Unilever is interested in the application of CFD for a number of process areas:

- **Newtonian fluids** (i.e. Backwashing)
- **Non-Newtonian (structured) liquids** (gels, emulsions etc. laminar or turbulent)

3 non-Newtonian viscosity models have been implemented into CODE_SATURNE:

\[
\tau = S \quad \text{(Newtonian)}
\]

\[
\tau = \frac{1}{n} S^n \quad \text{(Power law)}
\]

\[
\tau = \frac{1}{n} S^n \quad \text{(Herschel-Bulkley)}
\]

\[
\tau = \left(\frac{1}{n} + \frac{1}{S^n}\right) \quad \text{(Sisko)}
\]

**Static inline mixer**

- Process fluid feed lines
- Exit nozzle:
  - Area: 2.4 mm\(^2\)
  - \(\text{Re} = 81,500\)

**High shear batch mixer**

- 860 Screen holes, \(\phi=1.588\) mm
- Rotor OD=64mm
- Flow rate = 0 -1800 kg/hr
- Rotational speed 1000 – 10000 rpm

**Cavity transfer mixer (CTM)**

- **Mixing** comes from movement between cavities
- Flow tortuosity & high shear improves mixing

**Goal:** maximize mixing, minimize \(\Delta p\), power and remove leak path.

- **Model:** \(k-\varepsilon\) turbulence model with rotation correction
- **Validation:**
  - Pilot scale CTM (CEAS, UoM)
  - Rotor \(\phi = 65\) mm
  - Cavity \(\phi = 30\) mm
  - Annulus = 0.15mm
  - \(N = 100\ Hz, Q = 100\ l/h\)
  - 60 % g/w solution
  - \(\text{Re}_{\text{CAV}} = 66,450\)

**Parametric studies:** Mixing, Power/\(\Delta P\) vs. \(N, Q\)

- Tracer mass fraction (after 10 revolutions)
- Strain rate distribution (after 10 revolutions)
- Iso-Q, coloured by vorticity (after 10 revolutions)