energies

MDPI

Supplementary material

Interaction between droplets and particles as oil-water slurry components

Islamova A.G., Tkachenko P.P., Pavlova K.A. and Strizhak P.A.*

National Research Tomsk Polytechnic University
30, Lenin Avenue, Tomsk, 634050, Russia
* Correspondence: Corresponding author. Tel.: +7 (3822) 701-777, ext. 1910,
E-mail: pavelspa@tpu.ru. Website: http://hmtslab.tpu.ru.

Table S1. Critical values of dimensionless numbers describing regime boundaries.

Authors	Regime boundaries	Comments
Interaction of a droplet with a substrate		
Mundo et. al. [1]	Oh $Re^{1.25}$ < 57.7 – deposition; Oh $Re^{1.25}$ = 57.7 – incipient splashing; Oh $Re^{1.25}$ >57.7 – splashing	Liquids: water, ethanol, sucrose Surface: steel
Ribeiro et. al. [2]	Water Non-Splashing: We<200; Splashing: We=273–1000; Jetting: We=800–1000 100% Jet Fuel Non-Splashing: We=156–320; Splashing: We=250–320 and 460–1570; Jetting: We=660–1570 75% JF–25% HVO Non-Splashing: We=156–255; Splashing: We=265–316 and 465–1570; Jetting: We=560–1570 50% JF–50% HVO Non-Splashing: We=165–330; Splashing: We=495–1630; Jetting: We=610–1630	Liquids: water, 100% Jet Fuel, 75% JF–25% HVO, 50% JF–50% HVO Surface: perspex
Range and Feuillebois [3]	Splash: $We_{cr}=k\log^{n}(R_d/Ra)$	Liquids: water, ethanol, water glycerol mixtures Surface: 24 surfaces with different roughness (plexiglas, aluminum, glass, paper). The expression obtained [4] is used. Coefficients *n* and *k* are obtained by approximation for different liquids.
Wal et. al. [5]	Dry surface: If $OhRe^{0.609}$>0.85 – Splash; If $OhRe^{0.609}$<0.85 – No splash. Wet surface:	Liquids: heptane, nonane, decane, dodecane, tetradecane, hexadecane, DI water, 30% glycerol/water, methanol, ethanol, *n*-propanol, butanol

	If $OhRe^{1.17}$>63 – Splash; If $OhRe^{1.17}$<63 – No splash	Surface: aluminum
Cossali et. al. [6]	Deposition: $WeOh^{-0.4}/(2100+5880\delta^{1.44})<1$; Splash: $WeOh^{-0.4}/(2100+5880\delta^{1.44})>1$	Liquids: water, water glycerol mixtures 200< We< 1600, $2.2\cdot10^{-3}$ < Oh < 0.141 δ – liquid film thickness;
Xian-Yan He et. al. [7]	Deposition: T^*+3.8Re/1000=2.13, T^*> 1.876; Receding: T^*+3.8Re/1000=2.163, T^*> 1.876; Prompt Splashing: T^*+3.8Re/1000=2.163, T^*> 1.876; T^*+3.8Re/1000=2.22, T^*> 1.876 and T^*=1.876 66.8<Re<89.6; Retraction Deposition: T^*+3.8Re/1000=2.22, T^*> 1.876 and T^*+3.3Re/1000=2.199, *Re<89.6;* Retraction Splashing: Re>89.6 and T^*=1.835–1.903	Liquids: blast furnace slag; Surface: quartz glass
Jadidbonab et. al.[8]	Splash: We>490, T=100–270°C; Breakup: We ≥ 490, T=270–350°C; Breakup-rebound: We=19–490, T≈350°C	Liquid: summer diesel fuel; Surface: aluminum
Interaction of droplet with a particle		
Pawar et. al. [9]	D_d/D_p=1.37 Agglomeration: We=0.34–52, B<0.2; Separation: We=30–52, B>0.2	Liquids: water; Surface: glass
Jadidbonab et. al. [10]	Coating: We=240–700, T=140–700 °C; Splash: We=750–870, T=140–220 °C; Breakup: We=425–700, T=120–320 °C; Rebound: We=240–350, T=320–340 °C	Liquid: diesel fuel; Surface: brass
Mitra et. al. [11]	Coating: We<50, T=20–175 °C; Breakup: for water We>50; for isopropanol and acetone We>80; Rebound: T=250 °C	Liquids: water, isopropanol, acetone; Surface: brass
Mitra et. al.[12]	Breakup: for water 1) D_d/D_p=0.228, We>16.5; 2) D_d/D_p=0.249, We>40.6; 3) D_d/D_p=0.287, We>63.5; for isopropanol We>85.2	Liquids: water, isopropanol; Surface: bras T=250 °C
Mitra et. al. [13]	Rebound: We < 50, contact times ~18–19 ms; Disintegration: We > 50, contact time ~14 ms	Liquids: water; Surface: brass; T= 350 °C
Charalampous and Hardalupas [14]	Deposition: We < 400, Oh=0.007–0.009; Splash: We < 400, Oh=0.007–0.009	Liquids: water; Surface: glass

References

[1] C. Mundo, M. Sommerfeld, C. Tropea, Droplet-wall collisions: Experimental studies of the deformation and breakup process, Int. J. Multiph. Flow. 21 (1995) 151–173. https://doi.org/10.1016/0301-9322(94)00069-V.

[2] D.F.S. Ribeiro, A.R.R. Silva, M.R.O. Panão, Insights into Single Droplet Impact Models upon Liquid Films Using Alternative Fuels for Aero-Engines, Appl. Sci. 2020, Vol. 10, Page 6698. 10 (2020) 6698. https://doi.org/10.3390/APP10196698.

[3] K. Range, F. Feuillebois, Influence of Surface Roughness on Liquid Drop Impact, J. Colloid Interface Sci. 203 (1998) 16–30. https://doi.org/10.1006/JCIS.1998.5518.

[4] C.D. Stow, M.G. Hadfield, An experimental investigation of fluid flow resulting from the impact of a water drop with an unyielding dry surface, Proc. R. Soc. London. A. Math. Phys. Sci. 373 (1981) 419–441. https://doi.org/10.1098/RSPA.1981.0002.

[5] R.L. Vander Wal, G.M. Berger, S.D. Mozes, The splash/non-splash boundary upon a dry surface and thin fluid film, Exp. Fluids. 40 (2006) 53–59. https://doi.org/10.1007/S00348-005-0045-1/FIGURES/2.

[6] G.E. Cossali, A. Coghe, M. Marengo, The impact of a single drop on a wetted solid surface, Exp. Fluids 1997 226. 22 (1997) 463–472. https://doi.org/10.1007/S003480050073.

[7] X.Y. He, X. Zhu, H. Wang, Y. Tan, B. Ding, Y.W. Lv, Q. Liao, Dynamic behaviors and regime map of a molten blast furnace slag droplet impacting a solid surface, Fuel. 279 (2020) 118451. https://doi.org/10.1016/J.FUEL.2020.118451.

[8] H. Jadidbonab, I. Malgarinos, I. Karathanassis, N. Mitroglou, M. Gavaises, We-T classification of diesel fuel droplet impact regimes, Proc. R. Soc. A Math. Phys. Eng. Sci. 474 (2018). https://doi.org/10.1098/RSPA.2017.0759.

[9] S.K. Pawar, F. Henrikson, G. Finotello, J.T. Padding, N.G. Deen, A. Jongsma, F. Innings, J.A.M.H.A.M.H. Kuipers, An experimental study of droplet-particle collisions, Powder Technol. 300 (2016) 157–163.

[10] H. Jadidbonab, N. Mitroglou, I. Karathanassis, M. Gavaises, Experimental Study of Diesel-Fuel Droplet Impact on a Similarly Sized Polished Spherical Heated Solid Particle, Langmuir. 34 (2017) 36–49. https://doi.org/10.1021/ACS.LANGMUIR.7B01658.

[11] S. Mitra, M.J. Sathe, E. Doroodchi, R. Utikar, M.K. Shah, V. Pareek, J.B. Joshi, G.M. Evans, Droplet impact dynamics on a spherical particle, Chem. Eng. Sci. 100 (2013) 105–119. https://doi.org/10.1016/j.ces.2013.01.037.

[12] S. Mitra, T.B.T. Nguyen, E. Doroodchi, V. Pareek, J.B. Joshi, G.M. Evans, On wetting characteristics of droplet on a spherical particle in film boiling regime, Chem. Eng. Sci. 149 (2016) 181–203. https://doi.org/10.1016/j.ces.2016.04.003.

[13] S. Mitra, G. Evans, Dynamic Surface Wetting and Heat Transfer in a Droplet-Particle System of Less Than Unity Size Ratio, Front. Chem. 6 (2018). https://doi.org/10.3389/fchem.2018.00259.

[14] G. Charalampous, Y. Hardalupas, Collisions of droplets on spherical particles, Phys. Fluids. 29 (2017) 103305. https://doi.org/10.1063/1.5005124.