



ADVANCED MODELLING & SIMULATION – AMS

FOOD & BEVERAGES PROCESSING

May 2019

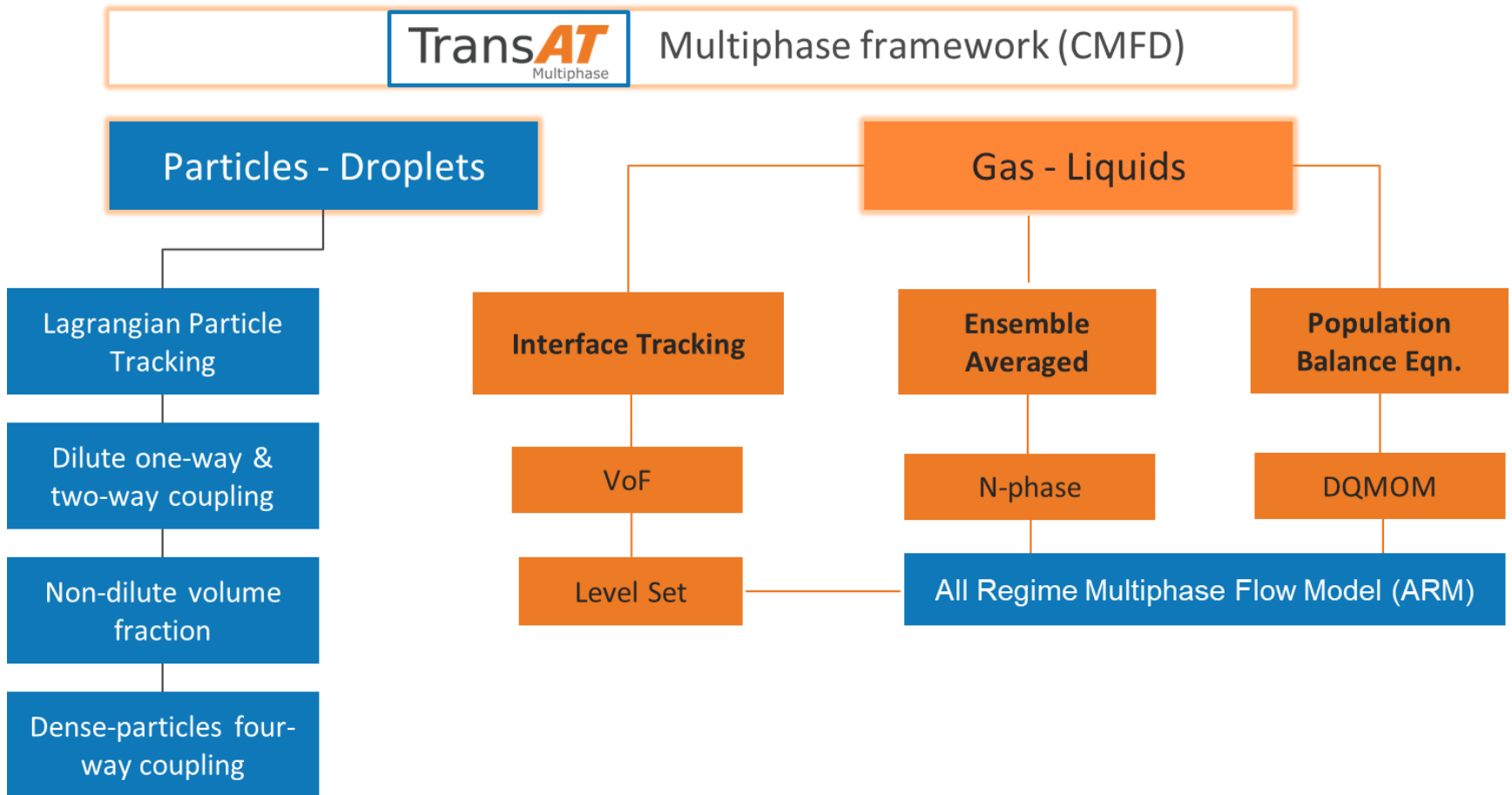
ams@poyry.com; www.poyry.com/ams



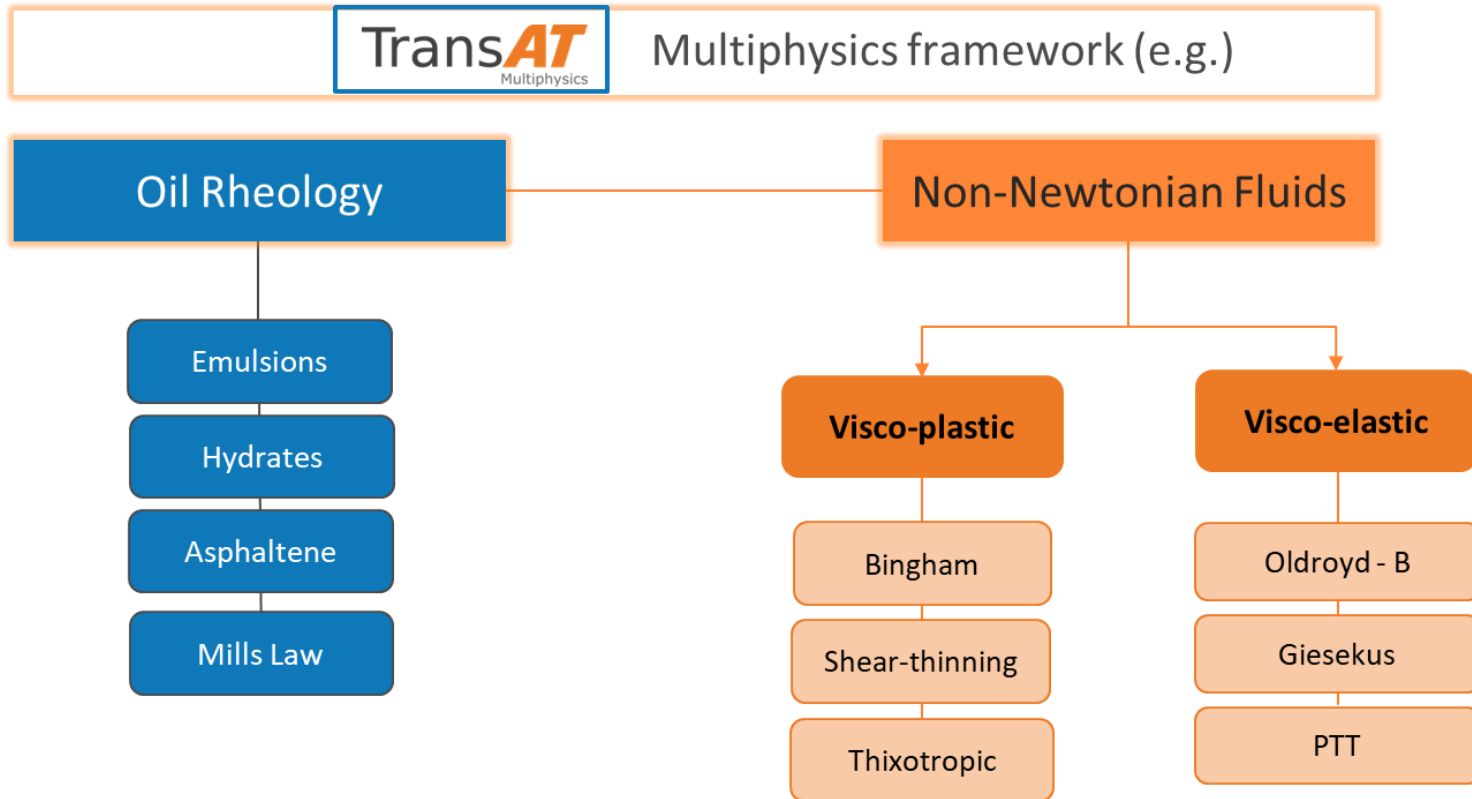
A- TransAT Multiphase, Multiphysics Technology



TRANSAT MULTIPHASE

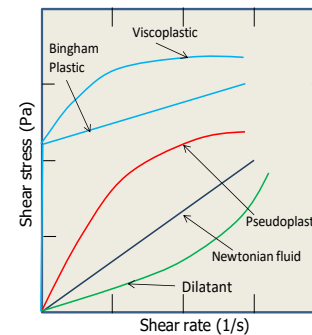


TRANSAT MULTIPHASE & MULTIPHYSICS

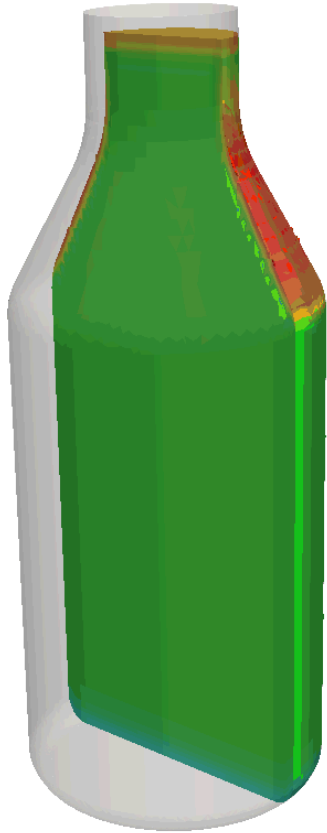


TRANSAT USP: MULTIPHASE NON-NEWTONIAN FLUID FLOWS

- Multiphase viscoplastic (shear-thinning) solver (level set)
- Multiphase viscoelastic solver (level set)
- Viscoplastic 'shear-thinning' models
 - Cross-Careau, Careau-Yasuda
 - Casson, Power Law
 - Bingham
 - Herschel-Bulkley
- Multimode viscoelastic models
 - UCM
 - Oldroyd-B
 - Linear-PTT
 - Exp-PTT
- Tested on single- and multiphase benchmark flows
- Extension to handle large Weissenberg & Deborah number flows
- Potential Applications
 - Blow moulding
 - Food processing
 - Extrusion moulding

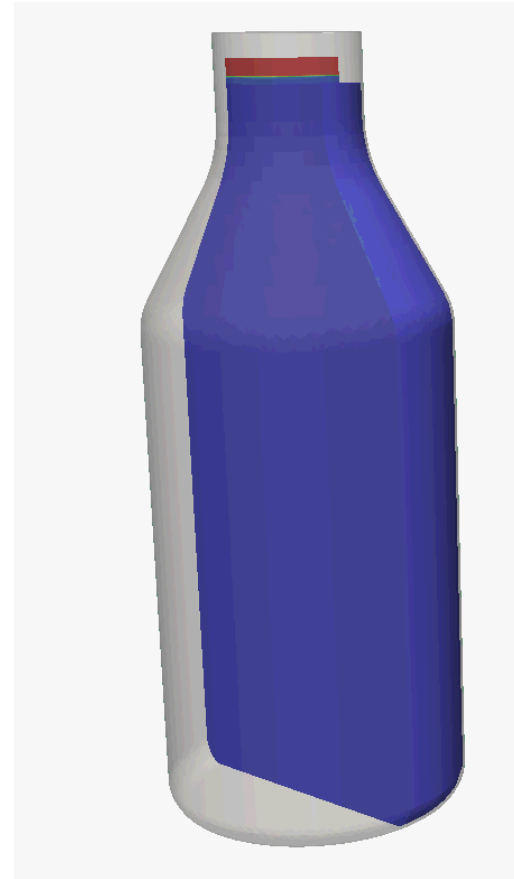


BOTTLE SHAKING, AND FILLING



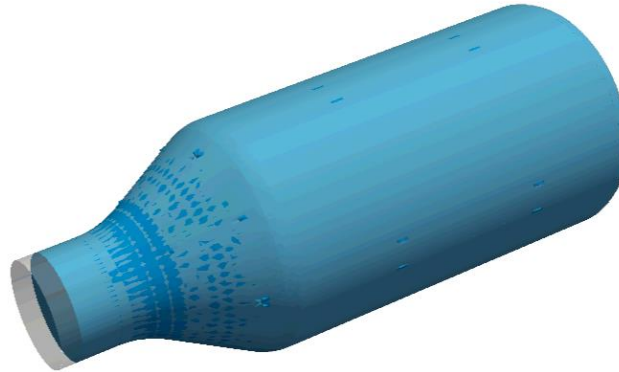
AIR-WATER MIXTURE

CARREAU-YASUDA FLUID



€ Using N-Phase average model

BOTTLE EMPTYING



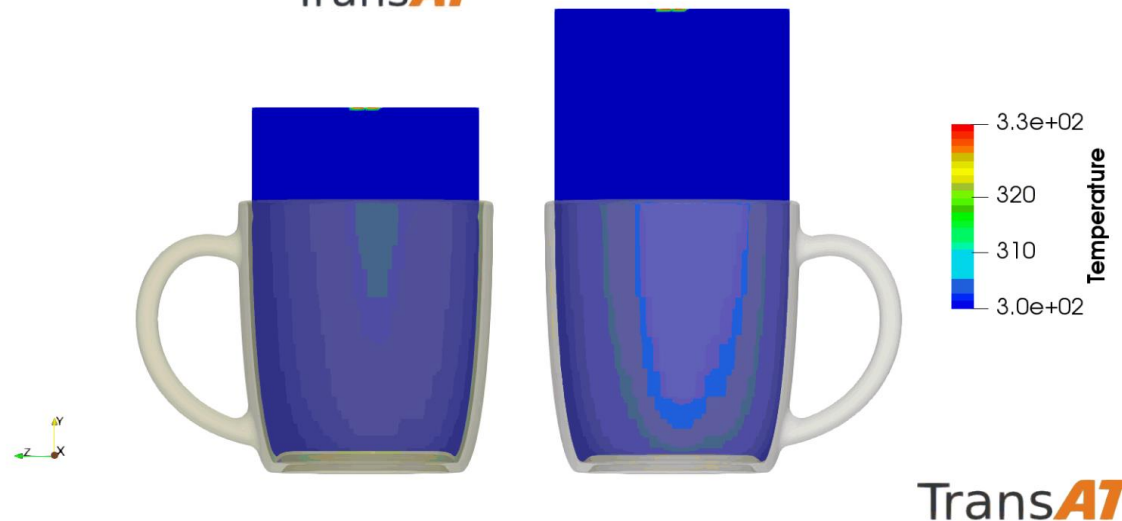
Trans**AT**

€ Using interface tracking method (Level Set), Newtonian fluid flow

COFFEE DISPENSING

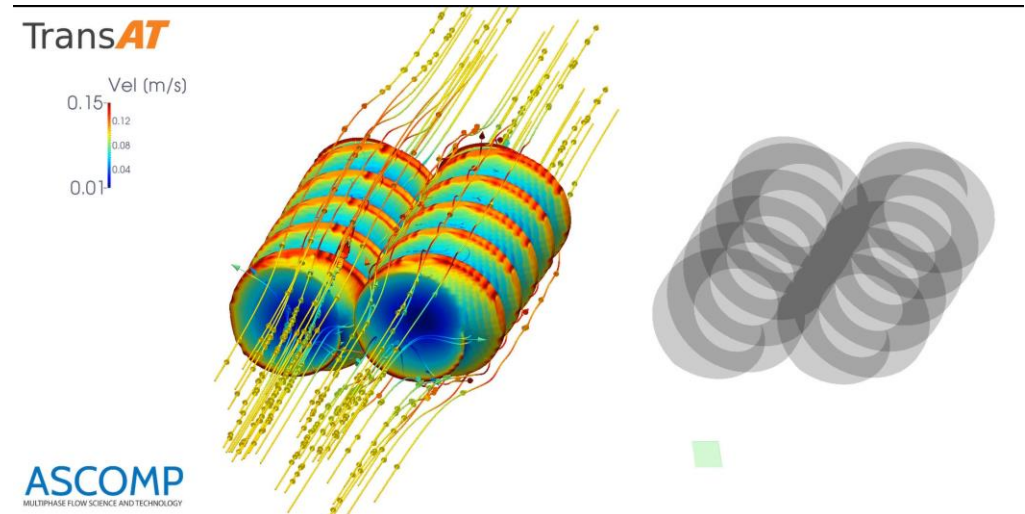


- ⊘ Using N-Phase average model
- ⊘ Newtonian fluid flow

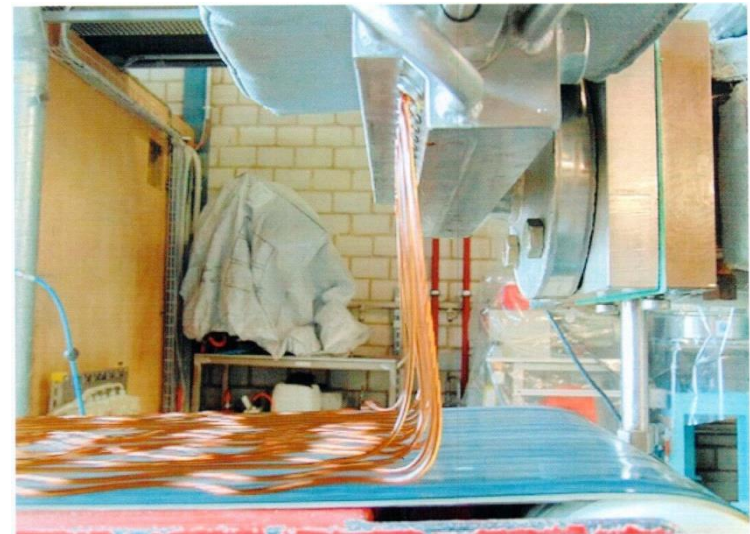
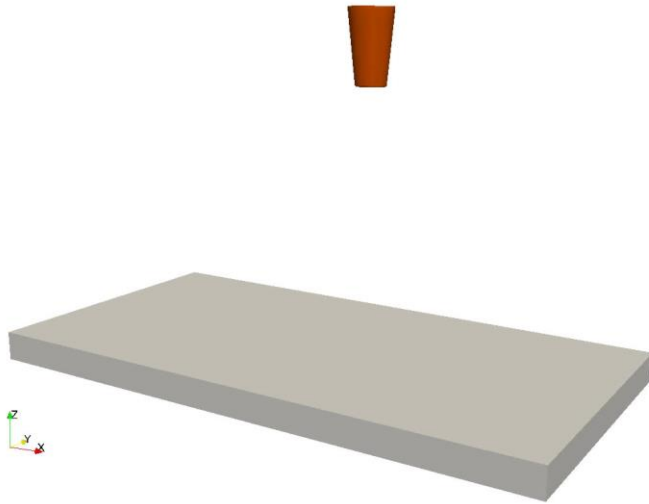


TWIN SCREW MIXER: DEMONSTRATION

- Single phase
 - Highly viscous liquid
 - Inflow-outflow problem
 - Short screw for demonstration
-
- TransAT: Moving objects feature only available for consulting
 - Available end of 2018 in product



STRAND CONVEYOR



PASTA EXTRUDER - 7 HOLE

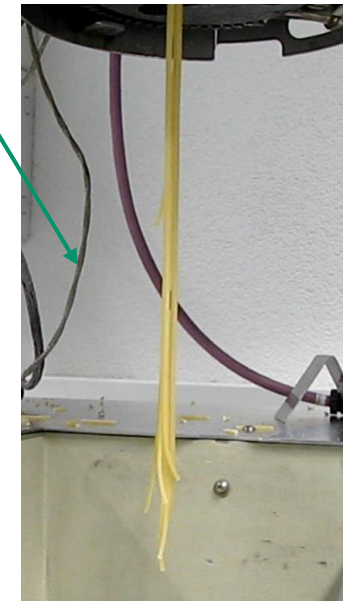
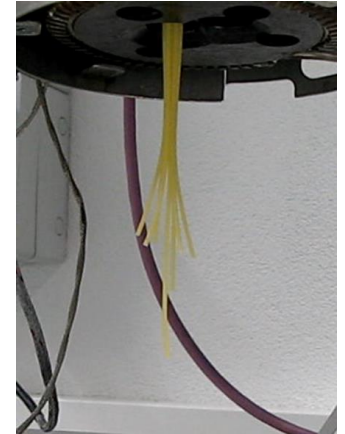
Observation

- Low flow rate, centre hole has higher flow rate
- High flow rate, peripheral holes have higher flow rate

Model

- Oldroyd-B
- Exponential-PTT

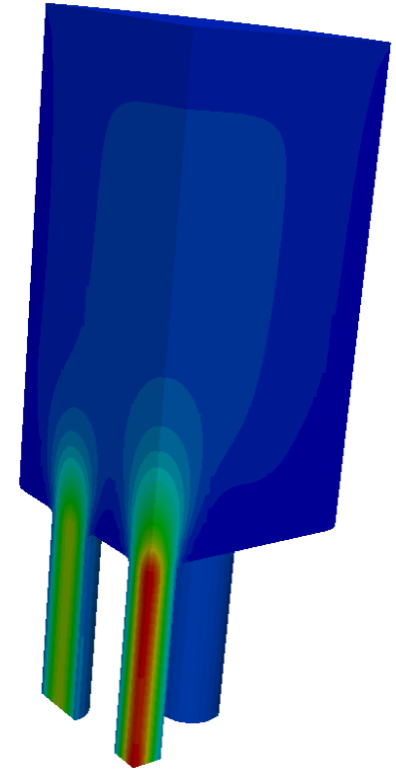
Practical applications have high Weissenberg numbers



PASTA EXTRUDER - 7 HOLE

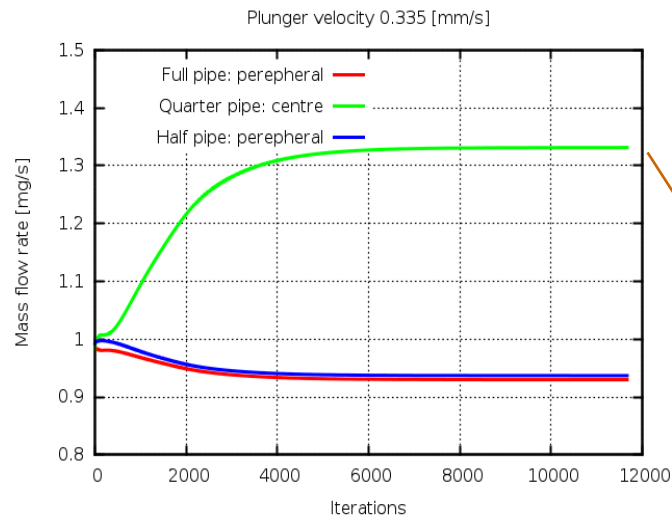
- Viscous heating at high flow rates
- Slip is encouraged by using Teflon surfaces
- Rheology is complex (6-mode UCM with large relaxation time scales: greater than 250 secs.)
- *Steady-state computations are possible with TransAT*

- Converged solutions obtained with Exp-PTT model
- No difference between centre and peripheral holes
 - For different flow rates
 - For different elastic relaxation times
- Slip is found to accentuate difference if it exists but does not create a difference
- Only upstream condition could create a difference
- Thermal effects?

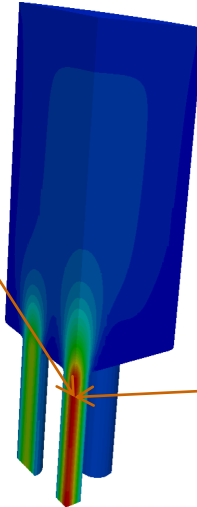
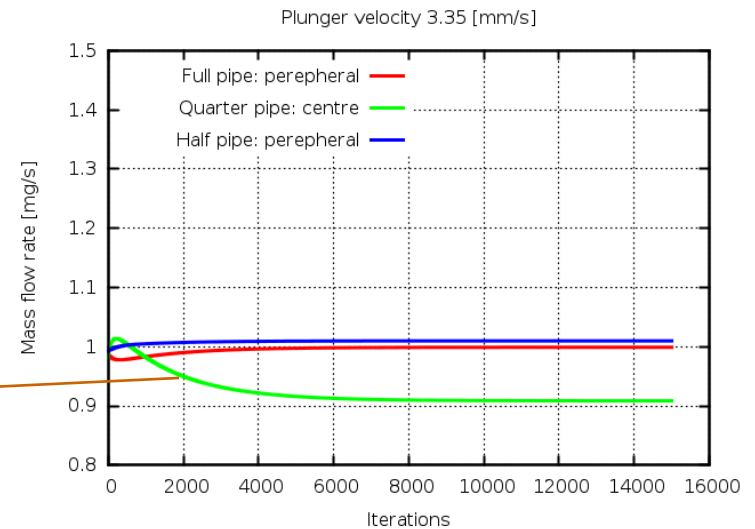


PASTA EXTRUDER - 7 HOLE

Low flow rate centre is longer



High flow rate centre is shorter



- Low flow rate → no viscous heating
 - Cold walls
- High flow rate → viscous heating in nozzle (15-20°C)
 - Can heat up whole tube
- Creates a difference between centre and periphery