XXVII SANTIAGO · CHILE IMPC·2014

XXVII International Mineral Processing Congress

Numerical simulation of water-air flow pattern in a TriFlo® cylindrical separator

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ECOMIN

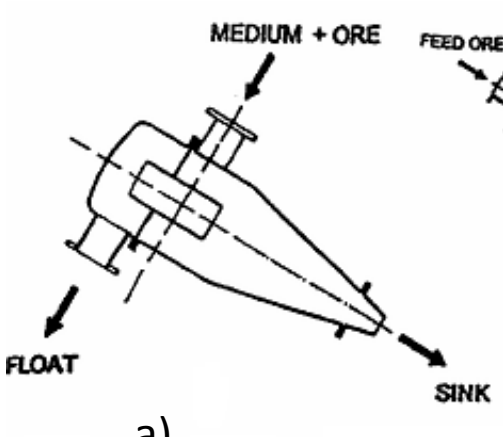
Fields of activity



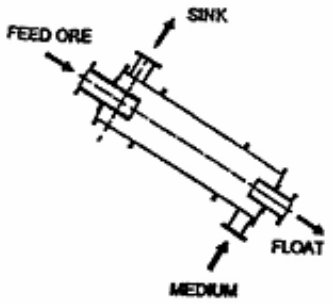
- hydromechanical processing and subsequent digestion of bio-wastes, domestic refuse and miscellaneous of municipal and industrial wastes and biomasses
- renewable energy
- ore dressing, industrial minerals
- environmental & recycling plants
- steelworks, material handling
- mining, tunneling & civil works

engineering services, assistance to plant operation and strategic consulting in above fields

Dense Medium Cyclone Separators



a)



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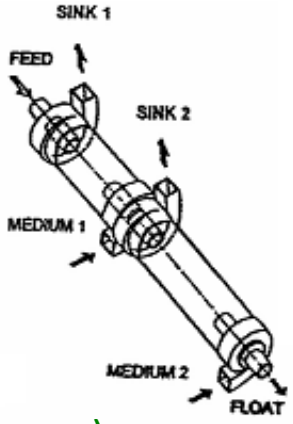


c)

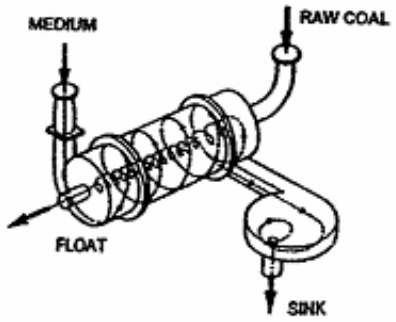
a) DutchStateMine conical cyclone

b) DynaWhirlPool DWP

c) TriFlo®

d) Larcodem

e) 3-product cyclone



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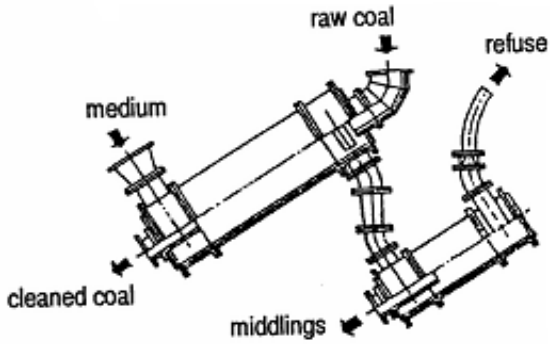


e)

TriFlo®

- cylindrical multistage separator applied in difficult separations or for 3-product separations
- 33 industrial plants
  16 pilot plants

Two stages: Why?

POTENTIAL APPLICATION FOR CHILE: COPPER PRECONCENTRATION GANGUE DISCARD

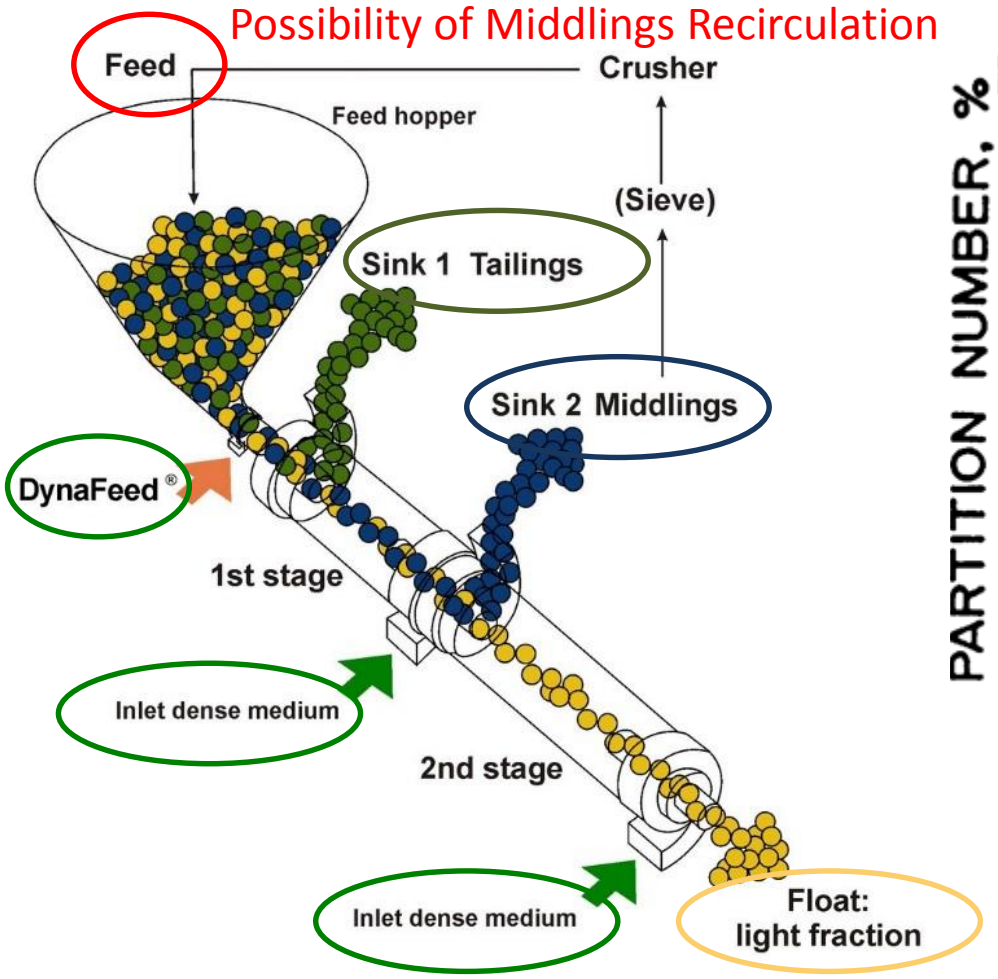
- 1st stage : rougher
- 2nd stage : cleaner > in coal prep
- 2nd stage : scavenger > in min prep
- Two density cuts (i.e 3 products) and/or 3 stages also possible

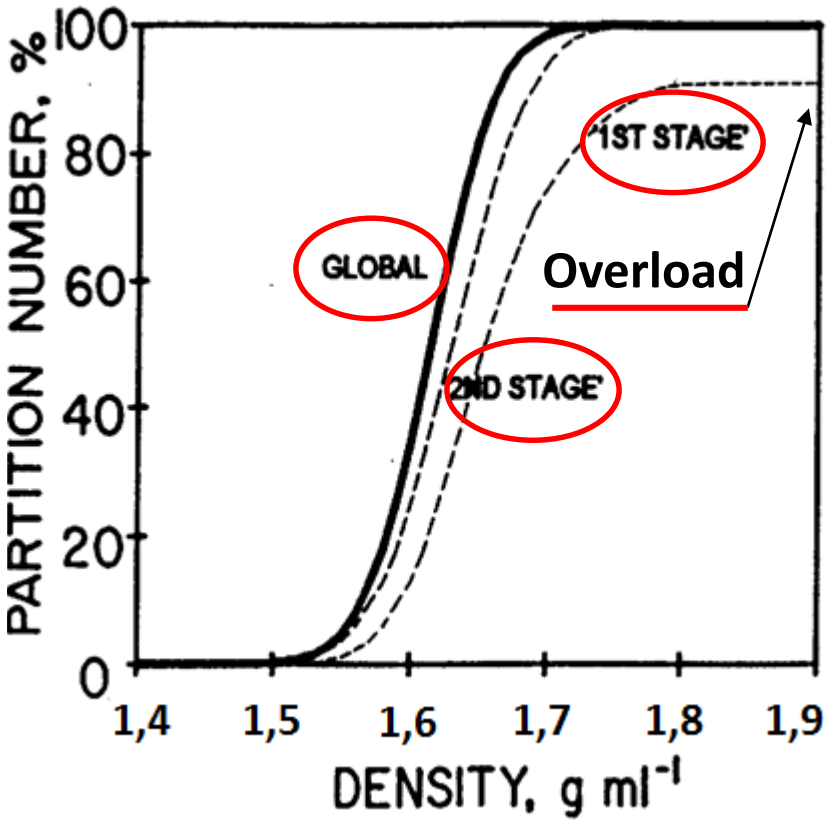
Chromite TriFlo® 400

TriFlo® 300 with Dynafeed®

Coal
TriFlo® 500
with Dynafeed®

Advantages of Rougher cleaner and rougher-cleaner with re-circulation

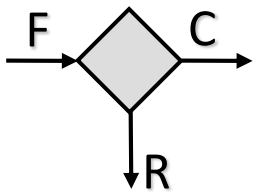
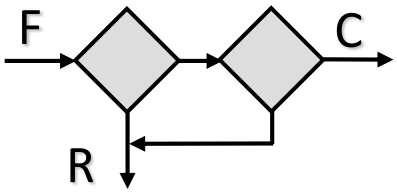
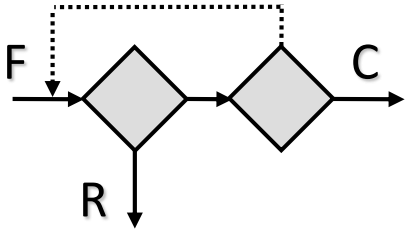
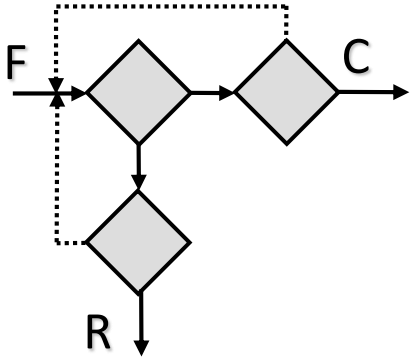




Second stage always corrects high density tails – very forgiving to feed variations

Circuits

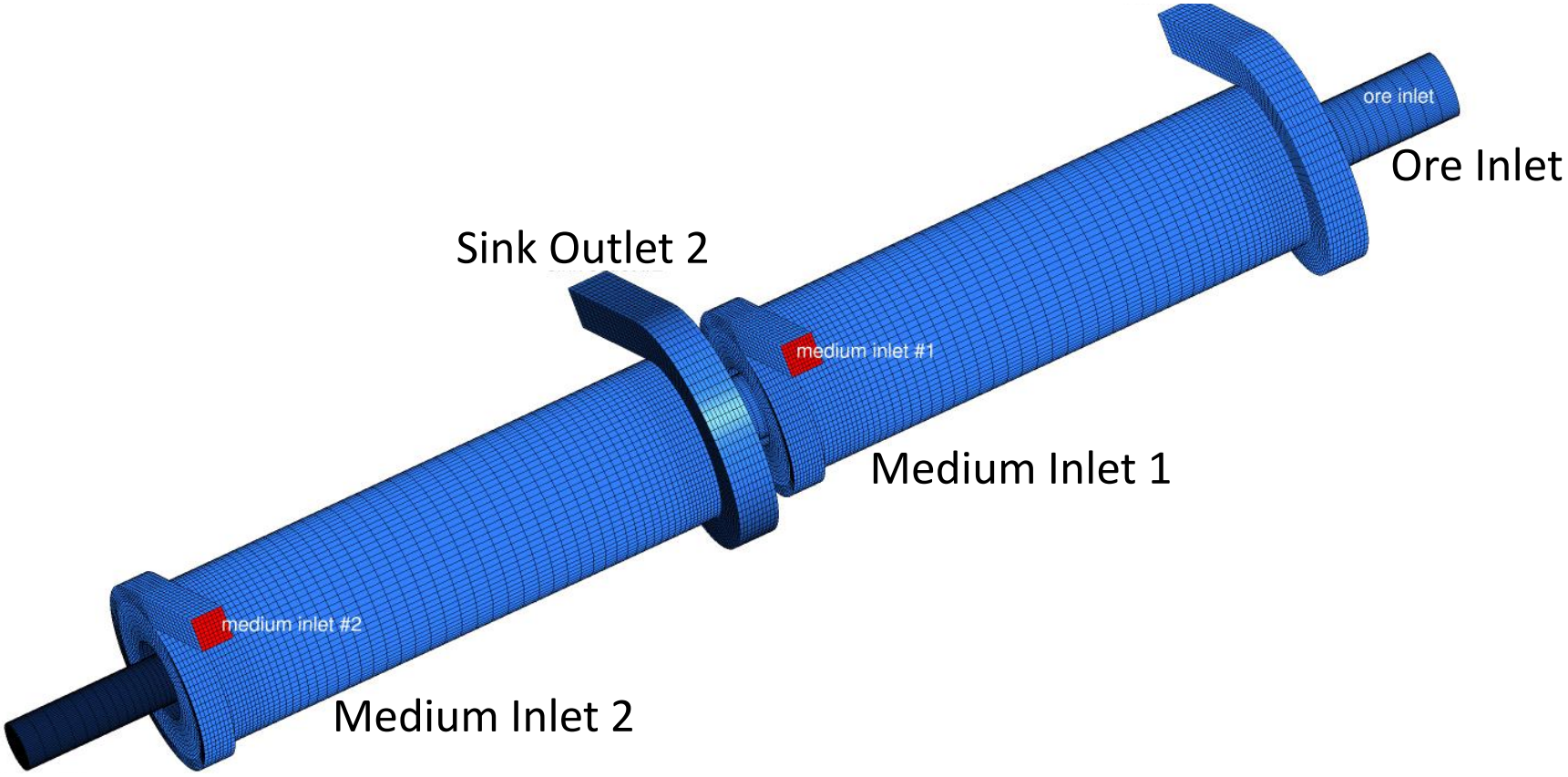
(F = Feed; C = Concentrate; R = Rejects)

1. Rougher	2. Rougher-Cleaner	3. Rougher-Cleaner with Re-circulation	4. Rougher-Scavenger-Cleaner with Re-circulation
			
Ep=1.000	Ep=0.850	Ep=0.727	Ep=0.500
SG50=1.600	SG50=1.568	SG50=1.582	SG50=1.600

Assumptions:

- each stage has the same Ep and the same separation cut point d_{50}
- Whiten partition equation
- the reported Ep of each circuit has been normalized to the single stage circuit

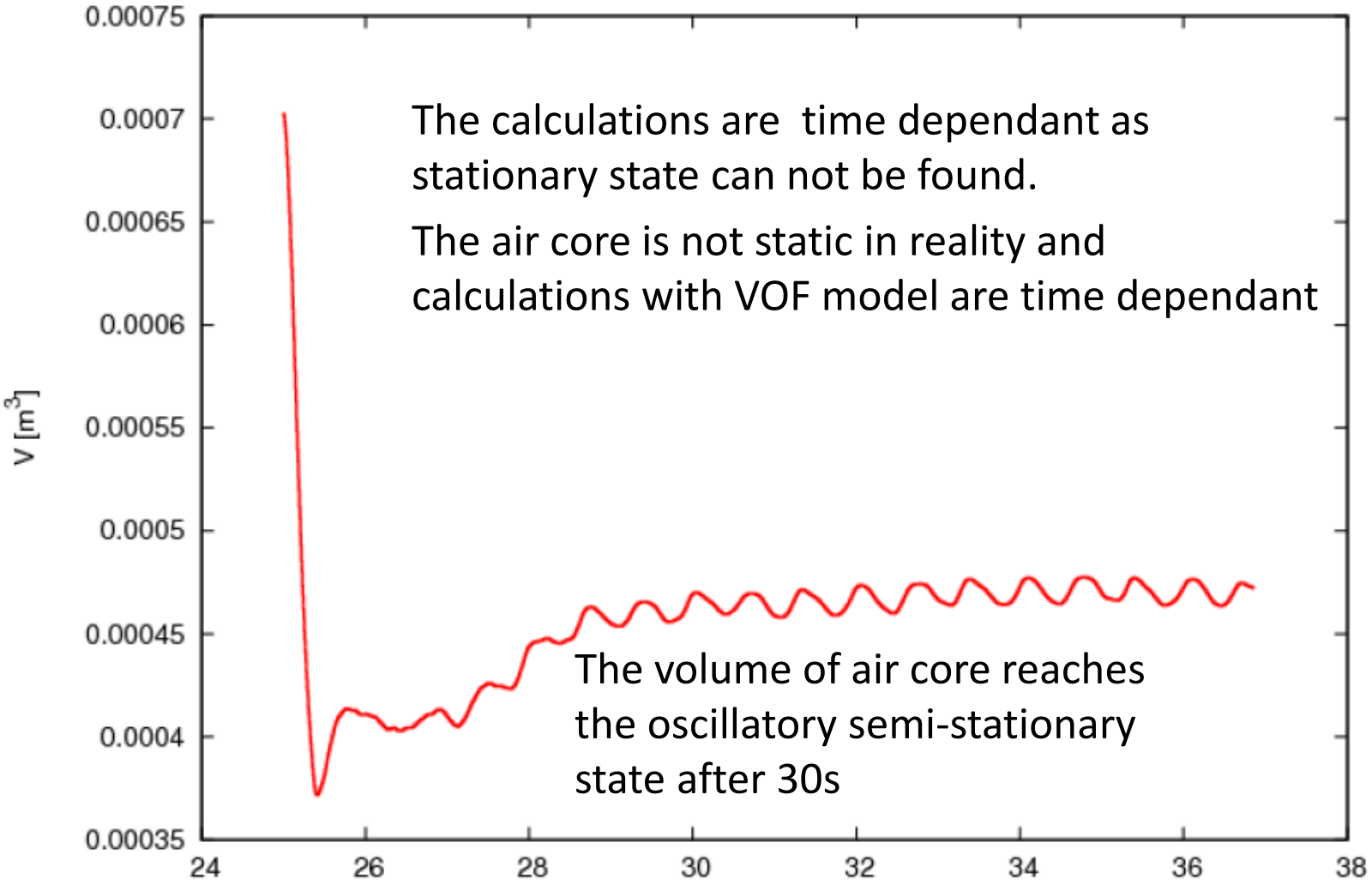
Triflo®- CFD study



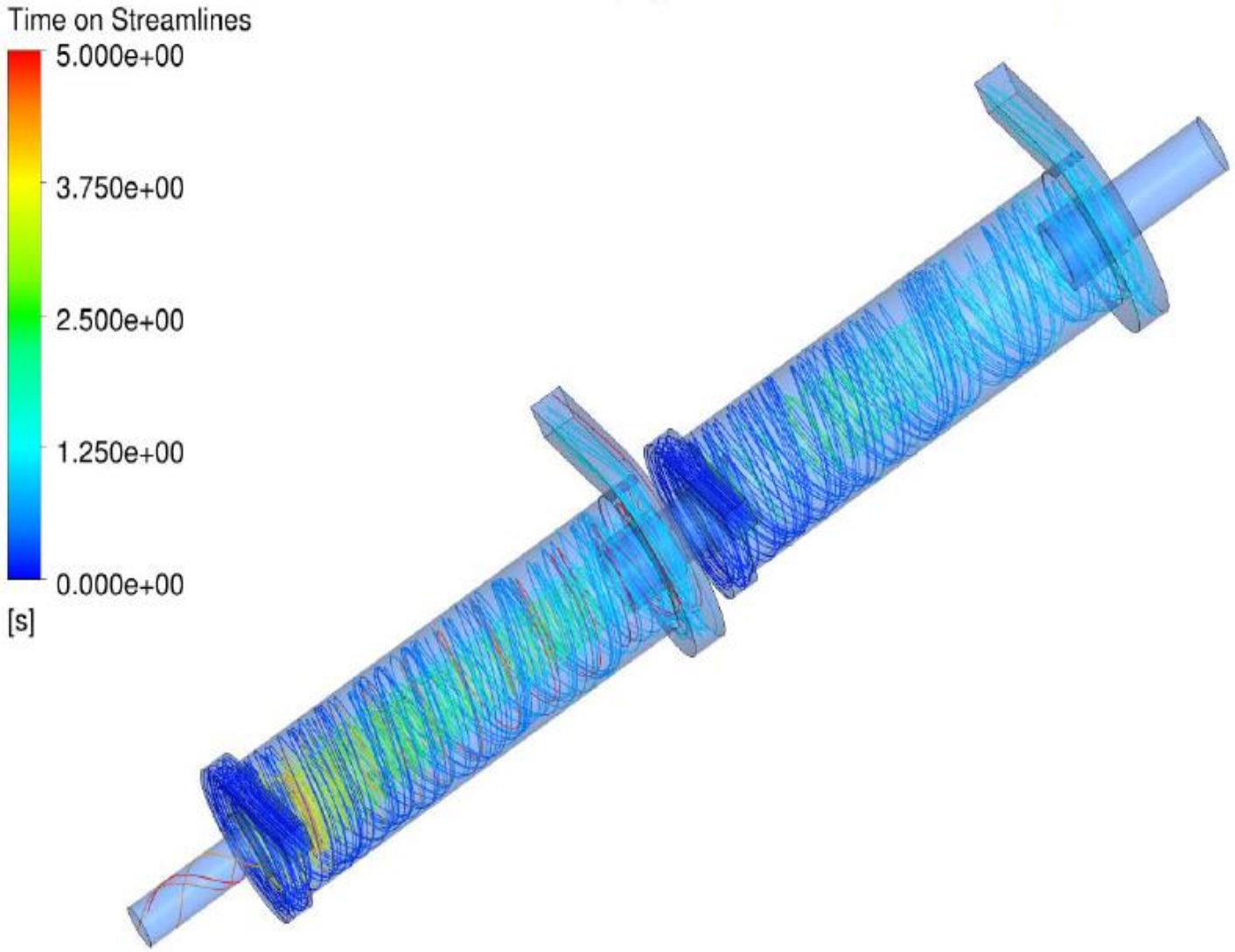
CFD Set-up

- CFD solver: Ansys-FLUENT ver 14.0
- Mesher: Ansys-ICEM (> 300 000 hexeahedral cells)
- Multiphase: Volume Of Fluids (VOF) model
- Inlet boundaries: prescribed velocity with 5% turbulence
- Outlet boundaries: prescribed back-pressure
- Turbulence: Reynolds-Stress (RSM) model
- Surface tension: Continuum Surface Force (CSF) model
- TriFlo® 100mm ID

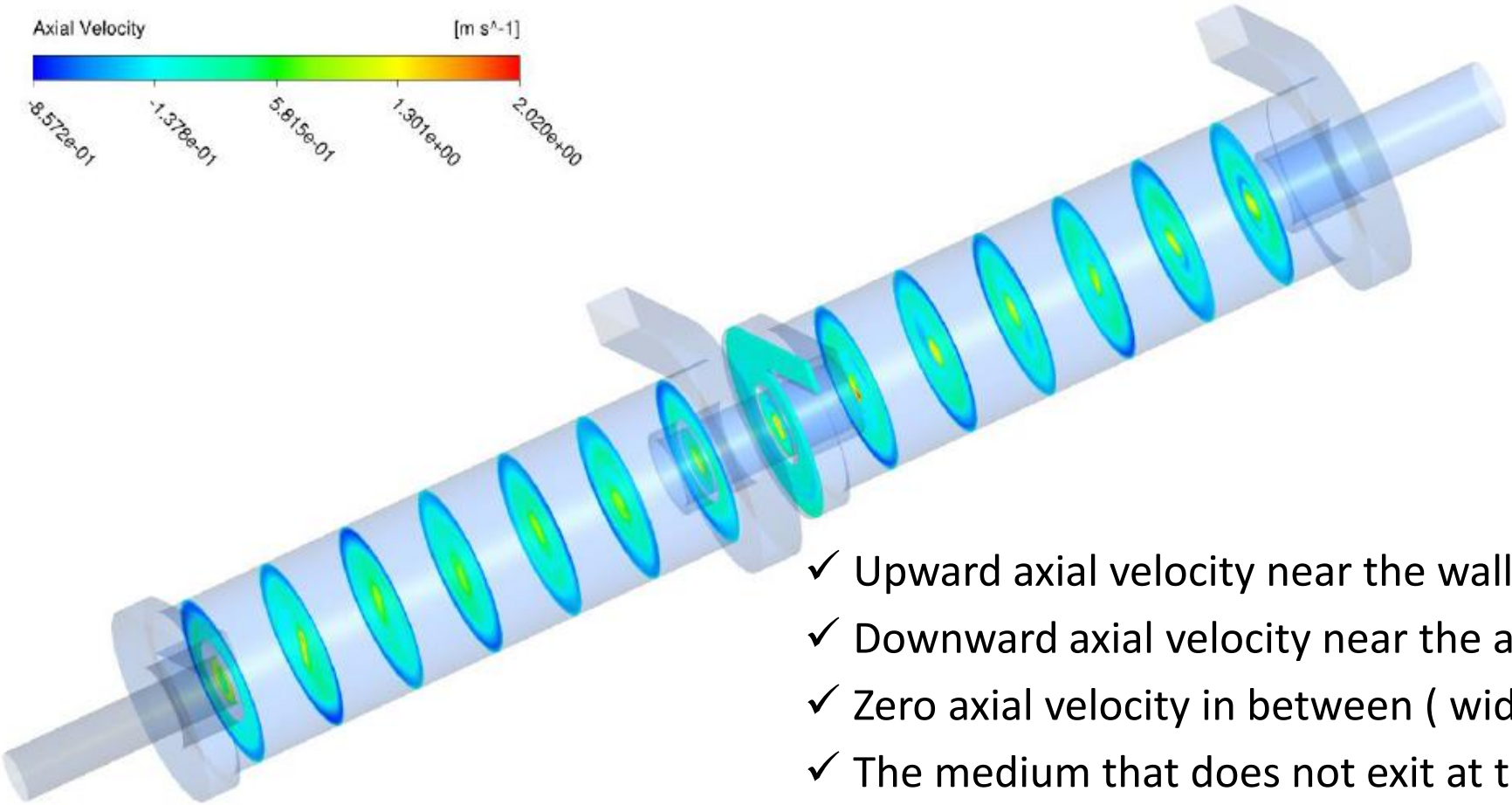
Time required for Semi stationary state



Timed Streamline



Axial velocity at several cross sections

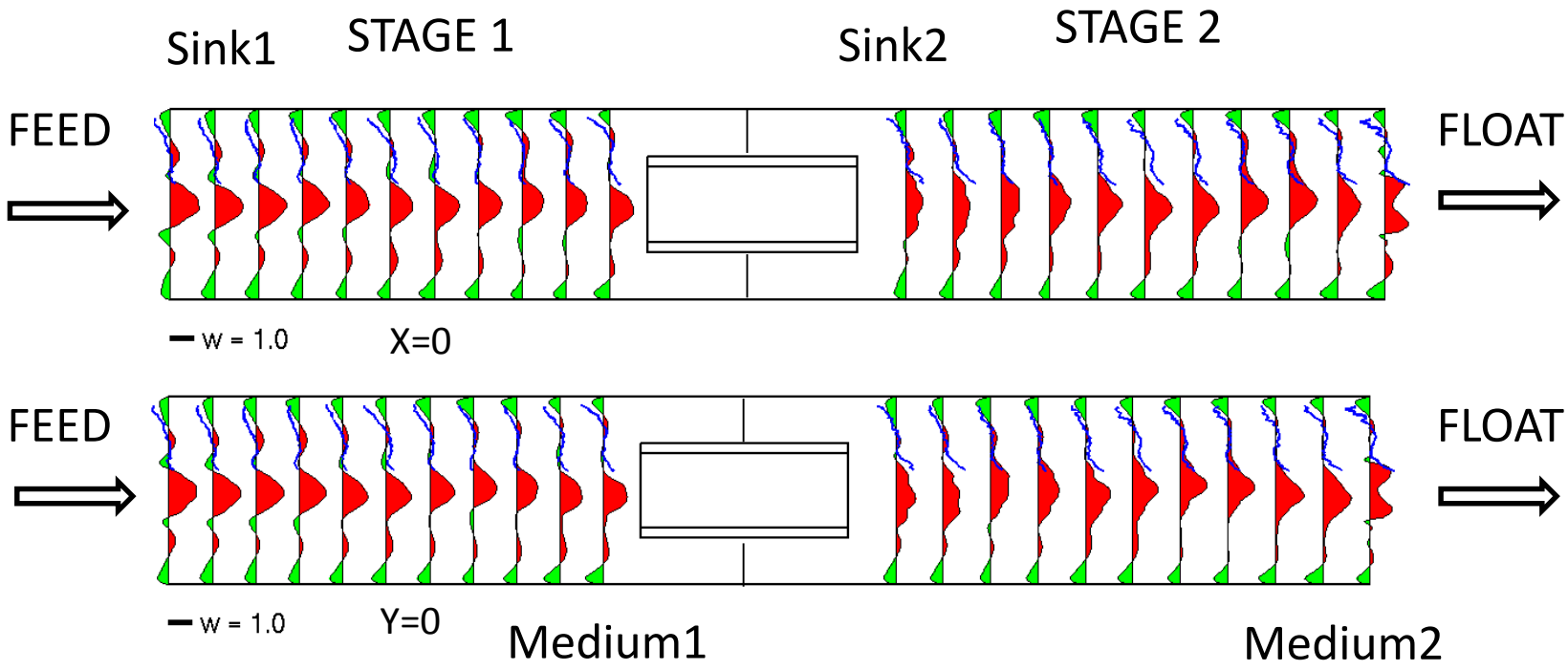


- ✓ Upward axial velocity near the wall
- ✓ Downward axial velocity near the air core
- ✓ Zero axial velocity in between (wide zone)
- ✓ The medium that does not exit at the sink is subjected to flow reversal and directed to the float outlet

Wide zone of zero axial velocity means favourable condition for high sharpness

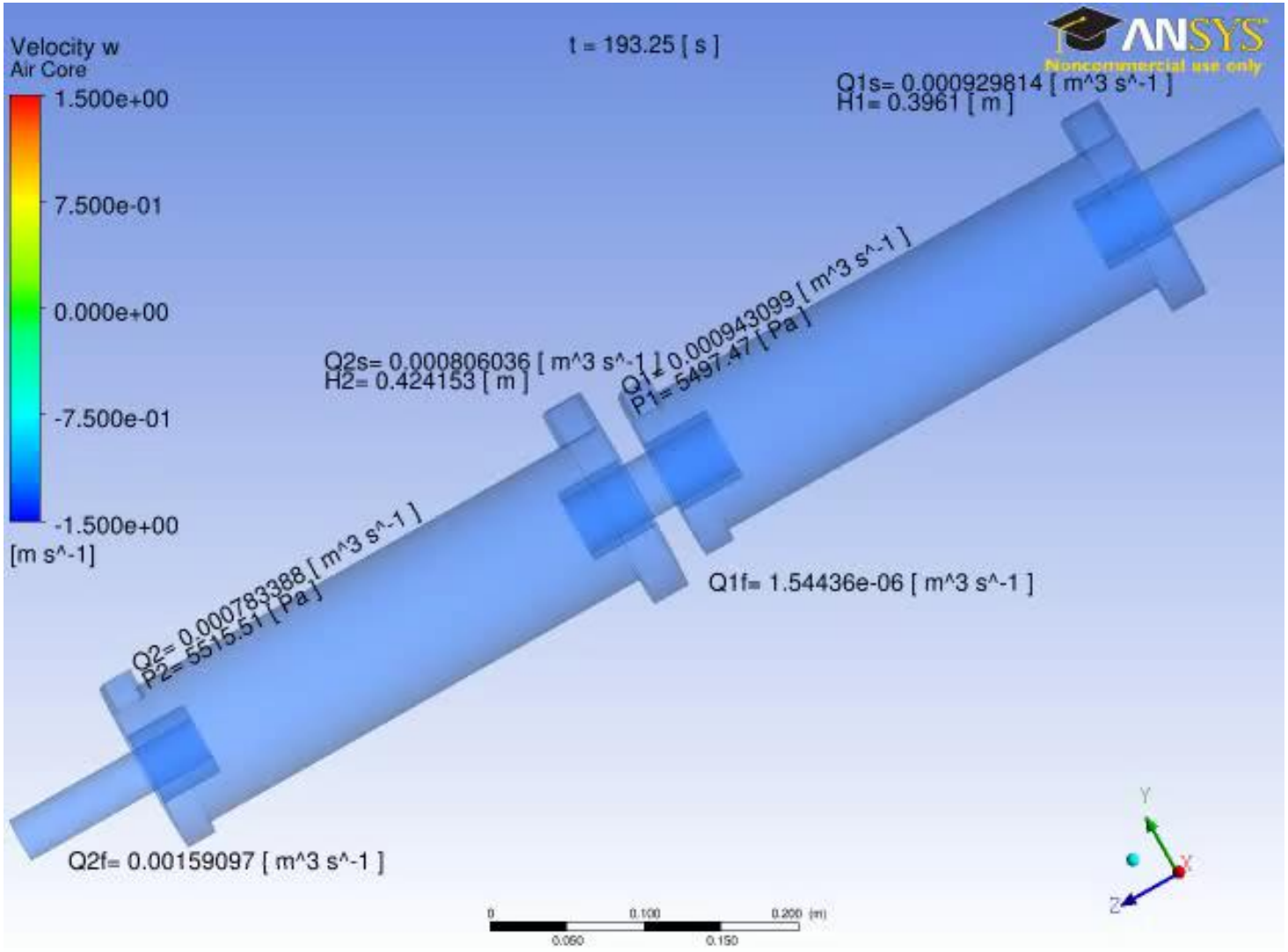
Axial velocities

CFD vs Experience: Comparison between CFD results and laser Doppler measurements on a transparent acrylic model TriFlo® 100mm ID

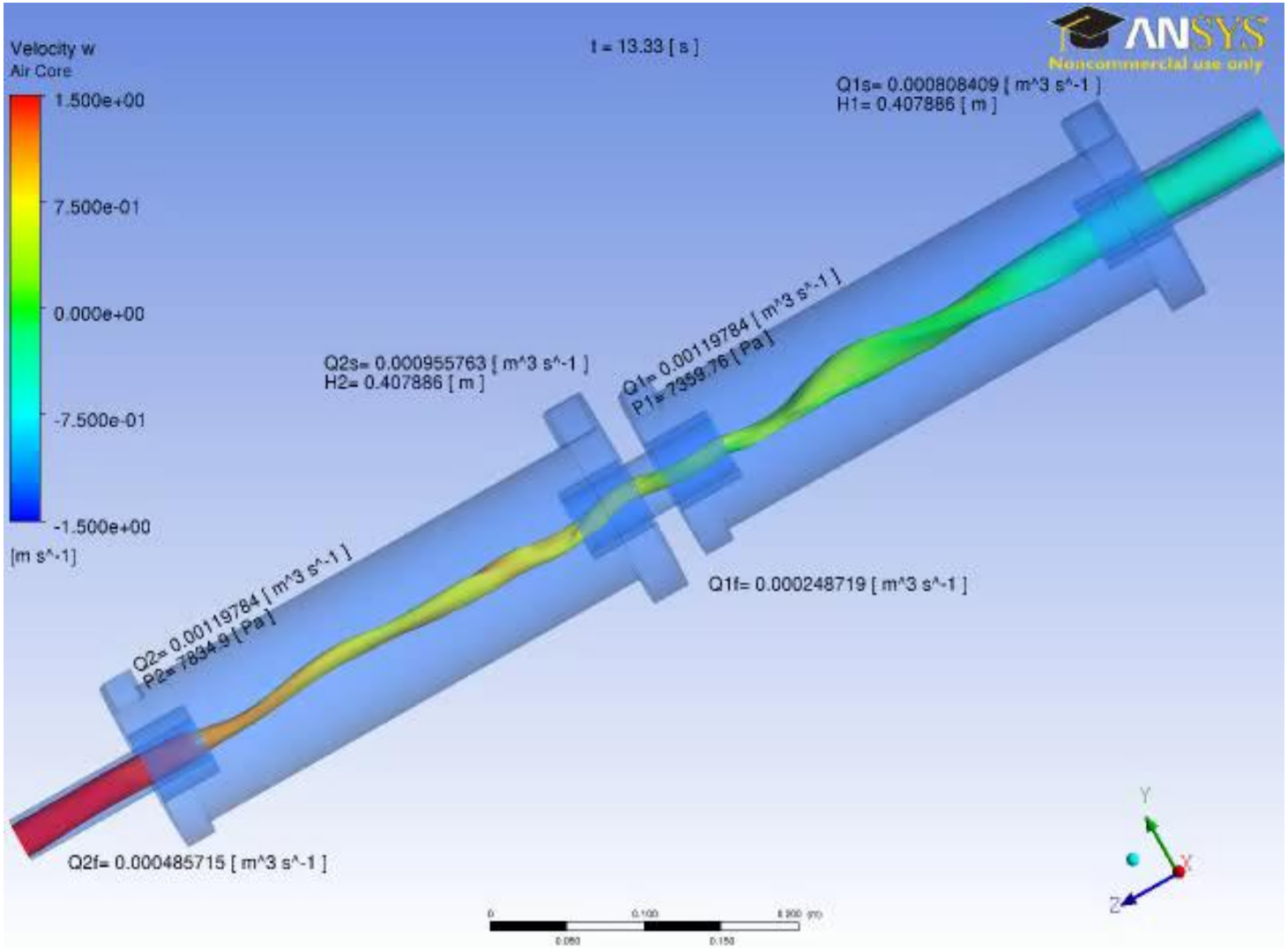


- ✓ Particles close to the wall report to the Sink products by the upward axial velocity
- ✓ The reversed flow (downard axial velocity) close to the air-core accompanies the Float products at the axial float discharge

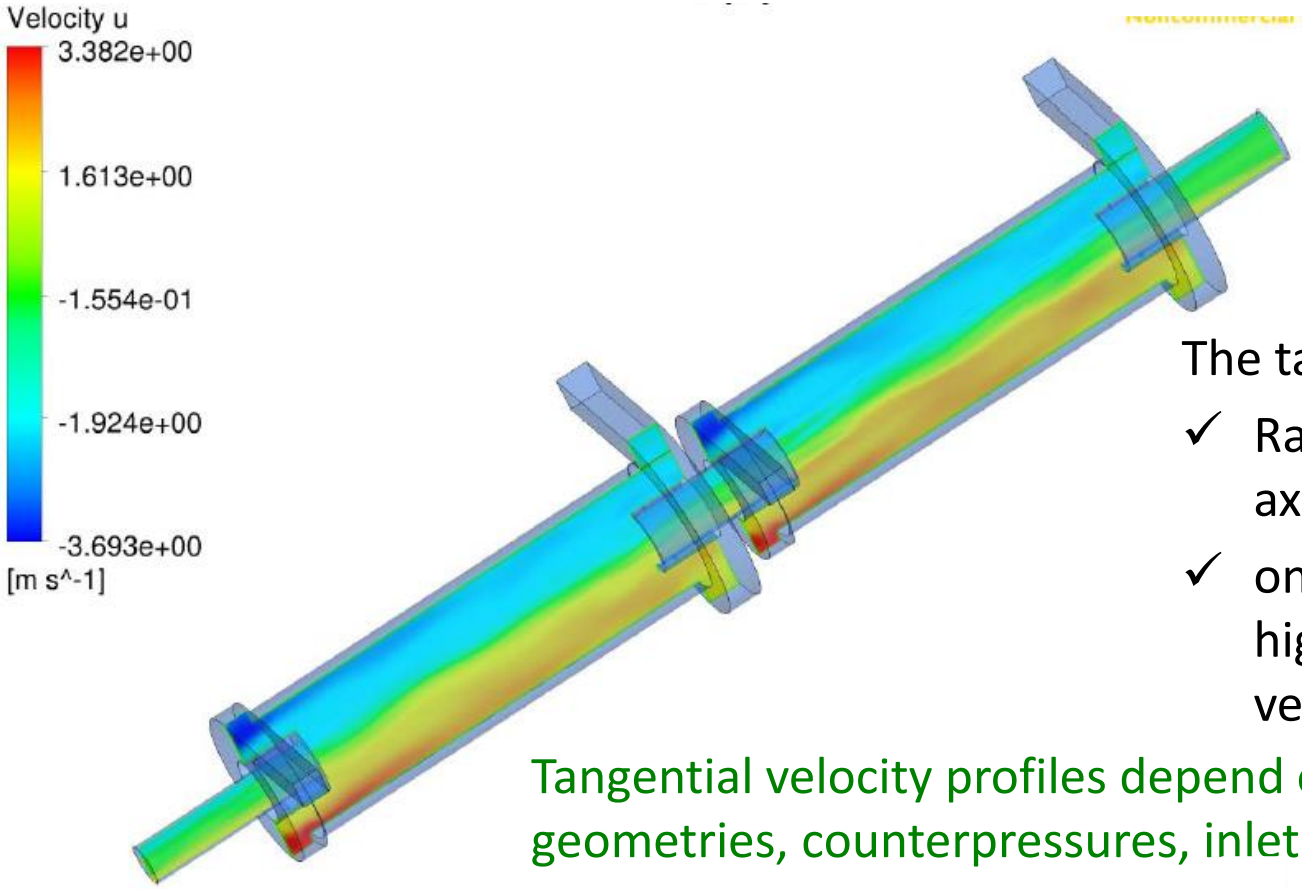
Simulation 51cm Counterpressure



Simulation Increasing Counterpressure



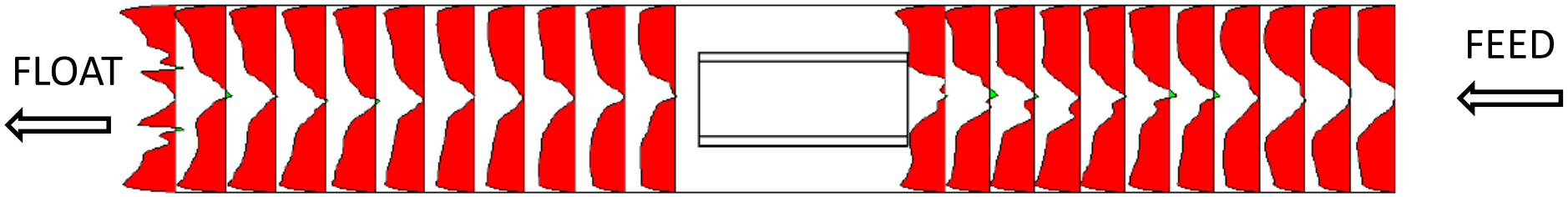
Tangential velocities



The tangential velocity is:

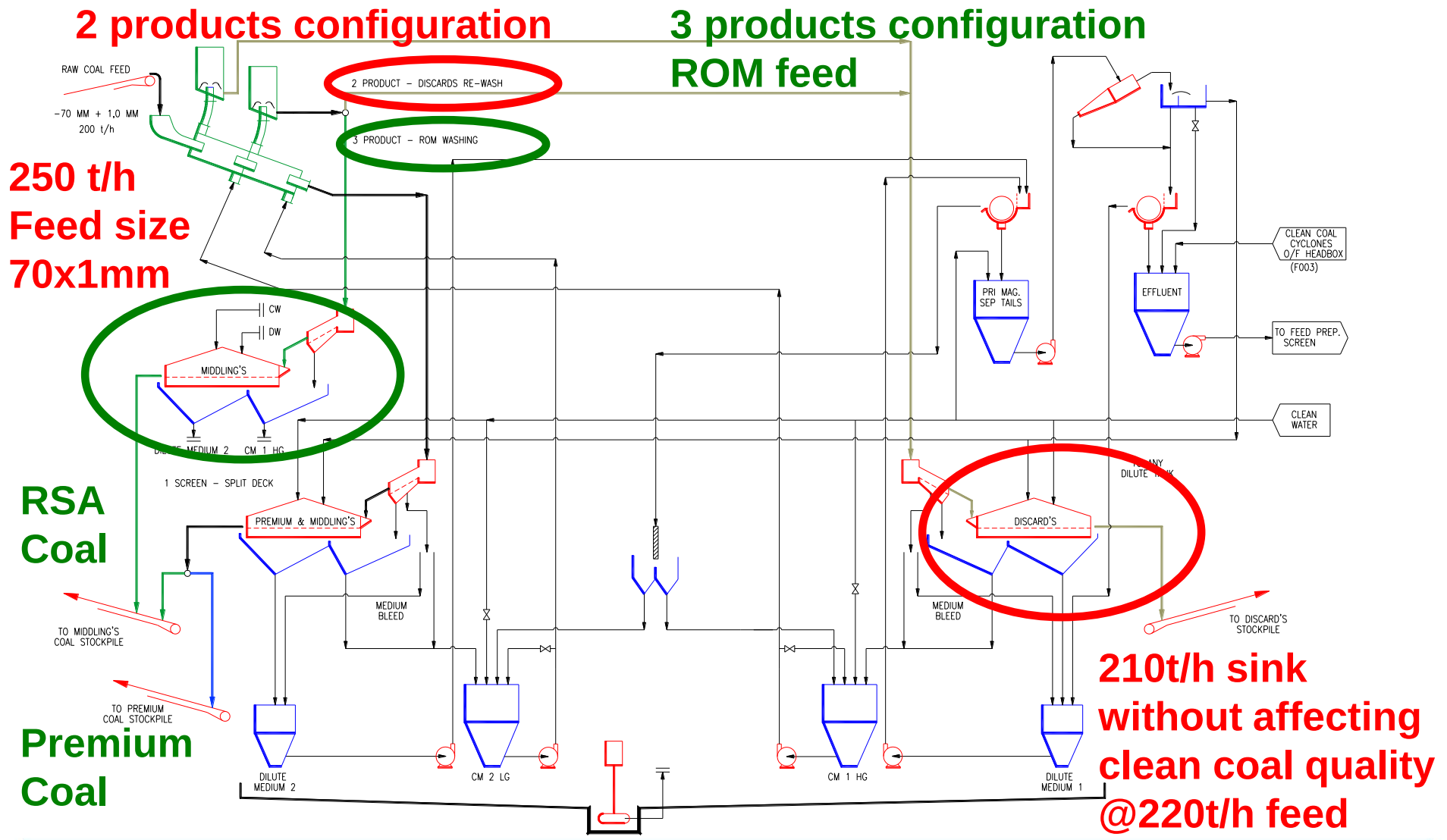
- ✓ Rather constant along the axis (forced vortex)
- ✓ one order of magnitude higher than axial & radial velocities

Tangential velocity profiles depend on many factors: geometries, counterpressures, inlet medium velocity



Typical plant flowsheet – Graspan RSA

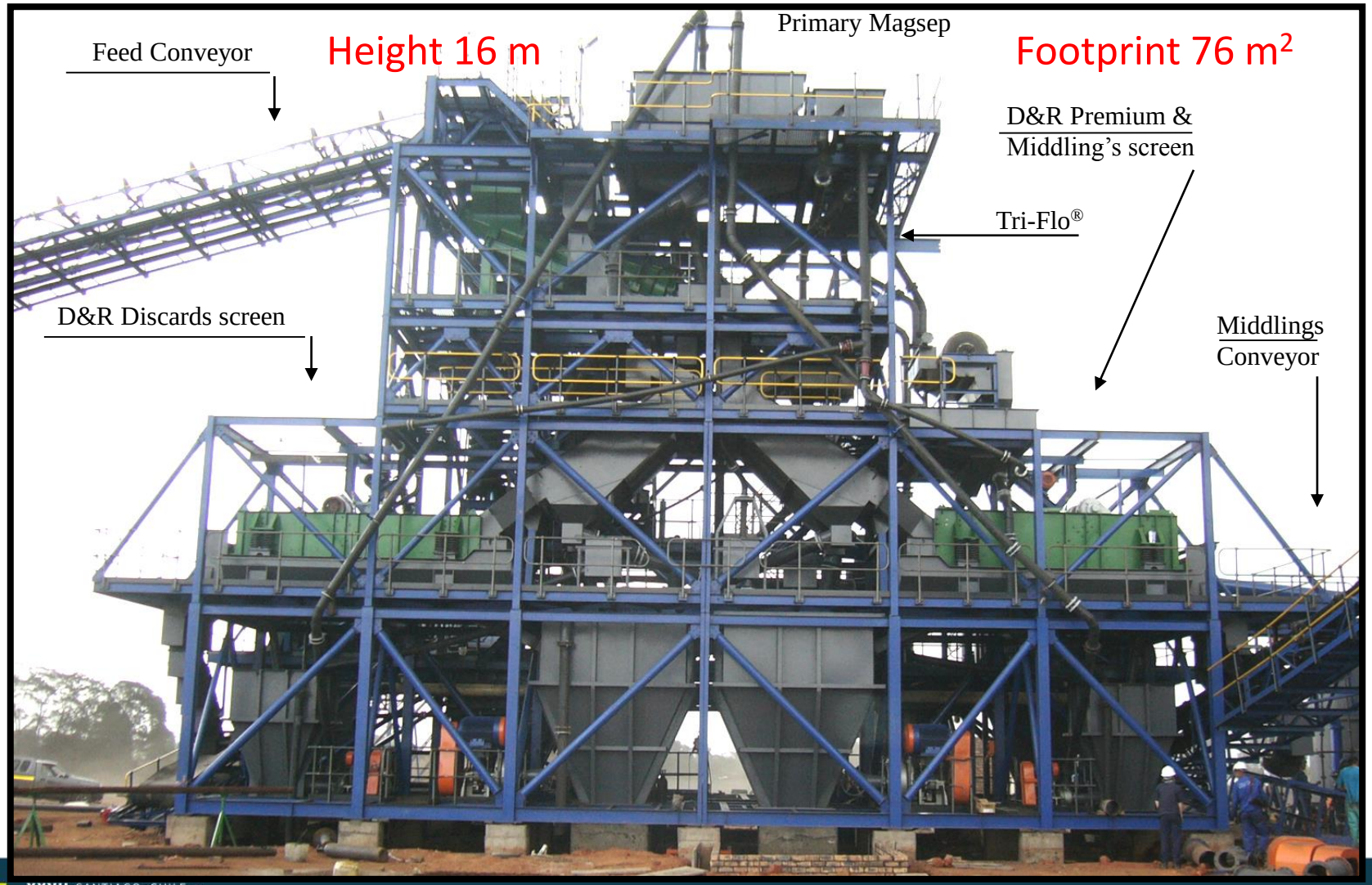
treating rejects from DMS plant with static bath 70x28mm, DMS 28x1mm, spirals <1mm



Graspan RSA – Coal Washing Plant

Average Ep=0.012/17 and very little misplaced materials 0,86%

Organic efficiency 98,9% - Near Gravity material ($\pm$0.1g/cm^3) 27,2%



Graspan RSA 700mm TriFlo®

Top sized washed
200x115x65mm

At Tabas CPP
300x190x100mm lumps
have been rejected

Tramp material
collected from the
sink discharge – steel
bar 800 mm long

Graspan RSA
Wear conditions after 1,25Mt discards

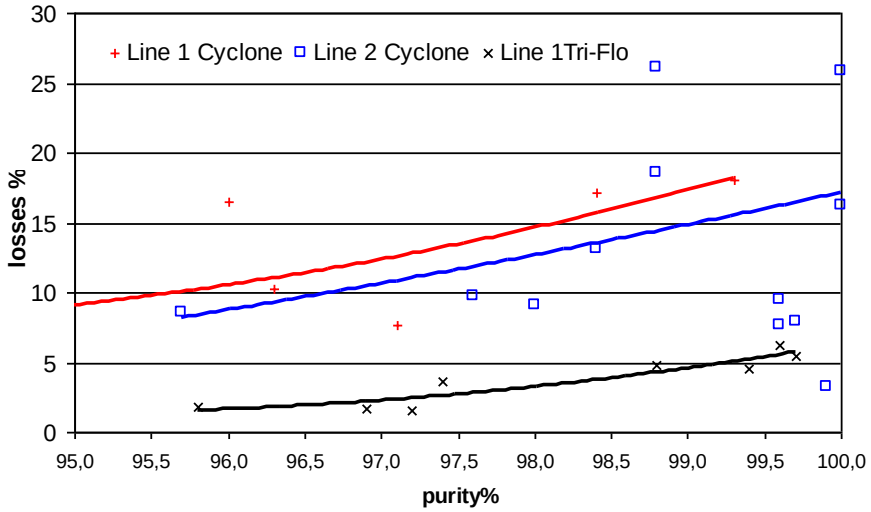
Very limited and localized wear in the Sink1 head (with Abrasion Index 2.000)

New TriFlo® can be fully ceramic lined

Woksop UK - PLASTIC RECYCLING

Plastic recycling from automobiles shredding residues 5 t/h – TriFlo® 250

Superior results of the TriFlo® technology in plastic separation



Comparison between conical cyclones and TriFlo®. Definitions: Purity - Wt% of light particles (SG<1.10) in float; Losses - Wt% of light particles (SG<1.10) in sinks

- ✓ Cylindrical cyclones are more suitable for low density separations;
- ✓ Cylindrical cyclones are less sensitive to particle shape (flat and elongated particles can not be separated efficiently in traditional conical cyclones);
- ✓ Double washing in one vessel with higher separation sharpness;
- ✓ Very forgiving of feed changes
- ✓ Compact layout;
- ✓ Gravity feed of difficult to pump and abrasive material;
- ✓ Low head plant

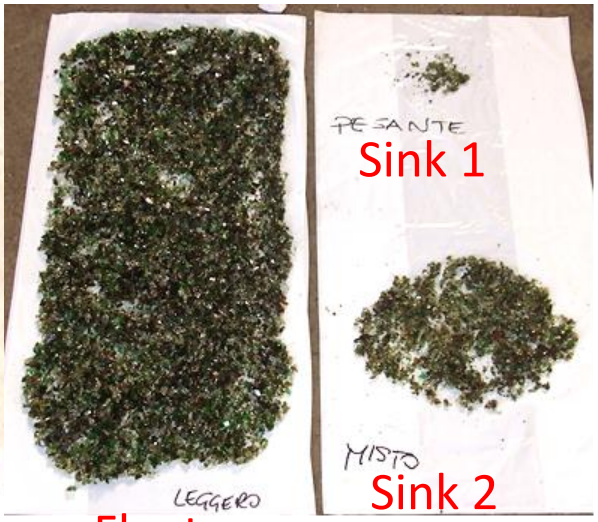
Brusnengo Italy – Glass recycling

Glass recycling from glass cullets 30 t/h – TriFlo® 300

TEST	Test A		Test B		Test A + B	
Size 10 mm x 1 mm	Weight [g]	PbO [ppm]	Weight [g]	PbO [ppm]	Weight [g]	PbO [ppm]
Feed (Recycled Glass)	24133	344	22688	376	46821	359
Heavy Fraction 1 (HF1)	269	14000	223	18500	492	16040
Heavy Fraction 2 (HF2)	1364	680	2230	430	3594	525
Final Product (Float)	22500	160	20235	170	42735	165
HF2 + Float	23864	190	22465	196	46329	193
HF1 Wt.% / PbO Yield %	1,11	45,4	0,98	48,4	1,05	46,9
HF2 Wt.% / PbO Yield %	5,65	11,2	9,83	11,2	7,68	11,2

Figure 1. Separation Results with Recycled Glass (no tracers present).

Figure 2. Tracers Separation. Left: 24% Pb crystals; Right: 4 mm Al_2O_3 particles.



Float

Copper Preconcentration

A potential application for increasing ROM Cu % to the design values of the existing concentration plants

GOAL: EARLY WASTE REJECT

Necessary precondition: Cu enrichment in heavier density fractions in size coarser than 0.5mm

MAIN ADVANTAGES:

1. Savings in grinding and processing costs (energy etc)
2. Savings in water consumption
3. Extended mine life due to lowered cut-off grade
4. Better utilization and higher metallurgical efficiency of existing plants (feed with design Cu%)

CFD Conclusions

- **Computational Fluid Dynamics is a powerful tool for a better understanding of the fundamental behaviors of the TriFlo®**
- **The model has been verified with Laser Doppler experimental data**
- **Prediction of separation results depending on feed material and operating parameters**
- **It is a cost-efficient way of achieving better and more accurate designs highly reducing expensive and time consuming prototyping**

QUESTIONS?

ECOMIN

We are your competent partner for:

- ore dressing, industrial minerals, steelworks, environmental & recycling plants, anaerobic digestion of biowaste, material handling

Tank House Crane

Lamella Thickener

TriFlo™

Rubber Hoses

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