to determine its permeability. And the corresponding tensor will have only diagonal identical components. Moreover, the type of experiment we perform is a standard procedure for the permeability estimation in many applied fields (**Reply1**)

The first impression when reading this document is that the text is very disjointed, which makes the document hard to understand. It seems that sections of the text have been moved (to the different appendices) after the document had originally been written. However, the numbering of figures etc appears not to have been updated. Hence, the numbering of figures is inconsistent. The first figure referenced in the text is Fig. 10, which can be found on page 23(!) Also, important information is missing from the main text. I am not sure if all appendices are referenced in the text. Within each figure, parts a, b c etc seem to be arranged randomly, which adds to the confusion. The text in the appendices is too long. A scientific paper needs to present all relevant information, but also needs to be concise and not unnecessarily long. We will address this point.

One of the main points made in the manuscript relates to the set-up of experiments for permeability measurement, specifically the diameters of tubes and specimens and the placement of pressure sensors. What is never really mentioned is that Eq. (1), i.e. the 1D formulation of Darcy's law, is only valid for uni-directional flow (please see Reply1). If this equation is used for non-unidirectional problems (e.g. experimental set-ups with different diameters of tube and porous specimen), the obtained results will be incorrect. Equation (1) assumes also that the pressure drop in the specimen is linear. Even if what is called "internal pressure ports" are used, the result may still be inaccurate if the pressure drop is non-linear. The only way to avoid this is using tubes and specimen of identical diameter. But this seems trivial and does not justify publication of a research paper. This is the main issue: the point in the manuscript is *almost* trivial. In our work we refer to the industry standards (ASTM D5084 and D5856) where there is no single phrase about the ratio of the specimen and connecting tubes. Also, we work at petroleum center and deal with commercial equipment for permeability estimation. It is designed according to industry standards, has very different specimen and tube diameter ratios (e.g., 1:24, Fig. 6G), and relies on one-dimensional Darcy's law.

It seems surprising that the authors attribute a noticeable temperature change to viscous dissipation, as the flow velocity is very low(?) Can it not be that there was heat transfer from the pump to the fluid in the syringe? As can be seen from the figures 1A and 15E, there is no heat source available, and the fluid is pushed by a syringe which is equilibrated with the room temperature within ~0.05C.

On page 5, it is implied that a 1 % change in temperature resulted to a 15 % change in the viscosity of the test fluid. Would it not have been better to select a test fluid that is less sensitive to temperature variations around the target test temperature? This point is discussed in Apx. A1. Such a fluid would have smaller viscosity and the corresponding pressure drop will be out of the working range for our pressure sensors.

It is mentioned that the pressure loss in the flow channel used for permeability measurement is 9 % of the system with sample. The equivalent permeability of an empty circular (straight) tube is d^2/32, where d is the tube diameter. Here, the diameter of the tubes is 9 mm. Hence the equivalent permeability is 2.53E-6 m^2. The authors state that the measured permeability of the specimens is in the order of 1E-10 m^2. As the pressure drop is inversely proportional to the permeability, the pressure loss in the empty flow channel would be expected to be 1/10000 of the pressure loss with specimen(?) Here Referee1 mixes tubing1 of 1.73mm diameter, and the tube2 confining the glass beads (9mm in diameter), Fig. 1A,C. 9% parasitic pressure losses originate from the pressure loss in the smallest tube (tubing1) but not tube2. Additionally, Referee1 operates with different characteristic lengths for permeability dimensionalization: tube diameter for tube2 and bead diameter for tube2 with glass beads (sample) inside — this is incorrect.

In summary, publication of the manuscript in its current form cannot be recommended, as the document is not prepared to the standard required for publication, some statements seem unclear and the main points made here appear not sufficiently original.

Some detailed questions/comments: <- will be addressed in the next submission

There should not be any references in the abstract.

Page 2

What are the links between the Darcy and Stokes equations?

Page 2

What does the characteristic length relate to?

Page 3

Appropriate definition of boundary conditions is critical in flow simulations.

Page 3

Without any further explanation, it is not clear what the pressure port placement refers to.

Page 3

Presumably, 0.5 mm is the diameter of the glass beads(?)

Page 4

Why is the Sauter mean diameter used here, not the average measured diameter?

Page 5

A rheometer is mentioned here, but it is not explained how it was used or why it is important.

Page 6

Is the suppression of "various CT artefacts" not somewhat subjective?

Page 13

If the flow rate is the same everywhere, the total pressure drop must be the sum of local pressure drops.

Page 14

"60 / 9 mm = 6.7"? Should it read "60 mm / 9 mm = 6.7"?