Karlsruhe Institute of Technology | TECHNISCHE UNIVERSITÄT DARMSTADT | TRR 150 Turbulent, chemically reactive, multi-phase flows near walls | Friedrich-und-Elisabeth BOYSEN Stiftung für Forschung und Innovation

Jahrestreffen ProcessNet Fachgruppen
Mehrphasenströmungen und CFD
9.-10. März 2021

Drop impingement on heated hydrophobic surfaces

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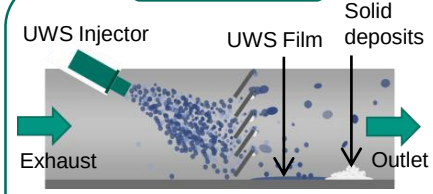
1 - Motivation



Prevent urea-water-solution (UWS) film and deposits in exhaust aftertreatment

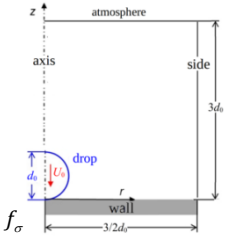
2 - Numerical method and set-up

$$\frac{\partial C}{\partial t}+\nabla\cdot(\mathbf{u}C)=M\nabla^2\phi \qquad M=\chi\varepsilon^2$$

$$\phi=\frac{\lambda}{\varepsilon^2}C(C^2-1)-\lambda\nabla^2C+\nabla\lambda\cdot\nabla C \qquad \lambda=\frac{3\sqrt{2}}{4}\sigma\varepsilon$$

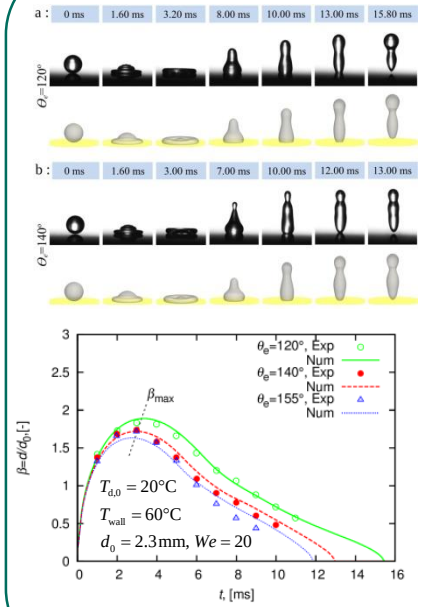
$$\frac{\partial T}{\partial t}+\nabla\cdot(\mathbf{u}T)=-\nabla(\alpha\nabla T) \qquad \alpha=\frac{k}{\rho c_p}$$

$$\frac{\partial(\rho u)}{\partial t}+\nabla\cdot(\rho\mathbf{u}\mathbf{u})=-\nabla p+\rho g+\nabla\cdot[\mu(\nabla u+(\nabla u)^{\mathrm{T}}]+f_\sigma$$



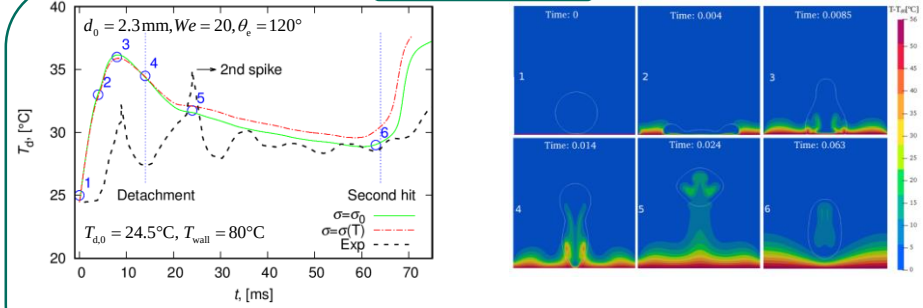
- Phase field method using Cahn-Hilliard Navier-Stokers eqs.
- Foam-extend-4.0
- Axisymmetric domain
- $Cn = \varepsilon/d_0 = 0.01$
- $\chi = 1$ m s/kg
- Water droplet in air impinging on a hot hydrophobic wall

3 - Hydrodynamics



Experiment: Guo, Maynes, Crockett and Zhao, *Int. J. Heat Mass Transfer* **137** (2019) 857-867

4 - Heat transfer



Mean drop temperature T_d over time. **1**: initial impact, **2**: maximum spreading, **3**: recoil (maximum mean temperature) **4**: detachment, **5**: bouncing, **6**: before second impact.

5 - Conclusions

- Weber number (We) and wettability (contact angle θ_e) mostly affect maximum spreading β_{max} and contact time τ
- Correlations derived from a large number of simulations varying d_0, U_0 ,θ_e

$$\beta_{max}=\frac{d_{wetted,max}}{d_0}=\sqrt{\frac{1.872+0.152\cdot We}{1-\cos\theta_e}}$$

$$\tau=\frac{1.88}{1-\cos\theta_e}We^{0.465}$$