Particulate Fouling Test Rig

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Motivation

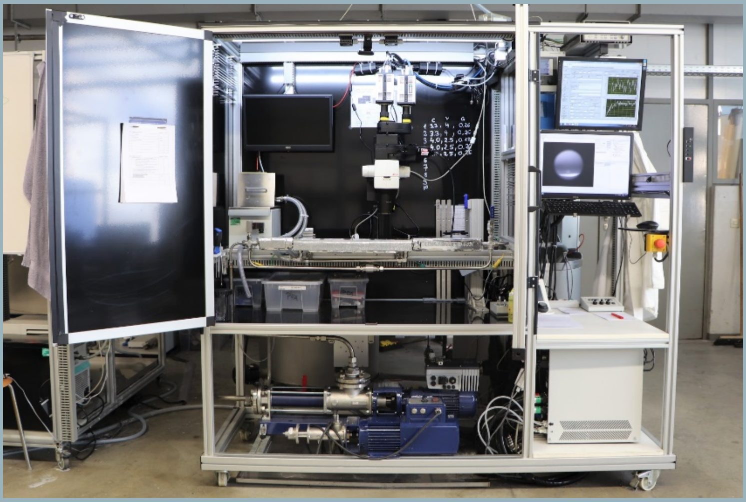
- Structuring of surfaces increases the thermo-hydraulic efficiency of heat exchangers, but also influences particle fouling.
- Dimpled surfaces inducing turbulence, causing less particle deposition on the surfaces und fouling conditions.
- An efficiency criterion for structured heat exchangers must consider not only the thermohydraulic efficiency but also the fouling propensity.
- Knowledge about the mechanisms of particle fouling on structured surfaces is necessary.

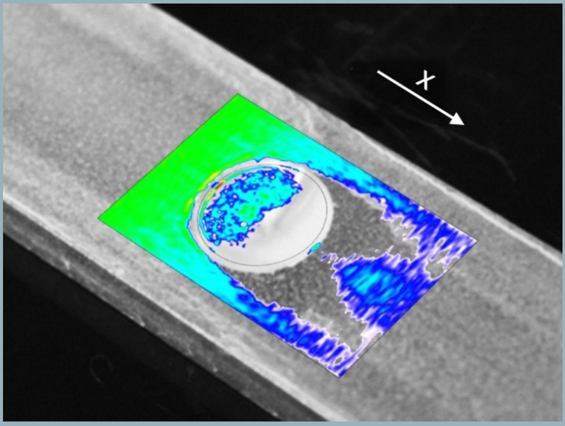
Measuring range

- Flow channel
  - Cross section: 4 mm × 18 mm
  - Length: 500 mm
- Dimple properties
  - Diameter: D = 10 mm
  - Depth t to D ratio: 0.18; 0.26; 0.35
  - Single dimple, dimple row
- Particles
  - Spherical glass particles
  - Diameter $d_{p,50}$ = 3,14 µm
- Process parameter
  - Particle concentration: 2 g/L - 10 g/L
  - Flow velocity: 1 m/s - 4 m/s
  - Reynolds number: 8,200 – 32,700
  - Suspension temperature: 30 - 50 °C
  - Heating temperature: 30 - 80 °C

Experimental setup

- Flow channel
  - Exchangeable test plates with different surface structures, e.g. dimple geometry
  - Fluidically heated
  - Optical accessibility
- Stereoscopic micro PIV
  - Three-dimensional visualization of streamlines
  - Quantification of local velocity fields
- 2 × stirred and heated 300 L Vessel
- Magnetic flow meter
- Progressive cavity pump
- Turbidity sensor





Results

- Experimental and numerical quantification of particle removal on the surface downstream of the dimple.
- Detection of significant influence factors for particulate fouling, heat transfer and turbulence on dimpled surfaces.
- Interpretation of the local fouling pattern with the measured wall shear stress distribution and resulting hydrodynamic forces acting on the particles.
- Identification of superior dimple geometry t/D = 0.26 regarding thermo-hydraulic efficiency and fouling propensity.
- Conclusion on the correlation between thermo-hydraulic efficiency and fouling propensity: process settings that are advantageous for the heat transfer efficiency are also beneficial under fouling conditions.

Literature

- Kasper, R., Deponte, H., Michel, A., Turnow, J., Augustin, W., Scholl, S., Kornev, N.: Numerical investigation of the interaction between local flow structures and particulate fouling on structured heat transfer surfaces, Int. J. Heat Fluid Flow 71 (2018), pp. 68-79
- Deponte, H., Rohwer, L., Augustin, W., Scholl, S.: Investigation of deposition and self-cleaning mechanism during particulate fouling on dimpled surfaces, Heat Mass Transf. 55 (2019), pp 3633-3644

DFG Deutsche Forschungsgemeinschaft

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