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NPTEL

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Courses » Modeling Transport Phenomena of Microparticles

Announcements **Course** Ask a Question Progress

Unit 5 - Week 4

Course outline

Week 4: Assignment

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2017-02-22, 23:59 IST.

Modeling Transport Phenomena of Micro-particles
Week 4: Assignment

Note: Follow the notations used in the lectures. Symbols have their usual meanings.

1) *1 point*

Consider a sponge which is in the shape of a cube having each side 5 m. If the volume of the void part (hallow of the cube is 8 m^3 then the porosity of the cube is

(a) 0.04

(b) 0.064

(c) 0.25

(d) 0.08

No, the answer is incorrect.
Score: 0

Accepted Answers:
(b) 0.064

2) The S.I unit of permeability is *1 point*

(a) m

(b) m/s

(c) m^2

(d) m^2/s

No, the answer is incorrect.
Score: 0

Accepted Answers:
(c) m^2

3) *2 points*

Consider a sphere of radius 3 cm which is made of gravel. The volume occupied by the void is 60 cm^3. If the r grain diameter of the gravel is 2 mm, then the permeability of the sphere is (hint: use Carman Kozney relation)

(a) $4.8 \times 10^{-2} cm^2$

(b) $2.8 \times 10^{-2} cm^2$

(c) $4.8 \times 10^{-4} cm^2$

(d) $2.8 \times 10^{-4} cm^2$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(d) $2.8 \times 10^{-4}\text{cm}^2$

4) *1 point*

Consider flow through a pipe of diameter 20 cm which is filled with a porous material of permeability 10^{-5} cm the total pressure drop is 10^2 dyn/cm^2 which is taking place over a length 10 cm and the viscosity of the flowin fluid is 10^{-3} dyn. s/cm^2, then the total discharge (volume flux, Q) using Darcy equation is

(a) 16π m^3/s

(b) 10π m^3/s

(c) 18π m^3/s

(d) 20π m^3/s

No, the answer is incorrect.
Score: 0

Accepted Answers:
(b) 10π m^3/s

5) *4 points*

Consider a channel filled with anisotropic porous material. Let the flow inside the porous media be governed b equation of the form $-\nabla p + \mu \nabla^2 \mathbf{u} - \mu \mathbf{K}^{-1}\mathbf{u} = 0,$ where $\mathbf{K}$ is the permeability of the medium that is given by matrix $\mathbf{K} = \begin{pmatrix} K_1 & K_2 \\ K_2 & K_3 \end{pmatrix}$, $K_1K_3 > K_2^2$, then the x-component of the momentum equation is

(a) $-\frac{\partial p}{\partial x} + \mu\nabla^2 u - \frac{\mu}{K_1K_3 - K_2^2}(K_3u - K_2v) = 0$

(b) $-\frac{\partial p}{\partial x} + \mu\nabla^2 u - \frac{\mu}{K_1K_3 - K_2^2}(K_1u + K_2v) = 0$

(c) $-\frac{\partial p}{\partial x} + \mu\nabla^2 u - \frac{\mu}{K_2^2 - K_1K_3}(K_1u + K_2v) = 0$

(d) $-\frac{\partial p}{\partial x} + \mu\nabla^2 u - \frac{\mu}{K_1K_3 - K_2^2}(K_3v - K_2u) = 0$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(a) $-\frac{\partial p}{\partial x} + \mu\nabla^2 u - \frac{\mu}{K_1K_3 - K_2^2}(K_3u - K_2v) = 0$

6) For very low values of permeability, flow inside a porous medium is supposed to be governed by *1 point*

(a) Darcy equation

(b) Stokes equation

(c) Euler equation

(d) Brinkman equation

No, the answer is incorrect.
Score: 0

Accepted Answers:
(a) Darcy equation

7) *4 points*

Consider a unidirectional flow (along x-direction) between two parallel plates located at $y = h$ and $y = 0$ unde pressure gradient. The lower plate is stationary and upper plate is moving with a velocity U. If the effective vis and the dynamic viscosity are equal and $\alpha^2 = \frac{1}{K}$ then the velocity profile is

(a) $u(y) = \frac{1}{\alpha^2}\frac{\sinh \alpha y}{\sinh \alpha h}U$

(b) $u(y) = \frac{\mu}{\alpha^2}\frac{\sinh \alpha y}{\sinh \alpha h}U$

(c) $u(y) = \mu \frac{\sinh \alpha y}{\sinh \alpha h} U$

(d) $u(y) = \frac{\sinh \alpha y}{\sinh \alpha h} U$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(d) $u(y) = \frac{\sinh \alpha y}{\sinh \alpha h} U$

8) *6 points*

Consider a unidirectional flow (along x-direction) between two parallel plates located at $y = h$ and $y = 0$ ... a constant pressure gradient $\frac{dp}{dx} = G$. The lower plate is stationary and the upper plate is moving with a velocit... If the effective viscosity and the dynamic viscosity are equal and $\alpha^2 = \frac{1}{K}$, then the velocity profile is

(a) $\frac{1}{\alpha^2 \mu \sinh \alpha h}\Big(G \sinh \alpha h(-1 + \cosh(\alpha y)) - \sinh(\alpha y)(G \cosh \alpha h - \mu\alpha^2 U - G)\Big)$

(b) $\frac{1}{\alpha^2 \mu \sinh \alpha h}\Big(G \sinh \alpha h(-1 + \cosh(\alpha y)) - \sinh(\alpha y)(G \cosh \alpha h - \mu\alpha^2 U - 1)\Big)$

(c) $\frac{1}{\alpha^2 \mu \sinh \alpha h}\Big(G \sinh \alpha h(-1 + \cosh(\alpha y)) - \sinh(\alpha y)(G \cosh \alpha h - \mu\alpha^2 - G)\Big)$

(d) $\frac{1}{\alpha^2 \mu \sinh \alpha h}\Big(G \sinh \alpha h(-1 + \cosh(\alpha y)) - \sinh(\alpha y)(\cosh \alpha h - \mu\alpha^2 U - 1)\Big)$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(a) $\frac{1}{\alpha^2 \mu \sinh \alpha h}\Big(G \sinh \alpha h(-1 + \cosh(\alpha y)) - \sinh(\alpha y)(G \cosh \alpha h - \mu\alpha^2 U - G)\Big)$

9) *6 points*

Consider the Brinkman equation in two-dimensions: $0 = -\nabla p + \mu\nabla^2 \mathbf{u} - \frac{\mu \mathbf{u}}{K}$. If the stream function is introdu... then the corresponding equation satisfied by the stream function is

(a) $\nabla^2(\nabla^2 - \frac{1}{K})\psi = 0$

(b) $\nabla^2(\mu\nabla^2 - \frac{1}{K})\psi = 0$

(c) $\nabla^2(\nabla^2 - K)\psi = 0$

(d) $\nabla^4 \psi = 0$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(a) $\nabla^2(\nabla^2 - \frac{1}{K})\psi = 0$

10) *4 points*

Consider a flow through porous medium that is governed by the extended Brinkman equation:
$\rho\Big(\frac{\partial \mathbf{u}'}{\partial t'} + \mathbf{u}'.\nabla\mathbf{u}'\Big) = -\nabla p' + \mu\nabla^2\mathbf{u}' - \frac{\mu \mathbf{u}'}{K}$,
where $\mathbf{u} = (u, v)$ represent the velocity. In order to non-dimensionalize the above equation, the following dimensionless variables are used: $x' = \frac{x}{L}, y' = \frac{y}{L}, t' = \frac{Ut}{L}, u' = \frac{u}{U}, v' = \frac{v}{U}, p' = \frac{p}{\mu U/L}$, $Da = \frac{K}{L^2}$. If the corresponding x-momentum equation is given by
$\alpha\Big(\frac{\partial u'}{\partial t'} + u'\frac{\partial u'}{\partial x'} + v'\frac{\partial u'}{\partial y'}\Big) = -\frac{1}{\Lambda}\frac{\partial p'}{\partial x'} + \beta\Big(\frac{\partial^2 u'}{\partial x'^2} + \frac{\partial^2 u'}{\partial y'^2}\Big) - \gamma u'$,
then the parameters α, β, γ and Λ are given by

(a) $\alpha = Re,\ \beta = -1,\ \gamma = \frac{1}{Da},\ \Lambda = 1$

(b) $\alpha = \frac{1}{Re},\ \beta = 1,\ \gamma = \frac{1}{Da},\ \Lambda = 1$

(c) $\alpha = Re,\ \beta = Re,\ \gamma = \frac{1}{Da},\ \Lambda = 1$

(d) $\alpha = Re,\ \beta = 1,\ \gamma = \frac{1}{Da},\ \Lambda = 1$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(d) $\alpha = Re,\ \beta = 1,\ \gamma = \frac{1}{Da},\ \Lambda = 1$

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