



Contribution ID: 755

Type: **Poster (+) Presentation**

Modification of Darcy's Law by Considering the inertial effect

Tuesday, 1 June 2021 19:00 (1 hour)

Permeability is a parameter introduced by Darcy's Law, which is believed to be an intrinsic property of the porous medium and should be independent of the nature of the fluid flowing through it. However, Darcy's Law has specific conditions. The assumptions inherent to Darcy's law are (1) a single, incompressible fluid is flowing; (2) flow is in the laminar regime; (3) the fluid is immobile at the pore walls; (4) isothermal conditions exist; (5) the fluid and medium are nonreactive. In this study, isothermal and nonreactive flow is considered. The dimensionless numbers corresponding to condition (1), (2) and (3) are Mach number (Ma), Reynolds number (Re) and Knudsen number (Kn) respectively. Only two of these three dimensionless numbers are independent since they are connected by $Kn = \frac{Ma}{Re} \sqrt{\frac{\gamma\pi}{2}}$. Therefore, and can be chosen as conditions for the establishment of Darcy's Law when isothermal and nonreactive flow is considered, where represents the gas slip effect and represents the inertial effect.

The inertial effect is studied by many researchers. The most famous and successful model is proposed by Forchheimer, which is expressed in 1D by $\frac{dp}{dx} = -(\frac{\mu}{\kappa}V + \beta\rho V^2)$, where $\frac{dp}{dx}$ is pressure gradient which is imposed on the both ends of porous medium, μ is dynamic viscosity of fluid, κ is intrinsic permeability of porous medium, ρ is density of fluid, V is Darcy velocity of fluid and β is Forchheimer coefficient. Except this, some researchers argued that the cubic term of Darcy velocity, V^3 , or the n-th power, V^n , should be included in the expression rather than the squared term. All of them have a similar coefficient as Forchheimer coefficient and the focus of related research is the expression of such coefficient. However, all of the expressions are too complicated to be applied in engineering.

In this study, we are trying to derive a concise expression of modified Darcy's Law by considering the inertial effect. The idea is to propose a suitable modified boundary condition which can account for the derivation due to the moderate inertial effect. Suitable numerical cases will be conducted and results will be carefully analyzed in order to get the suitable modified boundary condition.

Time Block Preference

Time Block C (18:00-21:00 CET)

References

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