Fedex literature review essay sample

Viscosity of some fluids

Fluid Air (at Benzene Water (at 18 ◦ C) Olive oil (at 20 ◦ C) Motor oil SAE 50 Honey Ketchup Peanut butter Tar Earth lower mantle 18 ◦ C) Viscosity [cP] 0. 02638 0. 5 1 84 540 2000–3000 50000–70000 150000–250000 3 × 1010 3 × 1025

Table: Viscosity of some fluids

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Shear dependent viscosity Models with pressure dependent viscosity Models with stress dependent viscosity Models with discontinuous rheology

Models with variable viscosity

General form: $T = -pI + 2\mu(D, T)D$

S

(2. 1)

Particular models mainly developed by chemical engineers.

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Ostwald–de Waele power law

¨ Wolfgang Ostwald. Uber die Geschwindigkeitsfunktion der Viskosit¨t disperser Systeme. I. Colloid Polym. Sci., 36: 99–117, a 1925 A. de Waele. Viscometry and plastometry. J. Oil Colour Chem. Assoc., 6: 33–69, 1923 $\mu(D) = \mu_0 | D| n-1$ (2. 2)

Fits experimental data for: ball point pen ink, molten chocolate, aqueous dispersion of polymer latex spheres

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Carreau Carreau–Yasuda

Pierre J. Carreau. Rheological equations from molecular network theories. J. Rheol., 16(1): 99–127, 1972 Kenji Yasuda. Investigation of the analogies between viscometric and linear viscoelastic properties of polystyrene fluids. PhD thesis, Massachusetts Institute of Technology. Dept. of Chemical Engineering., 1979 $\mu_0 - \mu_\infty$ $(1 + \alpha | D| 2)$ 2 n n−1 a

$\mu(D) = \mu_\infty +$

(2. 3) (2. 4)

$\mu(D) = \mu_\infty + (\mu_0 - \mu_\infty)$ $(1 + \alpha \mid D\mid a)$ Fits experimental data for: molten polystyrene Josef M´lek a Non-Newtonian fluids

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Eyring

Henry Eyring. Viscosity, plasticity, and diffusion as examples of absolute reaction rates. J. Chem. Phys., 4(4): 283–291, 1936 Francis Ree, Taikyue Ree, and Henry Eyring. Relaxation theory of transport problems in condensed systems. Ind. Eng. Chem., 50(7): 1036–1040, 1958 $\mu(D) = \mu_\infty + (\mu_0 - \mu_\infty)$ arcsinh $(\alpha \mid D\mid)$ $\alpha \mid D\mid$ arcsinh $(\alpha_1 \mid D\mid)$ arcsinh $(\alpha_2 \mid D\mid)$ $\mu(D) = \mu_0 + \mu_1 + \mu_2$ $\alpha_1 \mid D\mid$ $\alpha_2 \mid D\mid$ (2. 5) (2. 6)

Fits experimental data for: napalm (coprecipitated aluminum salts of naphthenic and palmitic acids; jellied gasoline), 1% nitrocelulose in 99% butyl acetate Josef M´lek a Non-Newtonian fluids

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Cross

Malcolm M. Cross. Rheology of non-newtonian fluids: A new flow equation for pseudoplastic systems. J. Colloid Sci., 20(5): 417–437, 1965 μ(D) = μ∞ + μ0 − μ∞ 1 + α | D| n (2. 7)

Fits experimental data for: aqueous polyvinyl acetate dispersion, aqueous limestone suspension

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Sisko

A. W. Sisko. The flow of lubricating greases. Ind. Eng. Chem., 50(12): 1789–1792, 1958 μ(D) = μ∞ + α | D| n−1 Fits experimental data for: lubricating greases (2. 8)

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Barus

C. Barus. Isotherms, isopiestics and isometrics relative to viscosity. Amer. J. Sci., 45: 87–96, 1893 μ(T) = μref eβ(p−pref) Fits experimental data for: mineral oils1 , organic liquids2 (2. 9)

Michael M. Khonsari and E. Richard Booser. Applied Tribology: Bearing Design and Lubrication. John Wiley & Sons Ltd, Chichester, second edition, 2008 2 P. W. Bridgman. The effect of pressure on the viscosity of forty-four pure liquids. Proc. Am. Acad. Art. Sci., 61(3/12): 57–99, FEB-NOV 1926 Josef M´lek a Non-Newtonian fluids

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Ellis

Seikichi Matsuhisa and R. Byron Bird. Analytical and numerical solutions for laminar flow of the non-Newtonian Ellis fluid. AIChE J., 11(4): 588–595, 1965 μ(T) = μ0 1 + α | Tδ | n−1 (2. 10)

Fits experimental data for: 0. 6% w/w carboxymethyl cellulose (CMC) solution in water, poly(vynil chloride)3

T. A. Savvas, N. C. Markatos, and C. D. Papaspyrides. On the flow of non-newtonian polymer solutions. Appl. Math. Modelling, 18(1): 14–22, 1994 Josef M´lek a Non-Newtonian fluids

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Glen

J. W. Glen. The creep of polycrystalline ice. Proc. R. Soc. A-Math. Phys. Eng. Sci., 228(1175): 519–538, 1955 μ(T) = α | Tδ | n−1 Fits experimental data for: ice (2. 11)

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Seely

Gilbert R. Seely. Non-newtonian viscosity of polybutadiene solutions. AIChE J., 10(1): 56–60, 1964 μ(T) = μ∞ + (μ0 − μ∞) e − | Tδ |

τ0

(2. 12)

Fits experimental data for: polybutadiene solutions

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Blatter

Erin C. Pettit and Edwin D. Waddington. Ice flow at low deviatoric stress. J. Glaciol., 49(166): 359–369, 2003 H Blatter. Velocity and stress-fields in grounded glaciers – a simple algorithm for including deviatoric stress gradients. J. Glaciol., 41(138): 333–344, 1995 μ(T) = 2

A | Tδ | +

2 τ0

n−1 2

(2. 13)

Fits experimental data for: ice

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Shear dependent viscosity Models with pressure dependent viscosity Models with stress dependent viscosity Models with discontinuous rheology

Bingham Herschel–Bulkley

C. E. Bingham. Fluidity and plasticity. McGraw–Hill, New York, 1922 Winslow H. Herschel and Ronald Bulkley. Konsistenzmessungen von Gummi-Benzoll¨sungen. Colloid Polym. Sci., 39(4): 291–300, o August 1926 $| T\delta | > \tau *$ $| T\delta | \leq \tau *$ if and only if $T\delta = \tau * $ if and only if $D= 0$ $D + 2\mu(| D|)D$ $| D|$

(2. 14)

Fits experimental data for: paints, toothpaste, mango jam

Santanu Basu and U. S. Shivhare. Rheological, textural, micro-structural and sensory properties of mango jam. J. Food Eng., 100(2): 357–365, 2010 Josef M´lek a Non-Newtonian fluids

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Rivlin–Ericksen fluids

Rivlin–Ericksen

R. S. Rivlin and J. L. Ericksen. Stress-deformation relations for isotropic materials. J. Ration. Mech. Anal., 4: 323–425, 1955 R. S. Rivlin and K. N. Sawyers. Nonlinear continuum mechanics of viscoelastic fluids. Annu. Rev.

Fluid Mech., 3: 117–146, 1971 General form: $T = -pI + f(A_1\ A_2\ A_3\ . . .)$ (3. 1) where $A_1 = 2D$ $dA_{n-1} + A_{n-1} L + L A_{n-1}$ $A_n = dt$ (3. 2a) (3. 2b)

d where dt denotes the usual Lagrangean time derivative and L is the velocity gradient. Josef M´lek a Non-Newtonian fluids

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Rivlin–Ericksen fluids

Criminale–Ericksen–Filbey

William O. Criminale, J. L. Ericksen, and G. L. Filbey. Steady shear flow of non-Newtonian fluids. Arch. Rat. Mech. Anal., 1: 410–417, 1957 $T = -pI + \alpha_1 A_1 + \alpha_2 A_2 + \alpha_3 A_2\ 1$ (3. 3)

Fits experimental data for: polymer melts (explains mormal stress differences)

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Rivlin–Ericksen fluids

Reiner–Rivlin

M. Reiner. A mathematical theory of dilatancy. Am. J. Math., 67(3): 350–362, 1945 T = −pI + 2μD + μ1 D2 Fits experimental data for: N/A (3. 4)

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Maxwell

J. Clerk Maxwell. On the dynamical theory of gases. Philos. Trans. R. Soc., 157: 49–88, 1867

T = −pI + S S + λ1 S = 2μD dM − LM − ML dt Fits experimental data for: N/A M = def Josef M´lek a Non-Newtonian fluids

(4. 1a) (4. 1b)

(4. 2)

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Oldroyd-B

J. G. Oldroyd. On the formulation of rheological equations of state. Proc. R. Soc. A-Math. Phys. Eng. Sci., 200(1063): 523–541, 1950

T = −πI + S S + λS = η1 A1 + η2 A1 Fits experimental data for: N/A

(4. 3a) (4. 3b)

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Oldroyd 8-constants

J. G. Oldroyd. On the formulation of rheological equations of state. Proc. R. Soc. A-Math. Phys. Eng. Sci., 200(1063): 523–541, 1950 T = −πI + S λ3 λ5 λ6 (DS + SD) + (Tr S) D + (S : D) I 2 2 2 λ7 (D : D) I = −μ D + λ2 D + λ4 D2 + 2

(4. 4a)

S + λ1 S +

(4. 4b)

Fits experimental data for: N/A

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Burgers

J. M. Burgers. Mechanical considerations – model systems – phenomenological theories of relaxation and viscosity. In First report on viscosity and plasticity, chapter 1, pages 5–67. Nordemann Publishing, New York, 1939

$T = -\pi I + S$ $S + \lambda_1 S + \lambda_2 S = \eta_1 A_1 + \eta_2 A_1$ Fits experimental data for: N/A

(4. 5a) (4. 5b)

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Giesekus

H. Giesekus. A simple constitutive equation for polymer fluids based on the concept of deformation-dependent tensorial mobility. J. Non-Newton. Fluid Mech., 11(1-2): 69–109, 1982

T = −πI + S S + λS − αλ2 2 S = −μD μ

(4. 6a) (4. 6b)

Fits experimental data for: N/A

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Phan-Thien–Tanner
N. Phan Thien. Non-linear network viscoelastic model. J. Rheol., 22(3): 259–283, 1978 N. Phan Thien and Roger I. Tanner. A new constitutive equation derived from network theory. J. Non-Newton. Fluid Mech., 2(4): 353–365, 1977

T = −πI + S Y S + λS + λξ (DS + SD) = −μD 2 Y = e Fits experimental data for: N/A Josef M´lek a Non-Newtonian fluids

(4. 7a) (4. 7b) (4. 7c)

−ε λ Tr S μ

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Johnson–Segalman

M. W. Johnson and D. Segalman. A model for viscoelastic fluid behavior which allows non-affine deformation. J. Non-Newton. Fluid Mech., 2(3): 255–270, 1977

$T = -pI + S$ (4. 8a) $S = 2\mu D + S$ (4. 8b) $S + \lambda$ $dS + S (W - aD) + (W - aD) S$ $dt = 2\eta D$ (4. 8c)

Fits experimental data for: spurt

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Johnson–Tevaarwerk

K. L. Johnson and J. L. Tevaarwerk. Shear behaviour of elastohydrodynamic oil films. Proc. R. Soc. A-Math. Phys. Eng. Sci., 356(1685): 215–236, 1977

$T = -pI + S$ S $S + \alpha \sinh = 2\mu D$ s_0 Fits experimental data for: lubricants

(4. 9a) (4. 9b)

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Kaye–Bernstein–Kearsley–Zapas

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B. Bernstein, E. A. Kearsley, and L. J. Zapas. A study of stress relaxation with finite strain. Trans. Soc. Rheol., 7(1): 391–410, 1963 I-Jen Chen and D. C. Bogue. Time-dependent stress in polymer melts and review of viscoelastic theory. Trans. Soc. Rheol., 16(1): 59–78, 1972 t

T=

ξ=−∞

∂W −1 ∂W C+ C dξ ∂I ∂II

(5. 1)

Fits experimental data for: polyisobutylene, vulcanised rubber

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