NEW HYDRODYNAMICS AND FILTRATION THEORY

Ideal fluid, dry water, shear-stress, dynamic and kinematic viscosity, Reynolds's number, non newtonian fluid, etc., etc., are heap of nonsense which are crowded theory of fluid motion and textbooks of physics and engineering. Therefore, I am on this subject decided to write "ab ovo" the work about "movement of fluids" using only my modest knowledge of physics and mathematics. The result of this work is myself amazed, and surprised me even more, that this "unscientific state", in which is that area of physics and engineering, is not at all surprised our "Professors". So here, I exhibit this work in order to someone else will be amazed too, with catch-32.

(Vjekoslav Brkić, Osijek)

CONTENTS:

FLUID DYNAMICS (HYDRODYNAMICS)

Fluid is a group of identical particles that occupy a space that we call continuum. Continuum is a space, in which particles of fluid are interacting, and interacts with the boundary particles surroundings continuums. Each continuum has its own state. State of the continuum, and of fluid can be solid, liquid or gaseous. In each continuum rules the same laws of physics. Each continuum respects the laws of thermodynamic equilibrium and conservation of mass and energy. Continuum - fluid, is in the fields of inertial and potential forces that in it induces pressure tensor and velocity vector field. Hydrodynamics studies the liquid state of the continuum - fluid.

MOTION OF THE FLUID IN THE CONTINUUM

(differential move in point (r) by speed (v) for the length (dr) in time (dt)):

$$v_x(r+dr, t+dt) = v_x + \nabla v_x dr + dt\frac{\partial v_x}{\partial t}$$

$$v_y(r+dr, t+dt) = v_y + \nabla v_y dr + dt\frac{\partial v_y}{\partial t}$$

$$v_z(r+dr, t+dt) = v_z + \nabla v_z dr + dt\frac{\partial v_z}{\partial t}\,, \qquad (1).$$

Or shorter written:

$$dv = dr\,\nabla v + dt\frac{\partial v}{\partial t}\,, \qquad (2)\ (\text{Euler's approach})\,, \qquad \frac{dr}{dt} = v\,, \qquad \text{so it will be:}$$

$$\frac{dv}{dt} = \frac{\partial v}{\partial t} + v\,\nabla v\,, \qquad (3)\ \ (\text{"2nd Newton's law in the fluid"}):$$

"Force acting on a point of the fluid by simultaneously changing the speed and energy of that point."

"Force of action (F_A) opposing reaction forces: potential force, pressure force and viscous force":

$$\frac{\partial v}{\partial t} + v\,\nabla v = F_A + F_G - F_P - F_\mu\,, \qquad (4)(\text{"3rd Newton's law in the fluid} - \text{all are force per unit mass"})$$

Potential force:

$$F_G = -\nabla U\,, \qquad (5)\ (\text{"potential force per unit mass"})$$

Pressure force:

$$P = \begin{vmatrix} p & 0 & 0 \\ 0 & p & 0 \\ 0 & 0 & p \end{vmatrix} \qquad (\text{pressure tensor})$$

On volume of fluid:

$$F_{VP} = -\int P da = -\nabla P, \qquad \text{(Gauss's theorem)}$$

$$F_P = -\frac{\nabla P}{\rho_F} \ , \qquad (6) \text{ (pressure force per unit mass)}$$

Viscous force:

Since, in the fluid there are not specific layers, surfaces, even volumes, in a fluid is the simplest to define all the force per unit mass (F) and thus should be defined and the viscous force. In physics textbooks there is confusion about the name and the meaning of important terms. So here I give the names and definitions used in this text:

$$G = \text{mass}, \qquad i = \text{impuls}, \qquad M = Gi = \text{moment}, \qquad F_m = \frac{dM}{dt} = \text{force}, \qquad F = \frac{F_m}{G} = \frac{di}{dt} = \frac{dv}{dt}.$$

$$j = \mu\frac{dv}{dr} \ , \qquad (7) \text{ ("flow of impulses")} \ = \ \text{(Newton's Law of "friction")}$$

"The flow of impulses in the fluid, is actually the work per unit mass [N m/kg] at some point in the fluid."

[N m/kg] = [m^2/s^2] so the dimension of the coefficient μ will be [m^2/s].

In fact, it would be more accurate to write Newton's law of "friction" in the form of:

$$\frac{j}{2} = \mu\frac{dv}{dr}, \qquad \text{(flow of impulses in one direction only!)}$$

And are instantly more clear meaning and dimensions of that term:

$$\frac{j}{2} = \mu\frac{dv}{dr} \sim \left[\frac{v^2}{2}\right] \quad \text{(Energy of motion of a viscous fluid } \left[\frac{m^2}{s^2}\right]\text{)}$$

Balance of impulses in the fluid (Acceleration – Deceleration – Friction = 0):

$$j_f = \mu_a\frac{dv}{dr} - \mu_d\frac{dv}{dr} = \mu\frac{dv}{dr} \qquad \text{("loss of impulses = friction")!}$$

$\mu_a = \mu_d =$ coefficient of self-diffusion of particles of fluid

$\mu =$ viscous friction coefficient of the fluid $\left[\frac{m^2}{s}\right]$

$j_f = \ \mu \ grad \ v \ ,$ "Viscosity is work performed by fluid in motion"!

$$\frac{di}{dt} + div\, j = 0 \quad \text{("continuity equation of impulses = equation of force")} \quad F = \frac{di}{dt}$$

$$F_\mu = -div\, j_f = -\mu\, div\, grad\, v = -\mu\, \Delta v$$

$$F_\mu = -\mu\, \Delta v \ , \qquad (8) \text{ (viscous force per unit mass)}$$

The basic equation (4) for the balance of forces in the fluid will now be:

$$\frac{\partial v}{\partial t} + v\,\nabla v = \frac{dv}{dt} - \nabla U + \frac{\nabla P}{\rho_F} + \mu\,\Delta v\,, \qquad \text{(9) with:}$$

$$v\,\nabla v = \frac{1}{2}\nabla v^2 - v \times rot\ v, \qquad \text{(10) (total kinetic energy).}$$

Basic equation of fluid dynamics (2) becomes (new, Navier-Stokes):

$$\frac{dv}{dt} = \frac{\partial v}{\partial t} - v \times rot\ v + \nabla\left(U - \frac{P}{\rho_F} + \frac{v^2}{2}\right) - \mu\,\Delta v, \qquad \text{(11) with:}$$

$$\frac{d\rho_F}{dt} + div\ \rho_F\ v = 0\,, \qquad \text{(12) (equation of continuity of mass)}$$

Equation of fluid statics (fluid is at rest, and acting external forces):

$$\frac{dv}{dt} = \nabla U - \frac{\nabla P}{\rho_F}\,, \qquad \text{(13) (First condition of the stationary flow!)}$$

Equation of fluid statics ($v = 0,\ dv/dt = 0,\ \partial v/\partial t = 0$):

$$\nabla P = \rho_F\,\nabla U, \qquad (14)$$

STATIONARY FLOW OF IRROTATIONAL FLUID:

Fluid flows only if an external force in it is induced pressure tensor, which will provide a fluid motion energy: kinetic energy and the energy needed to overcome internal friction. The fluid is in a state of steady flow when the work of external forces is equal to the sum of kinetic energy and energy losses due to friction during motion.

$$\frac{\partial v}{\partial t} = 0\,, \qquad v \times rot\ v = 0, \qquad \text{("Zeroth conditions of laminar and stationary flow")}$$

$$\frac{dv}{dt} = \nabla\left(U - \frac{P}{\rho_F} + \frac{v^2}{2}\right) - \mu\,\Delta v\,, \qquad \text{(15)("laminar flow equation")}$$

$$\frac{dv}{dt} - \nabla U + \frac{\nabla P}{\rho_F} = 0\,, \qquad \text{(16) ("1st condition of the stationary flow"!)}$$

$$\nabla\left(U - \frac{P}{\rho_F} + \frac{v^2}{2}\right) = 0, \qquad \text{(17) ("2nd condition of the stationary flow"!)}$$

$$U - \frac{P}{\rho_F} + \frac{v^2}{2} = Constant, \qquad \text{(18) (Bernoulli's theorem)}$$

After meeting all the conditions in equations (11) and (15), a fluid flowing, must still meet the remaining, speed members of vector equations of the stationary fluid flow:

$$\mu\,\Delta v - \nabla\left(\frac{v^2}{2}\right) = 0, \qquad (19)(\text{"3rd condition of the stationary flow"!})$$

"The force of the internal (viscous) friction is proportional to the gradient of the kinetic energy of the fluid "!

$$\nabla\left(\mu\,\nabla v - \frac{v^2}{2}\right) = 0\,, \qquad (\text{the same as (19) which implies}):$$

The Law of distribution of speed, at stationary flow of fluid:

$$\mu\,\nabla v - \frac{v^2}{2} = Constant = -\frac{v_{max}^2}{2}\,, \qquad (20)$$

All these equations (15), (19) and (20) are very difficult to solve.

But if we assume that all point of the same fluid velocity, also have the same coordinate:

Differential equations, for this (20) one-dimensional problem is:

$$\frac{dv}{dr} = -\frac{v_{max}^2 - v^2}{2\mu} \qquad (21)$$

And that after the separation of variables and integration:

$$\int \frac{dv}{v_{max}^2 - v^2} = -\frac{1}{2\mu}\int dr\,, \qquad \text{gives:}$$

$$\frac{1}{v_{max}}\tanh^{-1}\frac{v}{v_{max}} = -\frac{r}{2\mu} + C, \qquad \frac{R}{2\mu} = C$$

$$\tanh^{-1}\frac{v}{v_{max}} = \frac{v_{max}(R-r)}{2\mu} = \frac{1}{2}N_{(Re)}$$

$N_{(Re)}$ = dimensionless function of distance ("as Reynolds"!)

From this solution it follows that the distribution of velocity in a fluid, falls in the area of hyperbolic equations, rather than parabolic, how to interpret a valid theory of fluid flow. The same equation (21) over the logarithm will be:

$$\frac{1}{2v_{max}}\ln\left[\frac{v_{max}+v}{v_{max}-v}\right] = -\frac{r}{2\mu} + C, \quad \frac{R}{2\mu} = C$$

$$\ln\left[\frac{v_{max}+v}{v_{max}-v}\right] = \frac{v_{max}(R-r)}{\mu} = N_{(Re)}$$

$$\frac{v_{max}+v}{v_{max}-v} = e^{N_{(Re)}}, \qquad v = v_{max}\frac{(e^{N_{(Re)}}-1)}{(e^{N_{(Re)}}+1)}$$

How, in a fluid, applies the **"principle of relativity"**, then in the equation (21), we can introduce:

r_E - relative distance and v_E - relative speed between two points in the fluid, and the same equation read as follows:

$$\frac{dv_E}{dr} = -\frac{(v_E)^2}{2\mu},$$ which after the separation of variables and integration:

$$\int \frac{dv_E}{(v_E)^2} = -\frac{1}{2\mu}\int dr\,,$$ gives:

$$-\frac{1}{v_E} = -\frac{r}{2\mu} + C, \qquad \frac{R}{2\mu} = C, \qquad \frac{1}{v_E} = \frac{r_E}{2\mu}$$

and general definition of viscosity and laminar flow read as follows:

$$\mu = \frac{v_E r_E}{2} \qquad (22) \text{ (in one-dimensional space!)}$$

"A fluid flows such, that the product of the relative speed and distance is constant (of viscosity)".

Flow in pipes, is approximated, correction of equation (22):

$$\mu = \frac{v_E r_E}{2}\left(\frac{2r_E\pi}{R}\right) = \frac{v_E (r_E)^2\pi}{R}$$

So the maximum relative velocity of laminar flow in pipes, for r = R will be:

$$v_{E\,max} = \frac{\mu}{R\pi} \qquad (23) \text{ (in one-dimensional space!)}$$

Laminar flow may therefore be demonstrated in only a very small diameter profiles!

In general it can be said that the motion of the fluid is always defined by the condition of viscous friction (22) but when the maximum relative velocity in the fluid reaches the maximum critical speed then the condition: v × rot v = 0, is no longer valid and in the fluid must begin to flow, except current of impulses and the current of moment. The current of impulses in the fluid is always perpendicular to the direction of the relative speed of fluid, but the resultant of moment current have direction of the absolute velocity. Generation of current of moment in the fluid, allows living beings to swim and fly.

LAMINAR FLUID FLOW THROUGH POROUS MEDIA

$$f = \frac{Q}{\rho_F A} = \text{relative superficial velocity} = \frac{\left[\frac{kg}{s}\right]}{\left[\frac{kg}{m^3}\right][m^2]} = \left[\frac{m}{s}\right]$$

On the fluid in porous media can act external forces (acceleration), the kinetic forces (resistance and motion) and potential forces (gradient of pressure and gravity) and, balance of forces per unit mass, we can visualize by the equation:

$$\frac{df}{dt} + F(f) - F\left(\nabla\left(\frac{P}{\rho_F}\right) + g\right) = 0, \qquad (24)$$

Kinetic forces can be described by the relative superficial velocity and the corresponding coefficient of proportionality, a potential forces by the potential of pressure and gravity, and the corresponding coefficient of proportionality:

$$\frac{df}{dt} + K_\mu f - K_\gamma \left[\nabla\left(\frac{P}{\rho_F}\right) + g\right] = 0, \qquad (25)$$

For df/dt = 0 and ∇p = dP/dL equation (25) becomes:

$$K_\mu f = K_\gamma \frac{1}{\rho_F}\frac{dP}{dL} + K_\gamma g, \qquad \text{or,} \qquad \frac{K_\mu}{K_\gamma} f = \frac{1}{\rho_F}\frac{dP}{dL} + g$$

$$\frac{K_\mu}{K_\gamma} = \delta\,, \qquad [\delta] = \left[\frac{1}{s}\right] = \text{"coefficient of resistance of porous media"!}$$

$$\delta f = \frac{1}{\rho_F}\frac{dP}{dL} + g, \qquad (26)\ \text{(Darcy's equation)}$$

$$\frac{dP}{dL} = \rho_F\,\delta\,f - \rho_F\,g$$

$$dP = d(H\,\rho_F\,g), \qquad \text{(if pressure is hydrostatic):}$$

$$\frac{dH}{dL} = \frac{\delta}{g} f\ - 1$$

For multilayer porous medium will be:

$$P_{\Delta 1} = L_1\delta_1\rho_F f_1 - L_1\rho_F\,g$$

$$P_{\Delta 2} = L_2\delta_2\rho_F f_2 - L_2\rho_F\,g$$

$$P_{\Delta 3} = L_3\delta_3\rho_F f_3 - L_3\rho_F\,g \qquad \text{(third layer ... etc.)}$$

$$f_0 = f_1 = f_2 = f_3 \qquad \text{(continuity equation!)}$$

$$P_{\Delta U} = \sum P_{\Delta i} = \rho_F f_0 \sum_{i=1}^{n} L_i\delta_i - \rho_F\,g \sum_{i=1}^{n} L_i$$

$$L_U = \sum_{i=1}^{n} L_i \qquad \text{(cumulative thickness of all layers)}$$

$$\frac{P_{\Delta U}}{\rho_F L_U} = f_0 \frac{\sum_{i=1}^{n} L_i\delta_i}{L_U} - g \qquad \text{(summary equation)}$$

$$\delta_U = \frac{\sum_{i=1}^{n} L_i\delta_i}{L_U} \qquad \text{(a common overall coefficient of resistance)}$$

Furthermore you can run a combination type $P_{\Delta 1} = P_{\Delta 2}$, f1 ≠ f2 and the like.

This derivation shows that the hydrodynamic problem can be relatively successfully and accurately, interpret and be described without using the "viscosity".

NEW DERIVATION OF THE EQUATION OF FILTRATION

Anyone who's ever performed an experiment of filtration at constant pressure, immediately could convince that the theory has nothing with reality. Existing theories of filtration are based on numerous speculations and false assumptions, and worst of all is that the phenomenon of filtration can be described by Hagen-Poiseuille's equation with appropriate "adjustments". This equation describes the steady flow and is therefore inapplicable to the time-varying phenomena as filtration. In addition, this equation is the very speculative nature because I never saw its theoretically and mathematically correctly based derivation. Therefore, a phenomenon of filtration, should be interpreted on the basis of equations (24) and (25), which describes more completely the phenomenon of flow in porous media.

FILTRATION AT CONSTANT PRESSURE:

The force of slowing flow and friction forces, keep balance with the potential force of motion:

$$\frac{df}{dt} + K_\mu f = K_\gamma [\nabla(\frac{P}{\rho_F}) + g]$$

$$\Gamma = \nabla(\frac{P}{\rho_F}) + g \qquad \text{(potential gradient)}$$

$$\frac{df}{dt} + K_\mu f = K_\gamma \Gamma \qquad \Big| \cdot \frac{d}{dt}$$

$$\frac{d^2 f}{dt^2} + K_\mu \frac{df}{dt} = K_\gamma \frac{d\Gamma}{dt}$$

$$\frac{d\Gamma}{dt} = K \frac{dV}{dt} = K_\Gamma f \qquad \text{("time changes in gradient is proportional to the speed"!)}$$

$$\frac{d^2 f}{dt^2} + K_\mu \frac{df}{dt} - K_\gamma K_\Gamma f = 0 \,, \qquad \text{(27)("differential equation of filtration"!)}$$

The homogeneous differential equation of second order with constant coefficients is solved by substitution:

$f = e^{-rt}$, $f' = -re^{-rt}$, $f'' = r^2 e^{-rt}$, so that (27) will be:

$r^2 e^{-rt} - K_\mu r e^{-rt} - K_\gamma K_\Gamma e^{-rt} = 0$, whose characteristic equation is:

$r^2 - K_\mu r - K_\gamma K_\Gamma = 0$, whose solution (two solutions) is:

$$r_{1,2} = \frac{K_\mu \pm \sqrt{K_\mu^2 + 4 K_\gamma K_\Gamma}}{2}$$

with the properties of the roots of quadratic equation:

$K_\mu = (r_1 + r_2)$ and $K_\gamma K_\Gamma = -(r_1 r_2)$, the relative superficial filtration velocity will be:

$$f = C_1 e^{-r_1 t} + C_2 e^{-r_2 t} \,, \qquad (28),$$

with the initial conditions:

$t = 0$, $f = f_0 = C_1 + C_2$, $f_0{}' = -(C_1 r_1 + C_2 r_2)$

Rate equation of filtration not only from mathematical reasons has of all by two coefficients, but this equation and realistically describes two causally related processes: obtaining of the filtrate and filtration cake. It's in mathematics and physics already known, damping equation.

Based on the known velocity of filtration, we can define the volume of the filtrate:

$$V = \int_0^t f\,dt = -\frac{C_1}{r_1}e^{-r_1 t} - \frac{C_2}{r_2}e^{-r_2 t} + C$$

$$t = 0\,, \qquad V = V_0 = 0\,, \qquad C = V_0 + \frac{C_1}{r_1} + \frac{C_2}{r_2}$$

$$V = V_0 + \frac{C_1}{r_1}(1 - e^{-r_1 t}) + \frac{C_2}{r_2}(1 - e^{-r_2 t})$$

$V_{max} = V_0 + \frac{C_1}{r_1} + \frac{C_2}{r_2}$, $\quad for \quad t = \infty$, and for: $V_0 = 0$ it will be:

$V_{ef} = \frac{C_1}{r_1} + \frac{C_2}{r_2}$ ("maximum effective amount of the filtrate"!)

"The amount of the filtrate, which is at all possible to get (in infinite time) is constant."

FILTRATION AT CONSTANT FLOW

Derivation of filtration equation is based on the equation (26) that well describing stationary flow in each homogeneous porous media:

$$\delta\, f = \frac{1}{\rho_F}\frac{dP}{dL} + g\,, \qquad \text{or,} \qquad \rho_F\,\delta\, f = \frac{dP}{dL} + \rho_F\, g$$

Coefficient of resistance of the total porous media (filter and cake), we can without error expressed by the coefficient of resistance of the filtration cake δ. Because the filtration at a constant flow rate is a process in which is continuously changing the pressure gradient (falling), and the thickness of the porous layer of the cake (rises), so by differentiating by time:

$$dP = \rho_F(\delta\, f - g)dL \qquad \Big| \cdot \frac{d}{dt}$$

we get the necessary starting equation:

$$\frac{dP}{dt} = \rho_F(\delta\, f - g)\frac{dL}{dt}$$

In which, the growth rate of the cake can be expressed as a function of the relative superficial speed (f) by the concentration of solids in suspension (C_s) and density of cakes (ρ_k), ie, the volume of cakes (V_k) per volume of suspension (V_s).

$\frac{dL}{dt} = K_V f$ where: $K_V = \frac{C_s}{\rho_k} = \frac{V_k}{V_s}$ = coefficient of filtration velocity

$$\frac{dP}{dt} = \rho_F(\delta\, f\ -\ g)(K_V f) \qquad \text{respectively:}$$

$$\frac{dP}{dt} = K_V \rho_F(\delta\, f^2 - g\, f)\,, \qquad \text{("differential equation of filtration at constant flow")}$$

$$\int dP = K_V \rho_F(\delta\, f^2 - g\, f) \int dt\ , \qquad \text{whose general solution:}$$

$$P = K_V \rho_F(\delta\, f^2 - g\, f)t + C\,, \qquad \text{with the initial conditions:}$$

$$t = 0\,, \quad P = P_0\,, \quad C = P_0 \qquad \text{becomes:}$$

$$P = K_V \rho_F(\delta\, f^2 - g\, f)t + P_0 \qquad \text{("equation of filtration at constant flow")}$$

$$P = H\, \rho_F\, g\,, \qquad \text{while the same becomes:}$$

$$H = \left(\frac{\delta\, f^2}{g} - f\right) K_V t + H_0 \qquad \text{(hydrostatic equation of filtration at constant flow)}$$

ABOUT MEASUREMENT OF CONSTANT OF VISCOSITY

Current engineering practice has a lot of problems, when as a parameter, of design, management and quality of a process and products is used "viscosity".

As shown, an derivation of the frictional force in the fluid, in the equation (8), constant of viscosity is, until now, quite wrongly interpreted, incorrectly measured, and incorrectly applied. For the vast majority of works in the field of fluid dynamics, which are based on the definition of "dynamic and kinematic viscosity" can be said to have been wrong.

All current measurements of constant of viscosity are based on the interpretation and application of viscosity, over some "versions" of Hagen-Poiseuille's equation, although it is not in fact clear, which is, "viscosity" used in this equation, as well as which in fact, "viscosity" measures various methods of measurement. All devices, which today measures "viscosity", only in a convenient way, creates tension in the fluid, and on the basis of this phenomenon, compares some tribological properties of fluids, but do not measures the viscosity.

The only first real viscometer is made by James Prescott Joule 1845, for the purposes of his famous experiment to determine the mechanical equivalent of heat. The theoretical basis of the Joule experiment still has not been set !? (By the movement, the fluid increases the mean velocity of its particles (temperature - energy) and thus the fluid must perform an irreversible work (viscosity - heat) to be moved.).

Hydrodynamics sucks! Numerous hydrodynamic experiments and their interpretations are based on the assumed "viscosity" and on that basis, derived dimensionless numbers. On this condition, also contributed completely uncritical application of dimensional analysis. Instead of, the dimensional analysis is used to detect errors in the interpretation of certain phenomena, it is used for their camouflage. The result of all this, are many funny, pseudo-empirical equations that nobody uses anyway.

Besides complex experimental devices which I do not have, the only tool to check a hypothesis, that everyone has, is dimensional analysis:

DIMENSIONAL ANALYSIS

Problem 1a :

LAMINAR FLOW THROUGH A PIPE WITH THE WRONG "VISCOSITY"

$$\frac{P}{L} = f(D, v, \rho, \mu), \qquad (starting\ function!), \qquad M = kg, \qquad L = m, \qquad T = s$$

$$pressure\ gradient \left[\frac{P}{L}\right] = \frac{\left[\frac{kg\ m}{s^2}\right]}{[m]\ [m^2]} = \left[\frac{kg}{m^2\ s^2}\right] = M^1\ L^{-2}\ T^{-2}$$

$$length\ [D] = [m] = L^1$$

$$velocity\ [v] = \left[\frac{m}{s}\right] = L^1\ T^{-1}$$

$$density\ [\rho] = \frac{[kg]}{[m^3]} = M^1\ L^{-3}$$

$$"viscosity"[\mu] = \left[\frac{kg}{m\ s}\right] = M^1\ L^{-1}\ T^{-1}$$

Include dimensions in the starting function form of:

$$\frac{P}{L} = K\ (D)^a (v)^b (\rho)^c (\mu)^d\ , \qquad \text{enter dimensions:}$$

$$M^1\ L^{-2}\ T^{-2} = (L^1)^a (L^1\ T^{-1})^b (M^1\ L^{-3})^c (M^1\ L^{-1}\ T^{-1})^d, \qquad \text{arrange exponents:}$$

$$M^1\ L^{-2}\ T^{-2} = (L)^{a+b-3c-d} (M)^{c+d} (T)^{-b-d}, \qquad \text{calculate a, b, c by using d:}$$

$$(T): -2 = -b - d\ , \qquad b = 2 - d$$

$$(M): 1 = c + d\ , \qquad c = 1 - d$$

$$(L): -2 = a + b - 3c - d\ , \qquad a = -1 - d\ , \qquad \text{enter the result in a starting function:}$$

$$\frac{P}{L} = K\ (D)^{-1-d} (v)^{2-d} (\rho)^{1-d} (\mu)^d\ , \qquad \text{group variables with the same exponents:}$$

$$\frac{P}{L} = K (D)^{-1} (v)^2 (\rho)^1 (\mu)^d (D)^{-d} (v)^{-d} (\rho)^{-d}$$

$$\frac{P}{L} = K[(D)^{-1} (v)^2 (\rho)^1][(\mu)^1 (D)^{-1} (v)^{-1} (\rho)^{-1}]^d\ , \qquad \text{the solution the starting function is:}$$

$$\frac{P}{L} = K v^2 \frac{\rho}{D} \left(\frac{\mu}{D v \rho}\right)^d\ , \qquad \text{if:}\ \ d = 1, \qquad \text{it will be:}$$

$$\frac{P}{L} = Kv\frac{\mu}{D^2}, \qquad \text{if}: \; K = 32, \qquad \frac{P}{L} = 32\frac{v\mu}{D^2}, \qquad \text{"Poiseuile's Law"?!}$$

"Professor," says K must be 32. Where did constant "32"? What is that, a natural magic number? Where disappeared Reynolds? Obviously, something is wrong!

Problem 2a :

RESISTANCE OF MOTION A SPHERE IN THE FLUID WITH THE WRONG "VISCOSITY":

$$R = f(D, v, \rho, \mu), \qquad (starting\ function!), \qquad M = kg, \qquad L = m, \qquad T = s$$

$$force\ of\ resistance\ [R] = \left[\frac{kg\ m}{s^2}\right] = M^1\ L^1\ T^{-2}$$

$$\text{"}viscosity\text{"}\ [\mu] = \left[\frac{kg}{m\ s}\right] = M^1\ L^{-1}\ T^{-1}$$

Include dimensions in the starting function form of:

$R = K\ (D)^a (v)^b (\rho)^c (\mu)^d$, enter dimensions:

$M^1\ L^1\ T^{-2} = (L^1)^a (L^1\ T^{-1})^b (M^1\ L^{-3})^c (M^1\ L^{-1}\ T^{-1})^d$, arrange exponents:

$M^1\ L^1\ T^{-2} = (L)^{a+b-3c-d} (M)^{c+d} (T)^{-b-d}$, calculate a, b, c by using d:

$(T): -2 = -b - d$, $b = 2 - d$

$(M): \ 1 = c$, $c = 1$

$(L): \ 1 = a + b - 3c - d$, $a = 2 + 2d$, enter the result in a starting function:

$R = K\ (D)^{2+2d} (v)^{2-d} (\rho)^1 (\mu)^d$, group variables with the same exponents:

$R = K\ (D)^2 (v)^2 (\rho)^1 (\mu)^d (D)^{2d} (v)^{-d} = K\ [(D)^2 (v)^2 (\rho)^1][(\mu)^1 (D)^2 (v)^{-1}]^d$, it is:

$R = KD^2 v^2 \rho \left(\frac{\mu D^2}{v}\right)^d$, if $d = 1$, it will be:

$$R = KD^4 v\rho\mu, \qquad K = \frac{\pi^2}{16}, \qquad R = \frac{\pi^2}{16} D^4 v\rho\mu = \left(\frac{D^2\pi}{4}\right)^2 v\rho\mu.$$

Here we do not recognize any natural law, least of all Stokes's law of motion of the sphere. Where is the Reynolds? Apparently there is something wrong! What do you say "Professor"?

And what will happen if, from the analysis, completely drop the "viscosity"? Let's try derivation:

Problem 1b :

LAMINAR FLOW THROUGH A PIPE WITHOUT THE USE OF VISCOSITY:

$$\frac{P}{L} = f(D, v, \rho), \qquad (starting\ function!), \qquad M = kg, \qquad L = m, \qquad T = s$$

Include dimensions in the starting function form of:

$$\frac{P}{L} = K\,(D)^a (v)^b (\rho)^c\,, \qquad \text{enter dimensions:}$$

$$M^1\,L^{-2}\,T^{-2} = (L^1)^a (L^1\,T^{-1})^b (M^1\,L^{-3})^c\,, \qquad \text{arrange exponents:}$$

$$M^1\,L^{-2}\,T^{-2} = (L)^{a+b-3c} (M)^c (T)^{-b}\,, \qquad \text{calculate values for a, b, c:}$$

$$(T):-2 = -b\,, \qquad b = 2$$

$$(M): 1 = c\,, \qquad c = 1$$

$$(L):-2 = a + b - 3c\,, \qquad a = -1\,, \qquad \text{enter the result in a starting function:}$$

$$\frac{P}{L} = K\,(D)^{-1} (v)^2 (\rho)^1\,, \qquad \text{group variables with the same exponents:}$$

$$\frac{P}{L} = K\,(D)^{-1} (v)^2 (\rho)^1 = K\,[(D)^{-1} (v)^2 (\rho)^1]\,, \qquad \text{the solution is:}$$

$$\frac{P}{L} = K v^2 \frac{\rho}{D}, \qquad \text{if}: \; K = 2, \quad \text{it will be,} \qquad \frac{P}{L} = 2v^2 \frac{\rho}{D}\,, \qquad \text{or,} \qquad \frac{D}{2}\,\frac{P}{\rho L} = v^2, \qquad \text{or:}$$

$$\frac{D}{4}\,\frac{P}{\rho L} = \frac{v^2}{2}, \qquad \text{Known members are: } \left(\frac{P}{\rho L}\right) \; and \; \left(\frac{v^2}{2}\right), \qquad \text{but,} \qquad \frac{D}{4} = \text{geometric member:}$$

$$\frac{D}{4} = \frac{\left(\frac{D^2\pi}{4}\right)}{D\pi} = S_c = \text{similarity coefficient for pipe} = \frac{\text{Area}}{\text{circumference}} \text{ crosssection}$$

$$\frac{\left(\frac{D^2\pi}{4}\right)}{D\pi}\,\frac{P}{\rho L} = \frac{v^2}{2}\,, \qquad \text{or in general:,} \qquad S_c \frac{P}{\rho L} = \frac{v^2}{2}$$

What is the general Bernoulli equation for any flow profile!

Here is K = 2 logical a natural number! The Bernoulli equation also has no Reynolds.

Problem 2b :

RESISTANCE OF MOTION A SPHERE IN THE FLUID WITHOUT THE USE OF VISCOSITY:

$$R = f(D, v, \rho), \qquad (starting\ function!), \qquad M = kg, \qquad L = m, \qquad T = s$$

$$force\ of\ resistance\ [R] = \left[\frac{kg\ m}{s^2}\right] = M^1\,L^1\,T^{-2}$$

Include dimensions in the starting function form of:

$$R = K\,(D)^a (v)^b (\rho)^c\,, \qquad \text{enter dimensions:}$$

$$M^1\,L^1\,T^{-2} = (L^1)^a (L^1\,T^{-1})^b (M^1\,L^{-3})^c\,, \qquad \text{arrange exponents:}$$

$$M^1\,L^1\,T^{-2} = (L)^{a+b-3c} (M)^c (T)^{-b}\,, \qquad \text{calculate values for a, b, c :}$$

$(T): \; -2 = -b\,, \qquad b = 2$

$(M): \; 1 = c\,, \qquad c = 1$

$(L): \; 1 = a + b - 3c\,, \qquad a = 2\,,$ enter the result in a starting function:

$R = K\,(D)^2(v)^2(\rho)^1,$ it is:

$R = KD^2v^2\rho\,,$ if, $K = \frac{\pi}{8}\,,$ it will be, $R = \frac{\pi}{8}D^2v^2\rho\,,$ or:

$R = \left(\frac{D^2\pi}{4}\right)\frac{v^2}{2}\rho\,,$ ("3rd Newton′s law"!)

The sphere, moves so that the drag force is balanced with kinetic energy of motion. The force of resistance is a pressure on the surface of the cross section of sphere. It's all right! Here also has no Reynolds!

I wonder, what is the solution of the same problems according to my definition of viscosity:

Problem 1c :

LAMINAR FLOW THROUGH A PIPE WITH THE CORRECT VISCOSITY:

$\frac{P}{L} = f(D, v, \rho, \mu), \qquad (starting\ function!), \qquad M = kg, \qquad L = m, \qquad T = s$

$viscosity\ [\mu] = \left[\frac{m^2}{s}\right] = L^2\,T^{-1}$

Include dimensions in the starting function form of:

$\frac{P}{L} = K\,(D)^a(v)^b(\rho)^c(\mu)^d\,,$ enter dimensions:

$M^1\,L^{-2}\,T^{-2} = (L^1)^a(L^1\,T^{-1})^b(M^1\,L^{-3})^c(L^2\,T^{-1})^d\,,$ arrange exponents:

$M^1\,L^{-2}\,T^{-2} = (L)^{a+b-3c+2d}(M)^c(T)^{-b-d}\,,$ calculate a, b, c by using d:

$(T): -2 = -b - d\,, \qquad b = 2 - d$

$(M): 1 = c\,, \qquad c = 1$

$(L): -2 = a + b - 3c + 2d\,, \qquad a = -1 - d\,,$ enter the result in a starting function:

$\frac{P}{L} = K\,(D)^{-1-d}(v)^{2-d}(\rho)^1(\mu)^d\,,$ group variables with the same exponents:

$\frac{P}{L} = K\,(D)^{-1}(v)^2(\rho)^1(\mu)^d(D)^{-d}(v)^{-d} = K\,[(D)^{-1}(v)^2(\rho)^1][(\mu)^1(D)^{-1}(v)^{-1}]^d\,,$ it is:

$\frac{P}{L} = Kv^2\frac{\rho}{D}\left(\frac{\mu}{Dv}\right)^d,$ if : $d = 1,$ it wil be:

$$\frac{P}{L} = Kv\frac{\rho\mu}{D^2}, \qquad \text{if}: \; K = \frac{4}{\pi}, \qquad A = \frac{D^2\pi}{4}, \qquad v = \frac{V}{At}, \qquad \text{equation becomes:}$$

$$\frac{P}{L} = \frac{4}{\pi}\frac{V}{At}\frac{\rho\mu}{D^2}, \qquad \frac{P}{L} = \frac{V\rho\mu}{A^2 t}$$

$$\frac{A^2 t}{V}\frac{P}{L\rho} = \mu = \left(\frac{D^2\pi}{4}\right)^2 \frac{t\,P}{VL\rho}, \qquad \text{ie:}, \qquad \frac{D^4\pi^2 tP}{16VL\rho} = \mu\,, \qquad \text{Poiseuille's law!}$$

$$\frac{P}{L\rho} = \frac{\mu}{A^2}\frac{V}{t} = F_f\frac{V}{At}\,, \qquad \text{Darcy's equation!}\,, \qquad F_f = \frac{\mu}{A} = \text{friction factor}\left[\frac{1}{s}\right].$$

This is obviously correct Darcy's equation, ie, Poiseuille's law. The constant K = 4 / π, is a geometric coefficient of proportionality, and the velocity is expressed by the flow rate (in the experiment, is measured volume, by the time!). Here also does not have any Reynolds's number! Originally that law is defined as: $Q = K\,D^4 P/L$, which is entirely correct, as opposed to mathematical ugliness that were later "derived".

And resistance of movement of sphere in the fluid ?:

Problem 2c :

RESISTANCE OF MOTION A SPHERE IN THE FLUID USING THE CORRECT VISCOSITY:

$$R = f(D, v, \rho, \mu), \qquad (starting\ function!), \qquad M = kg, \qquad L = m, \qquad T = s$$

$$force\ of\ resistance\ [R] = \left[\frac{kg\ m}{s^2}\right] = M^1\,L^1\,T^{-2}$$

$$viscosity\ [\mu] = \left[\frac{m^2}{s}\right] = L^2\,T^{-1}$$

Include dimensions in the starting function form of:

$$R = K\,(D)^a(v)^b(\rho)^c(\mu)^d\,, \qquad \text{enter dimensions:}$$

$$M^1\,L^1\,T^{-2} = (L^1)^a(L^1\,T^{-1})^b(M^1\,L^{-3})^c(L^2\,T^{-1})^d\,, \qquad \text{arrange exponents:}$$

$$M^1\,L^1\,T^{-2} = (L)^{a+b-3c+2d}(M)^c(T)^{-b-d}\,, \qquad \text{calculate a, b, c by using d:}$$

$$(T): -2 = -b - d\,, \qquad b = 2 - d$$

$$(M): 1 = c\,, \qquad c = 1$$

$$(L): 1 = a + b - 3c + 2d\,, \qquad a = 2 - d\,, \qquad \text{enter the result in a starting function:}$$

$$R = K\,(D)^{2-d}(v)^{2-d}(\rho)^1(\mu)^d\,, \qquad \text{group variables with the same exponents:}$$

$$R = K\,(D)^2(v)^2(\rho)^1(\mu)^d(D)^{-d}(v)^{-d} = K\,[(D)^2(v)^2(\rho)^1][(\mu)^1(D)^{-1}(v)^{-1}]^d\,, \qquad \text{it is:}$$

$$R = KD^2v^2\rho\left(\frac{\mu}{Dv}\right)^d, \qquad \text{if,} \qquad d = 1, \qquad \text{it will be:}$$

$R = KDv\rho\mu$, $K = \pi$, $R = \pi Dv\rho\mu$.

The resistance of sphere is proportional to circumference and the speed of sphere and the density and viscosity of the fluid. It is an essential part of Stokes's equation for resistance of sphere. Again has no Reynolds number! It is known, that to this basic equation, many experimentalists added additional coefficients, in order to cover up a mistake of wrong determination of the constant of viscosity.

(CATCH-32), WHAT IS NUMBER 32?

Presumption: $E * 32 = \frac{4}{\pi}$, $E = \frac{1}{8\pi} = 0{,}04$!?

It is a mistake, size of ≈ 0.04, which carry our methods of determining and the use of viscosity. In other words, all the values of "dynamic and the kinematic viscosity" should be multiplied by 1/25.13 to get a correct value and the dimension of the constant of viscosity. (Example: viscosity = $1x10^{-4}$ x $4x10^{-2}$ = $4x10^{-6}$ = 0.000004 m^2/s) (Reynolds 2320 x 25.13 = 58308) But why would someone do that? Who guarantees that the results are correct if the measurement does not fit the theory? Let's see what will happen with the famous Moody's chart when is corrected value of Reynolds: it will become clear that the friction factor has nothing to do with Reynolds and that the Reynolds number does not exist. This diagram is a monumental monument to the wrong measurement. That's why we measure again!

So we need to critically and the soberly consider our methods of measuring of viscosity and the clarify whether those measures diffusion constant or viscosity, or if at all, something measures, or just compare.

"Professors" whenever you drink a beer remember to James Prescott Joule, Leonhard Euler and Sir Isaac Newton!

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fluid, fluid friction, viscosity, hydrodynamics, fluid flow, laminar flow, stationary flow, relativity, porous media, filtration, Newton, Euler, Poaseuille, Joule, Stokes, Reynolds, Darcy, catch-32.