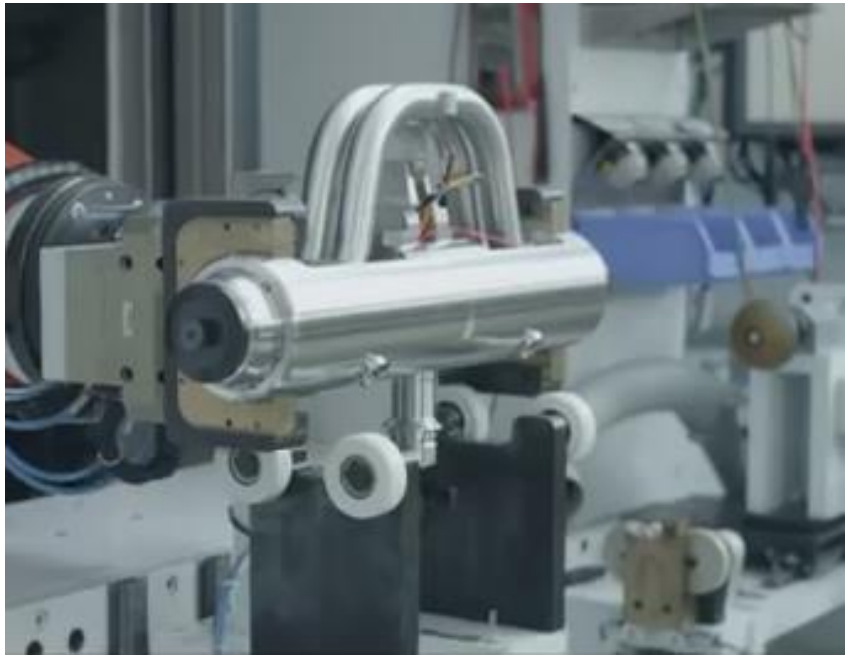
SIEMENS

10th European Fluid Mechanics Conference

A review of the theory of Coriolis flowmeter measurement errors due to entrained particles

Outline

1. Background
2. Bubble theory
3. Measurements and model
4. Outlook



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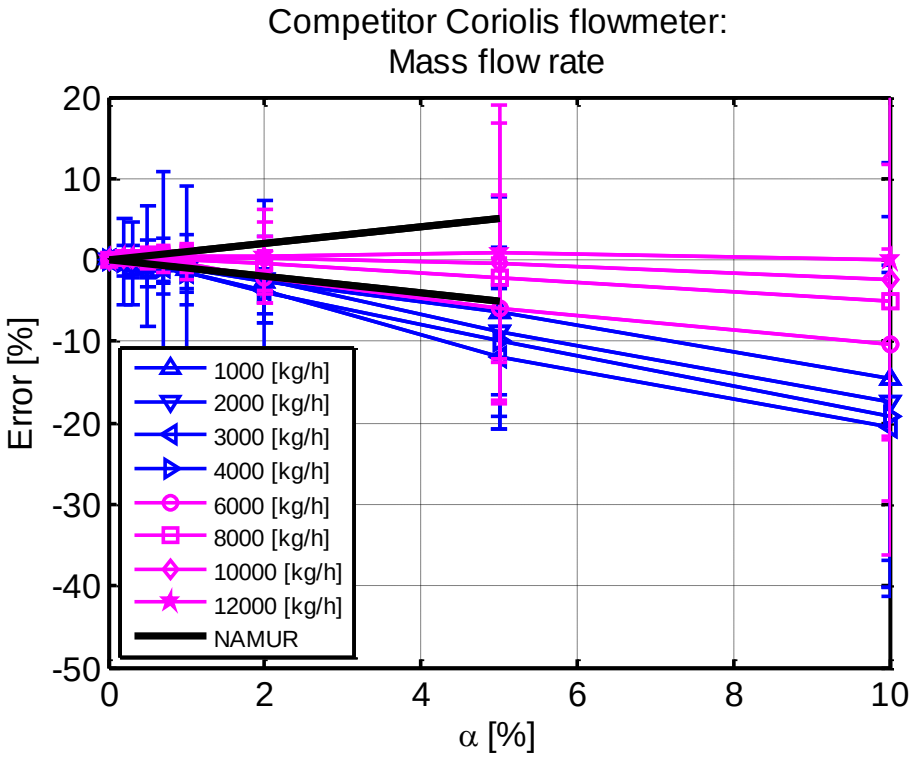
Background

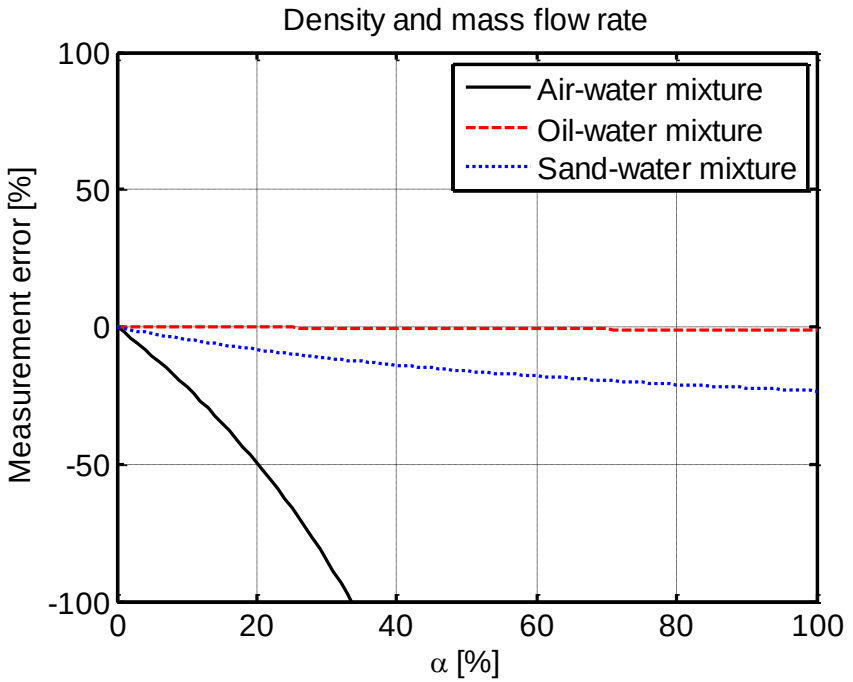
- Sometimes flow through flowmeters will consist of mixtures, e.g. water mixed with air bubbles, oil or sand
- Mixtures will cause (i) measurement errors and (ii) damping



Bubble theory

- Definitions:
  - A fluid is either a liquid or a gas
  - A particle can be either a solid or a fluid (gas bubble or liquid droplet)

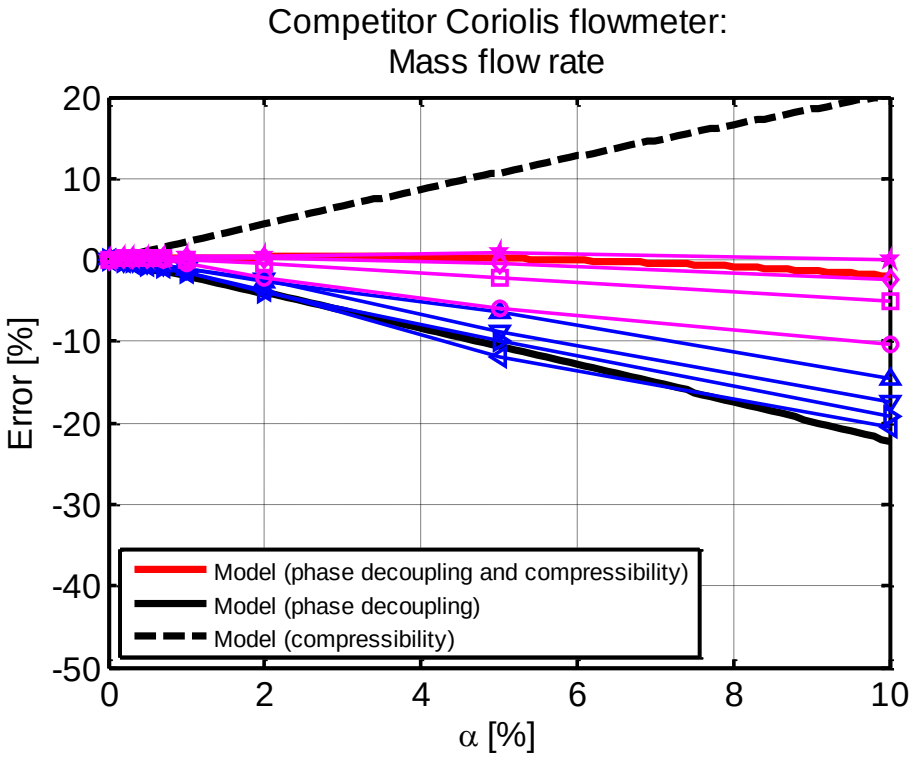
- Force on fluid:
  - $F_{f,z} = (\rho_f - \rho_p) V_p a_c F$
- Reaction force coefficient F:
  - Density, dynamic viscosity, St
- Total inertia reaction force on pipe:
  - $F_m = -\rho_f V_{f-p} a_c + F_{f,z}$
- Mass flow rate error:
  - $E_{\dot{m}} = \frac{\dot{m}_a - \dot{m}_{f-p}}{\dot{m}_{f-p}} = \frac{\alpha(\rho_f - \rho_p)(1-F)}{\alpha\rho_p + (1-\alpha)\rho_f}$



N.T.Basse, Flow Measurement and Instrumentation Vol. 37 pp. 107-118, 2014

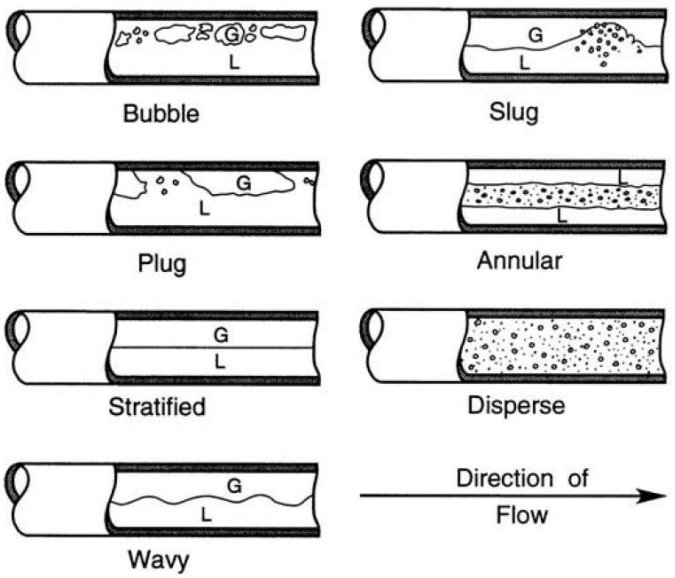
Measurements and model

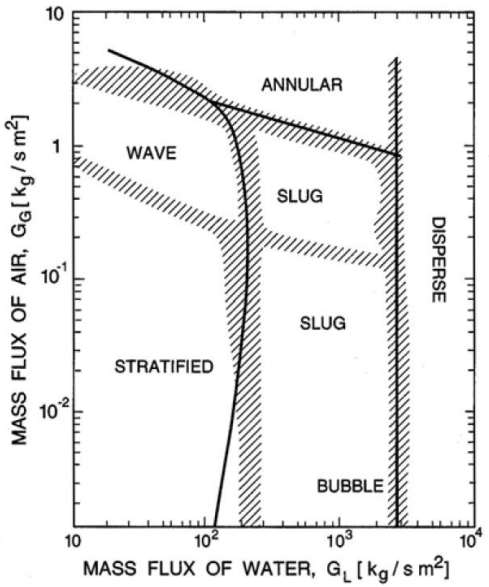
- Bubble theory (phase decoupling):
  - Negative error
- Compressibility:
  - Positive error



Outlook

- Add important effects not included:
  - Pressure loss
  - Pipe geometry
  - Flow pattern
  - Interplay between above-mentioned effects





J.Weisman, in Handbook of Fluids in Motion, pp. 409-425, 1983

Thank you for your attention!

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