Solid Earth Discuss.,
doi:10.5194/se-2017-8-AC1, 2017

Solid Earth
Discussions
Open Access

Interactive comment on "Modifications to Kozeny–Carman model to enhance petrophysical relationships" *by* Amir M. S. Lala

Dr. lala

amir77_lala@yahoo.com

Received and published: 8 May 2017

Dear editor,

We all appreciate your work and the comments from reviewers, and those comments are really helpful to improve the quality of this manuscript and our related research. Now we resubmit the revised version of this MS titled: "Modifications to Kozeny-Carman Model to Enhance Petrophysical Relationships ". RESPONSE TO REFEREE REPORT(S):

1)The derivation of KC formalism is based on flow through pipe having a circular cross section with radius R. The specific surface area S (defined as the pore surface area divided by sample volume) can be expressed in terms of equation 4.

Printer-friendly version

Discussion paper

Where is the tortuosity (defined as the ratio of total flow path length to length of the sample) .

Equation 5 is exact for an ideal circular pipe geometry is presented as

A common extension of the KC relation for a circular pipe is to consider a packing of identical spheres of diameter d. Although this granular pore space geometry is not consistent with the pipe like geometry, it is common to use the original KC functional form. This allow a direct estimate of the (S) in terms of the porosity. 2) Using the grain size and model of packing of identical spheres of diameter (d) with the formalism. Explore introducing the radius of circular pipe. The parameters of modified KC equs given in 14 to 17 provide the very important parameters (pore throat radius) controlling the fluid flow in low porosity tight formation. Classical Rudies data is a special case illustrate the good description of the permeability by the grain size idealization because its clean and well sorted formation. So it will give good fit for equ 2 and 16 because τ is zero but this assumption will not valid for other medium to tight ill sorted and clayey formations. Thus equ 25 is risen. Diameter of pores is measured by capillary pressure curves. 3) table is provided Line 202 – 204 The laboratory techniques used for measuring the petrophysical parameters used in this study are presented in Lala and Nahla (2015). 4) Darcy's law is inadequate for representing high velocity fluid flow in porous media, such as near the well bore. When correlating the data for high velocity water flow through porous media, Forchheimer (1901) found that the relationship between pressure gradient an fluid velocity was no longer linear, as described by linear Darcy's flow. Forchheimer effect also known as non-Darcy effect is very important for describing additional pressure drawdown due to high fluid flow rates (Katz and Lee, 1990). Non-Darcy behavior illustrate significant effect on well performance. Non-Darcy effect play important role on effective fracture conductivity and gas well productivity. The Non Darcy flow could reduce the effective fracture conductivity and gas production and this confirmed by previous work (Guppy et al., 1982; Matias et al., Granazha et al., 2000). Traditionally, the KC equation relates the absolute permeability to porosity and grain size (d), this form is fit permeability versus porosity for data set from clean well sorted sandstone during such calculations the grain sized kept constant. One find two inconsistences in this approach, a) KC equation has been derived for a solid medium with pipe conduits rather than for a granular medium and b) even if grain size is used in this equation, it is not obvious that it doesn't vary with varying porosity. bearing this argument in mind, we explore how permeability can be predicted consistently within the KC formalism by varying the radii of the conduits. However this approach requires tourtosity evaluation during porosity reduction. Some arrive at alternate forms for the KC equation by varying tourtuosity which predict permeability and produce permeability that match measured lab data. Line 48 and 51: I specify the industry Line 47 Line 53: Done (References) Line 61: Done Line 74: Done Line 85 to 87. The specific surface area is much more difficult to measure or infer from the porosity because the granular pore spaces geometry is not consistent with the pipe like geometry model of the original K-C functional form. Line 75: Done line 87 to 91. One other parameter that can be determined in the laboratory by sieve analysis or optical microscope is the average grain size (diameter) d. The sieve analysis is the most easily understood laboratory method of determination where grains are separated on sieves of different sizes. Line 80-81: Because the KC formalism is based on cylindrical pipe model not the spherical grain packing model so this is not consistent with the KC model. However, introducing the grain size diameter improve the relationship between the permeability and the porosity so it is useful. Line 82: Done (spherical) Line 87: Done (Reference) Line 102 Line 116: Rudies Data is provided in table, Done Line 129 to 131 the Rudies Formation data obtained from Belayim marine field, Gulf of Suez, Egypt and the respective theoretical curves according to equation 6 and presented in figures 1 and 2, Line 119 to 124: Done Line 134: equ 6 , figures 1 and 2 Done line 131 Line 137 to 144: I made test for these new equations to other published data which give good results. D and Do which determined from capillary pressure curves, this different work is send also for peer review Line 155 to 157: it doesn't include the term of clay percentage λ Line 206: citation done Line 209 to 211: Done Line 214 to 215: This is valid only for the ideal case of clean well sorted formation such as Rudies Formation, where the pore shrink with decreasing porosity. Line 223: I argue that equs 16 and 17 gives a better match than equ 6 at the lower porosity range (Tight formations). Line 225-229: The pore size concept is more consistent with the KC formalism than the grain size because it can describe permeability of tight formation at lower porosity range. Thus equations 16 and 17 give a better match at lower porosity range, also equ 16 gives a good job but overestimate permeability at high porosity but equs 6 and 24 include the grain size give poor work at lower porosity range (tight formation).

I appreciate for Editors/Reviewers' warm work earnestly, and hope that the correction will meet with approval. Once again, thank you very much for your comments and suggestions.

Please also note the supplement to this comment:
http://www.solid-earth-discuss.net/se-2017-8/se-2017-8-AC1-supplement.pdf

---

Interactive comment on Solid Earth Discuss., doi:10.5194/se-2017-8, 2017.