

**Review “A pulse-decay method for low permeability analyses of granular rock media”  
By Zhang et al.**

**Scientific significance:**

The manuscript presents a comprehensive and meaningful evaluation of different solutions for determining the gas permeability of granular rock samples. The authors derive different solutions and discuss their application to different experimental parameters and their overall applicability. Their work provides a significant contribution for a detailed analysis of pressure (pulse) decay curves to derive the permeability of low permeable (nD) rocks.

**Scientific quality:**

In general, the quality is considered good. Their derivations of constitutive equations as well as analyses and parameter studies show important relations.

**Presentation quality:**

The manuscript is well-structured and mostly concise. Some redundancies and confusing sentence structures are listed below. Only one major concern is raised here: At multiple locations in the main manuscript, the authors are referring to the appendix. This is not only the case when referring to large mathematical derivations but also when referring to fundamental equations used for calculations of parameters analyzed. In addition, large parts of the experimental procedure and data are moved to the appendix; I consider this however relevant for understanding the application of the theory (the derivations of solutions to determine permeability). Many times, important information is denoted in parenthesis; for the reason of concision and readability, I suggest including the information in the sentence structure. To some extent, the text would benefit from proofreading with special attention to sentence structure and the use of English wording.

In conclusion, I consider moderate revisions by addressing the detailed comments below and by changing the structure of the manuscript in such a way that important parts of the appendix will be included to the main manuscript. In particular, important equations and figures should be shown to make the manuscript comprehensible to the reader.

**In-text comments:**

Line 23 – 25: “Nano-darcy level permeability measurements ... are only practically feasible with gas invasion methods into granular-sized samples with short diffusion lengths and thereby reduced experimental duration;...” → This is a very strong and exclusive statement that I would not agree with. There are different (gas permeability) testing methods that work for low-perm materials. I suggest rephrasing the sentence in such a way: “Nano-darcy level permeability measurements ... are frequently conducted with gas invasion methods into granular-sized samples with short diffusion lengths and thereby reduced experimental duration;...”

Line 70: “(e.g., 254 cm in diameter)” → I consider the additions info about sample size not relevant in this sentence since the size depends strongly on the experimental setup and might vary. If still needed I suggest using “consolidated cm-sized core-plug samples”

Line 81: “confounding” → is this the appropriate word here?

Line 92: It is somehow confusing where the mesh size/range comes from. Is there a conversion from mesh size to mm? Reader who are not familiar with the specs of this device might be confused.

Line 108: “The rest of this article is organized as follows.” → redundand, can be deleted

Line 150: Reference error

Line 161 ff. Multiple times in the manuscript, the references are written twice.

Line 198: “... each solution holdS only ...”

Line 208: “ ... helps TO select ...”

Line 213 – 215: To my opinion, no need for recalling the definition of  $K_c$  again.

Line 221: delete “plotted in”

Line 223 & Fig. 1: the authors are referring to numbers not visible in the plot. I suggest to extend the x-axis to the point in the plot they are referring to.

Line 249: “...for  $K_c$  equals to 10,50 are...” → rephrase: “... where  $K_c$  equals 10 or 50 are ...”

Line 259: “... a minor difference but become very close ...” → I don't entirely understand what is meant here. Please rephrase and carify.

Fig. 2(b): I suggest using a different color scheme since the light blue is hardly visible.

Line 291: Replace “happen” by “occur”

Line 297-298: “For example, ...”. This is not a complete sentence; please, rephrase.

Line 302: “600s around for 0.1 nD” delete around

Line 305: I suggest removing the parentheses and adding the info to the sentence.

Line 327 ff: add space between equal sign and parameter/numbers

Line 334: “newLY”

Line 341-344: I suggest to move these sentences after the section header 4. (i.e. between lines 345 and 346)

Line 342: Be consistent in terminology. You used “mudstone” before

Line 352: “and or” → Confusing – please, rephrase.

Line 353: “See Fig. S2 in which it is shown how ... “ → Fig. S2 shows how...

Line 356: “... using different sample size from X-1. Similar pattern was observed for X-2 as well.” → I would delete redundant wording and add the specific sample sizes; maybe like this: “... using different sample size ranging from XXX to XXX mm.”

Line 359: To be consistent, you should use quotation marks around Penetration zone here as well.

Line 370: I strongly recommend to convert to SI units, or at least also denote SI units in parentheses.

Line 397 – 401: This paragraph appears a bit misplaced. I agree that measurements using liquids as permeating fluids underlie different assumptions and processes. But it appears here an explanation of why gases are used for testing. This section is, however, not the right place to state the usage of fluid type. I would simply omit the respective lines since the entire manuscript deals only with gas permeabilities.

Line 404: “behavior for a sample size of 0.675 mm (average granular diameter)” → change to “behavior for sample size with an average granular diameter of 0.675 mm”

Line 408: “For pressure range, argon ... ” → I don’t understand what is meant here. Please, rephrase.

Line 424: “... has slow equilibrium time” → either change to “slow equilibrium process” or “long equilibrium time”

Line 429: “Adsorption... (Busch et al., 2008)” → This sentence appears incoherent. I would omit this sentence.

Line 439: “would provide more analyzable data to determine the ...” → change to “would provide more data to be analyzed for determining the permeability”

Line 440 – 441: “This IS because... larger the pressure drop, AND (2) the longer ...”

Line 442: “ThIS is consistent ...”

Tab. 2: Change “size (mm)” to “granular size (mm)”

Line 466: “diameter smaller than Size A (average .. )” → Where does this term Size A come from (ssame for Fig. 8)? Please, change to “diameter smaller than on average 1.27 mm.” please also apply changes to line 470.

Line 484: You tested the applicability of the derived solutions with experiments on mudstones but not for crystalline rocks (so far). Therefore, I would not mention crystalline rocks here.

Line 495: change to “criteria”

Line 527: I suggest rephrasing “..., one solution was valid for the early time when gas storage ... and two were late-time solutions ...”

Line 540: You are stating good repeatability. Did you test that? Did you show any proof of repeatability in your manuscript? If not, please delete the last part since it appears as speculation only.