SAMPLING SYSTEM DESIGN

By Steve Watson Gabriel

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Why Sampling

Determine the quality

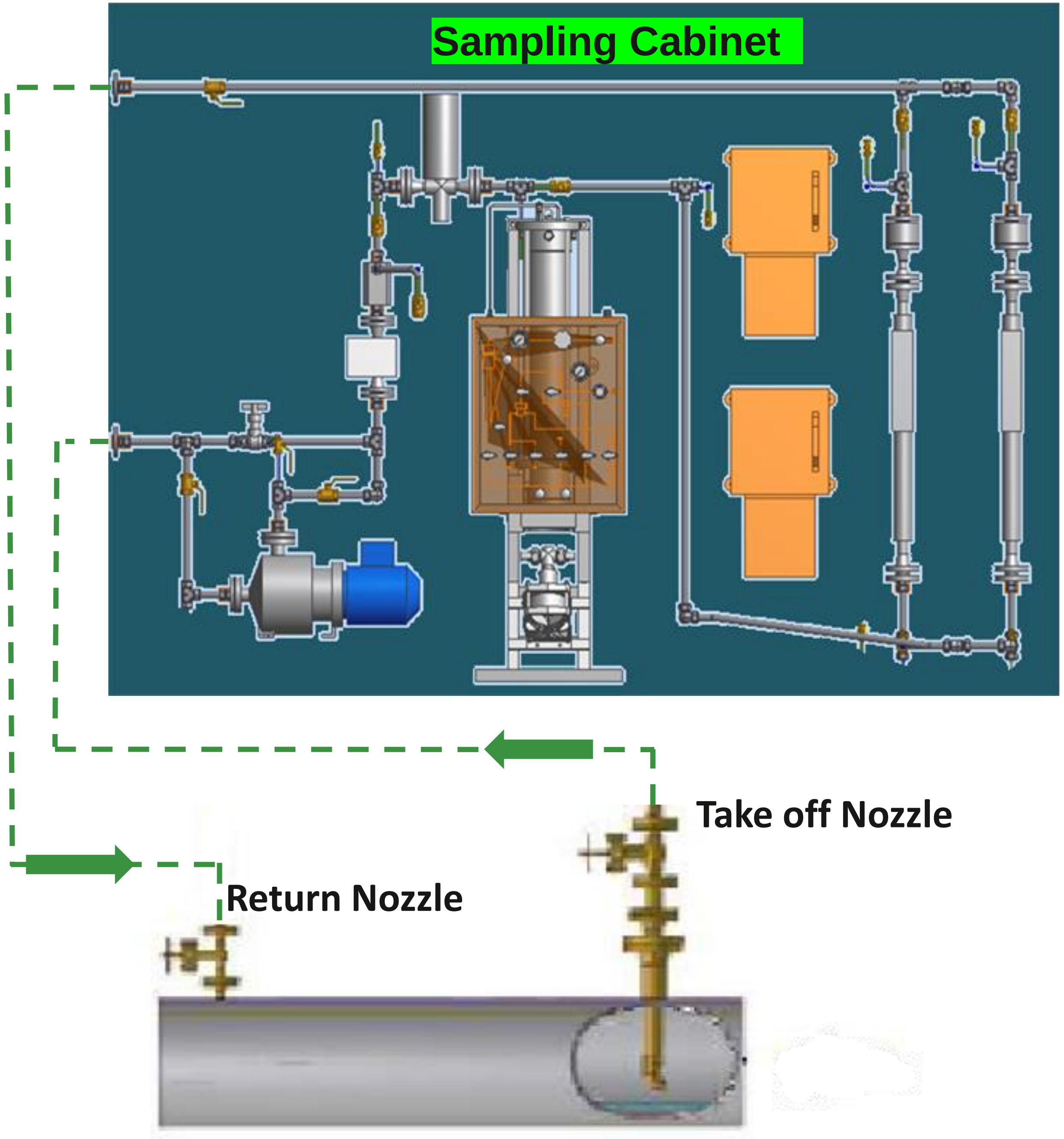
- Density
- Water in oil
- Composition
- Vapour pressure
- H2S content

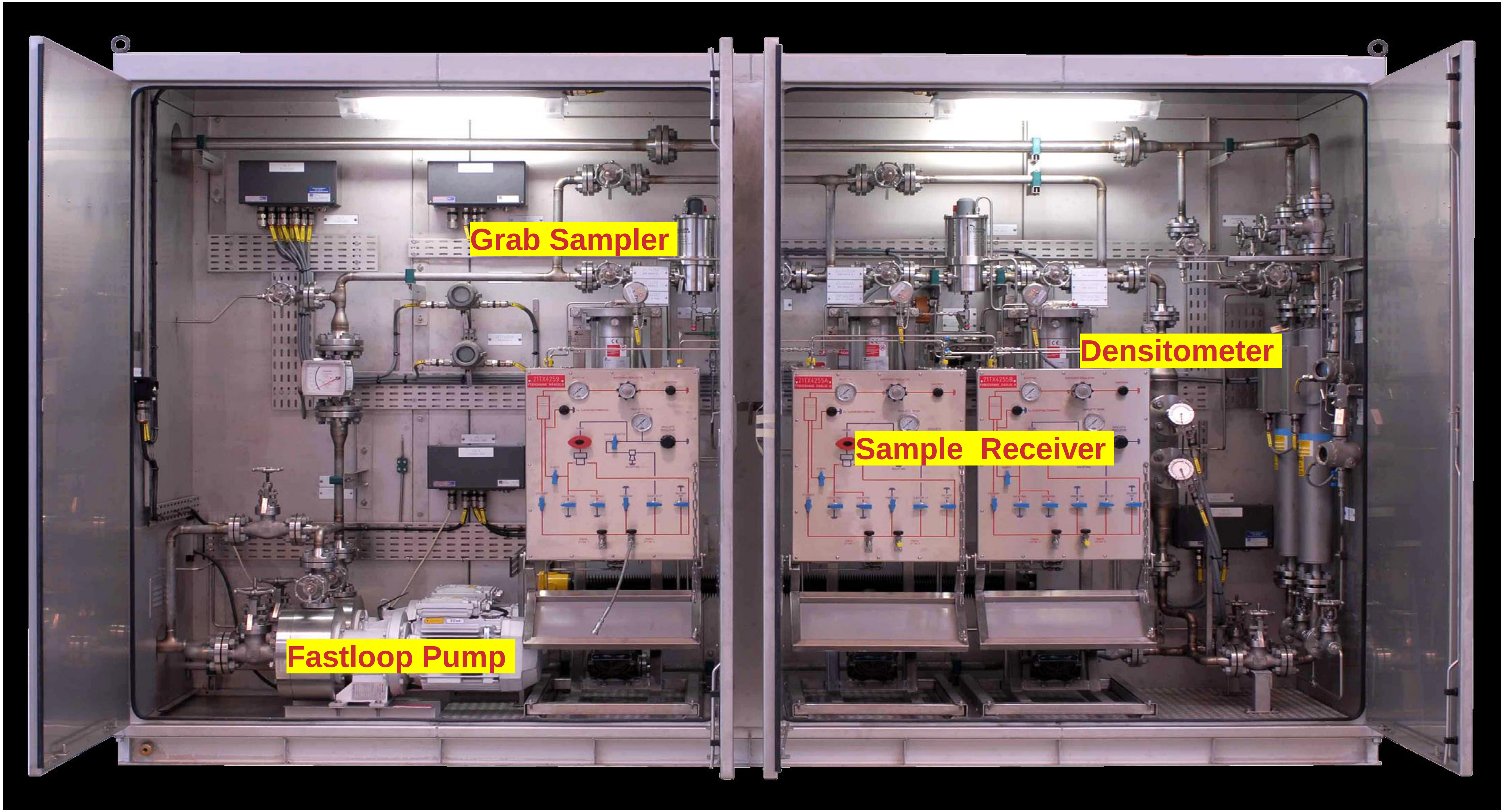
Buyer got what he paid for, the seller a fair price for his product

“FAIR TRADE”

Sampling System Overview

- Sampling Automatic – Flow proportional
- Provision for manual sampling
- Online Density
- Online Water in Oil (water cut)
- Others - vapour pressure analysers




Grab Sampler
Densitometer
Sample Receiver
Fastloop Pump

Sampling Standards

NPD regulations / NORSOK I-106

- Daily and monthly sampling
- Min. 10 000 samples per day/month/batch
- 1 mL grab min. 10 litres

ISO 3171 Automatic Pipeline Sampling

- Focus on homogenious mix of oil and water

API MPMS Ch. 8.2 Automatic Sampling of Liquid Petroleum

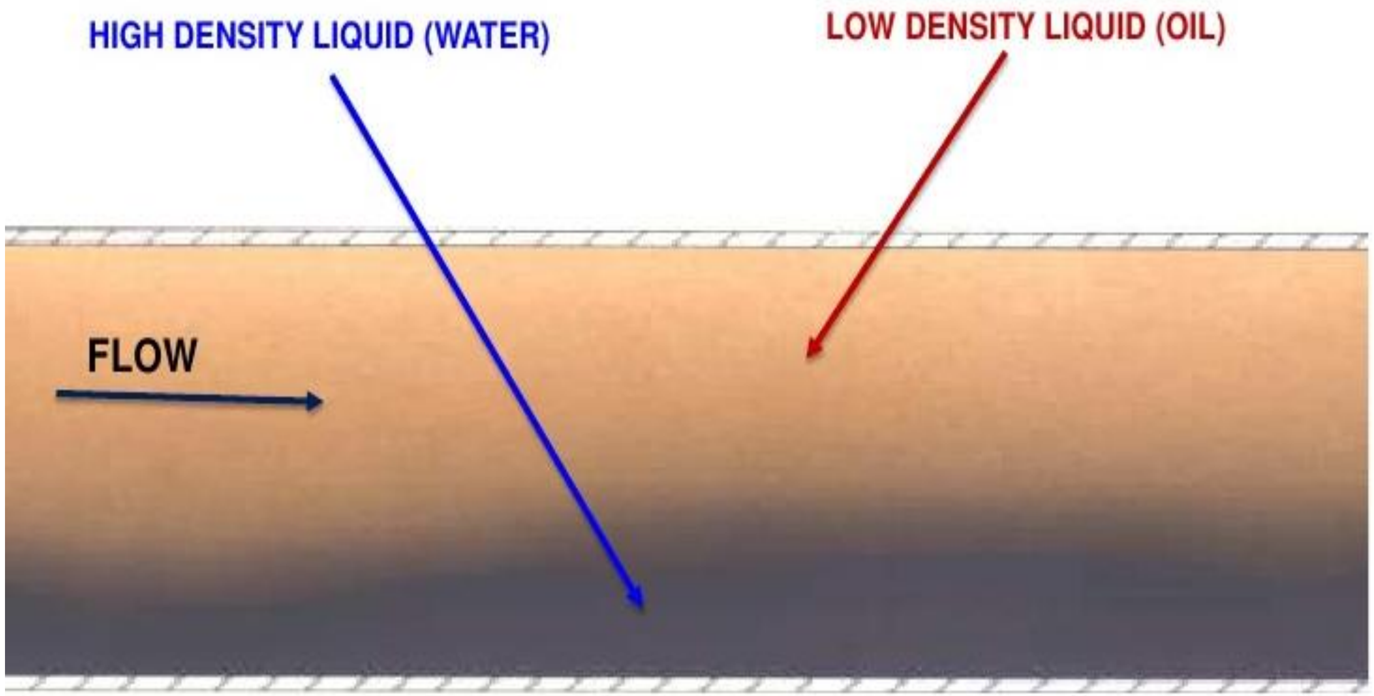
- Installation requirements

Mixing Requirements

C1 /C2 ratio > 0.9 indicates good mixing

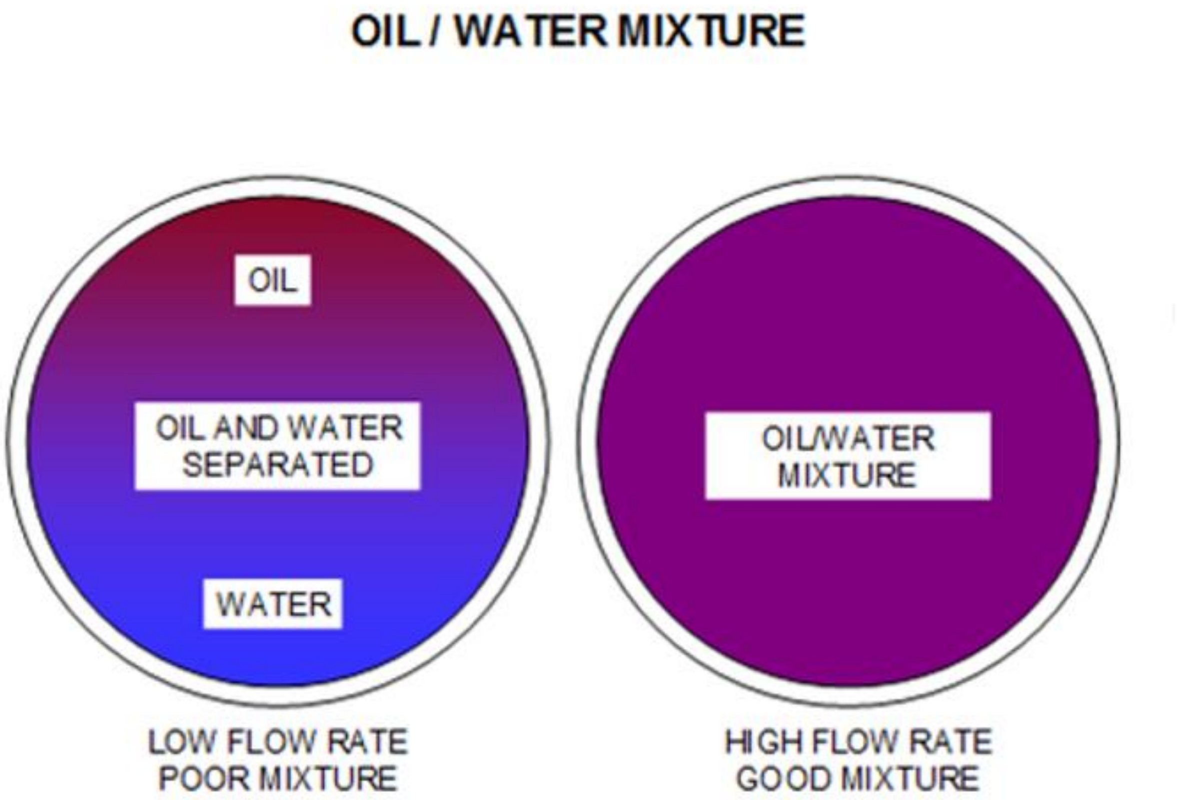
C1 water concentration at the top

C2 water concentration at the bottom



Mixing Requirements

Turbulence can provide adequate mixing. The minimum turbulence for adequate mixing depends on flow rate, pipe diameter, viscosity, density and interfacial tension.



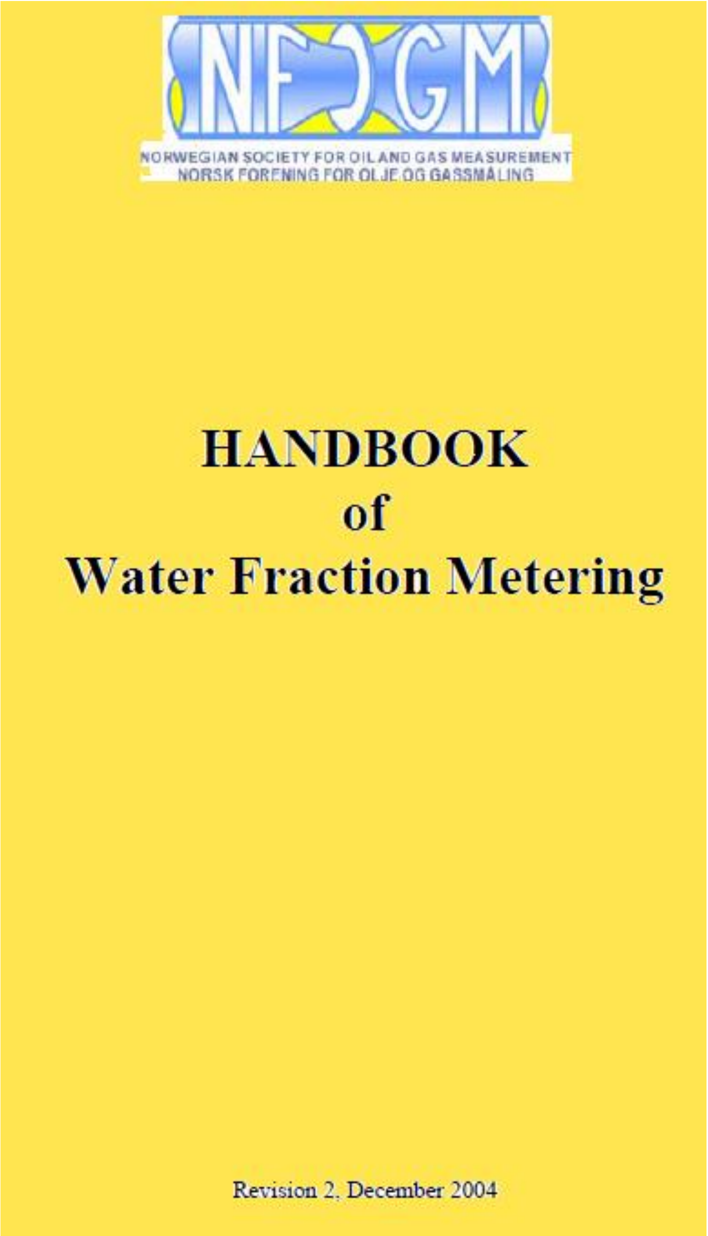
Principles of Representative Sampling

- ✓ Samples taken from the pipeline should have the same composition as the average composition of the pipeline cross section
- ✓ Representative sampling should persist throughout the period of transfer
- ✓ Sample should maintained in the same condition as at the point of extraction
- ✓ That subdivision of the sample and correct analysis is required

NFOGM Handbook

Handbook of water fraction metering (2004)

- Simplified ISO 3171 calculations.
- Determine the critical velocity (Vc) required when the fluid properties and the pipe diameter are known.
- Horizontal Vs Vertical pipe



How we ensure mixing is maintained in fast loop

Keep the <u>fast loop velocity at critical velocity</u> or higher to create adequate turbulence.

Critical velocity can be determined from the expression

$$V_c = K_1 \cdot G^{0.325} \cdot \sigma_{ow}^{0.39} \cdot \frac{(\rho_w - \rho_o)^{0.325}}{\rho_o^{0.283}} \cdot \frac{D^{0.366}}{\mu_o^{0.431}}$$

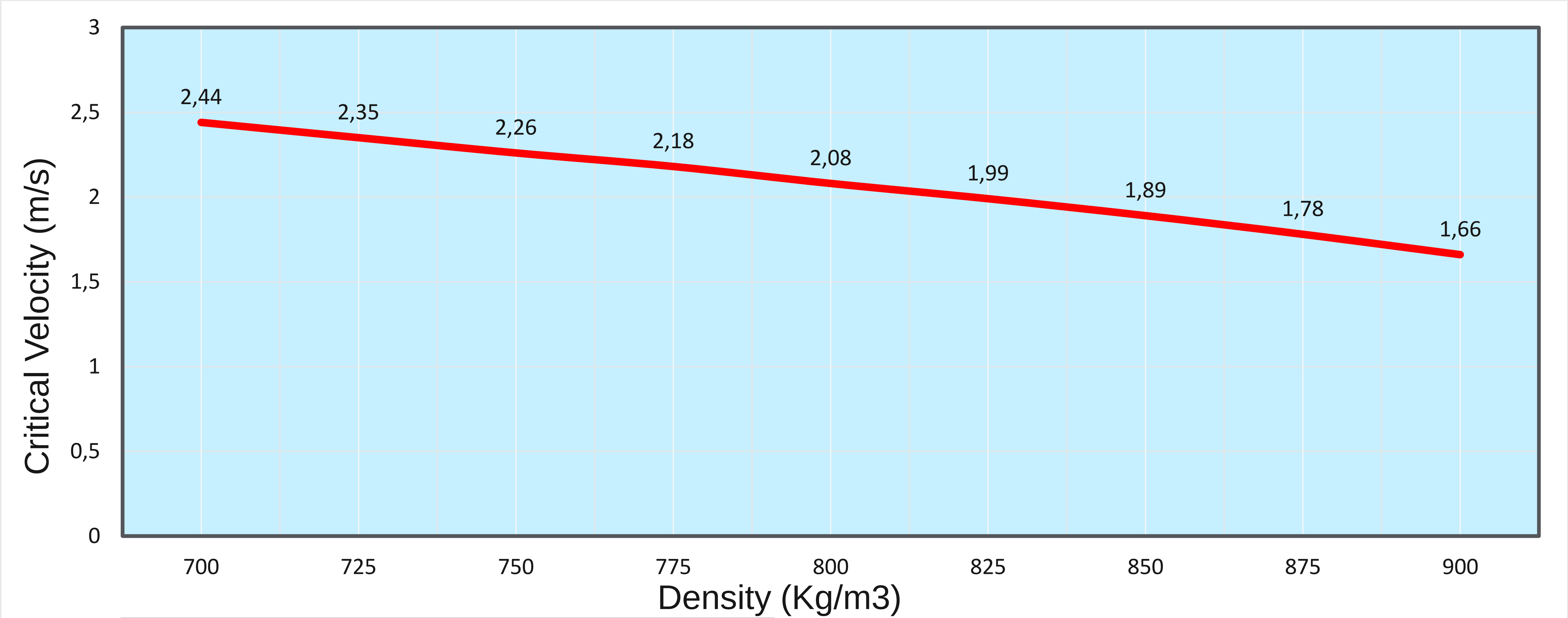
$\beta < 10 - 15\,\%$

Project:		
Parameters	**Value**	**Unit**
C1/C2	0,9	-
G	9,5	-
Rho_w	1025	kg/m3
Rho_hc (*)	840	kg/m3
Sigma	2,50E-02	N/m
D (*)	0,021	m
μ (*)	4	cP
K1	2,02	-
(*) Process data must be entered!		
Results		
	Critical Velocity [m/s]	**Critical Flow [m3/hr]**
	2,12	**2,65**
Calculations are valid for watercuts below 10-15%.		

Worst-case conditions expected to be considered

- Lowest density,
- Lowest viscosity
- Highest interfacial tension

Critical Velocity Vs Density



Parameters used for calculation
Tubing OD: 25mm, ID: 21mm
Viscosity: 5cP
Interfacial tension b/w HC and Water: 0.025 N/m

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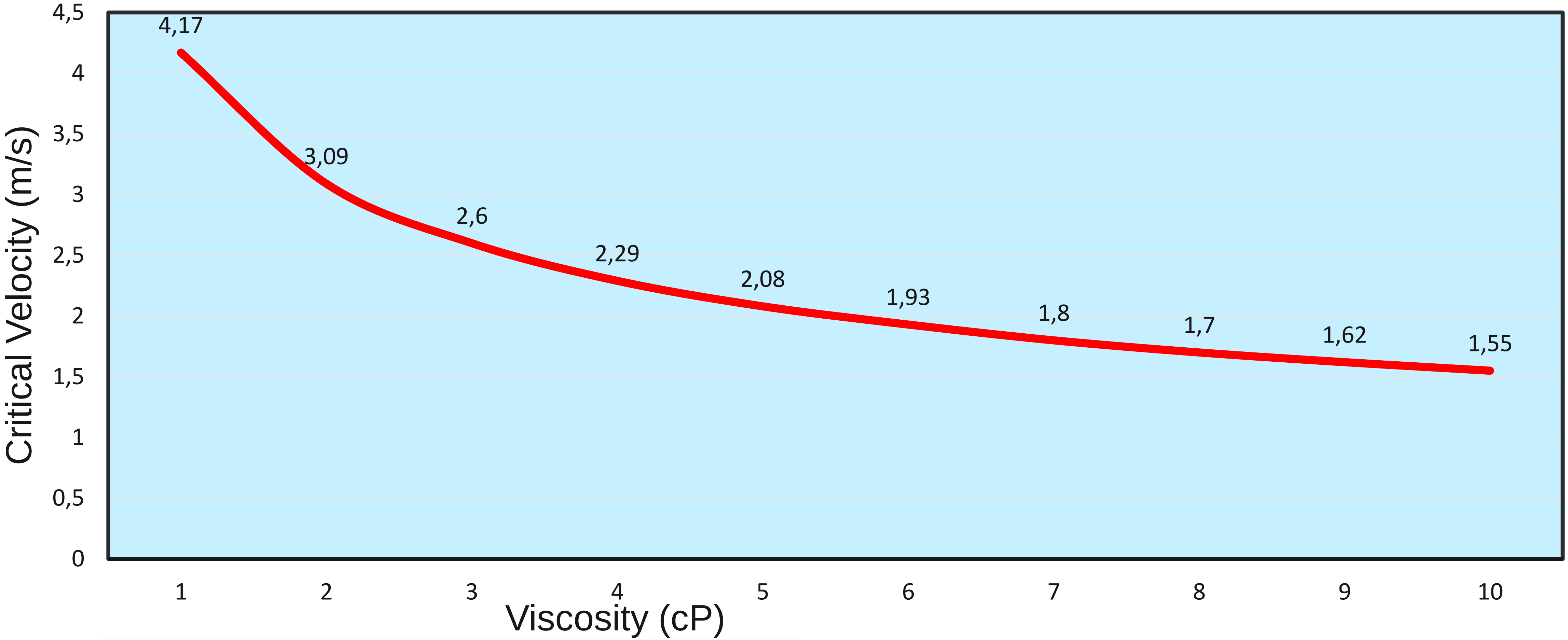
Critical Velocity Vs Viscosity



Parameters used for calculation
Tubing OD: 25mm, ID: 21mm
Density: 800Kg/m3
Interfacial tension b/w HC and Water: 0.025 N/m

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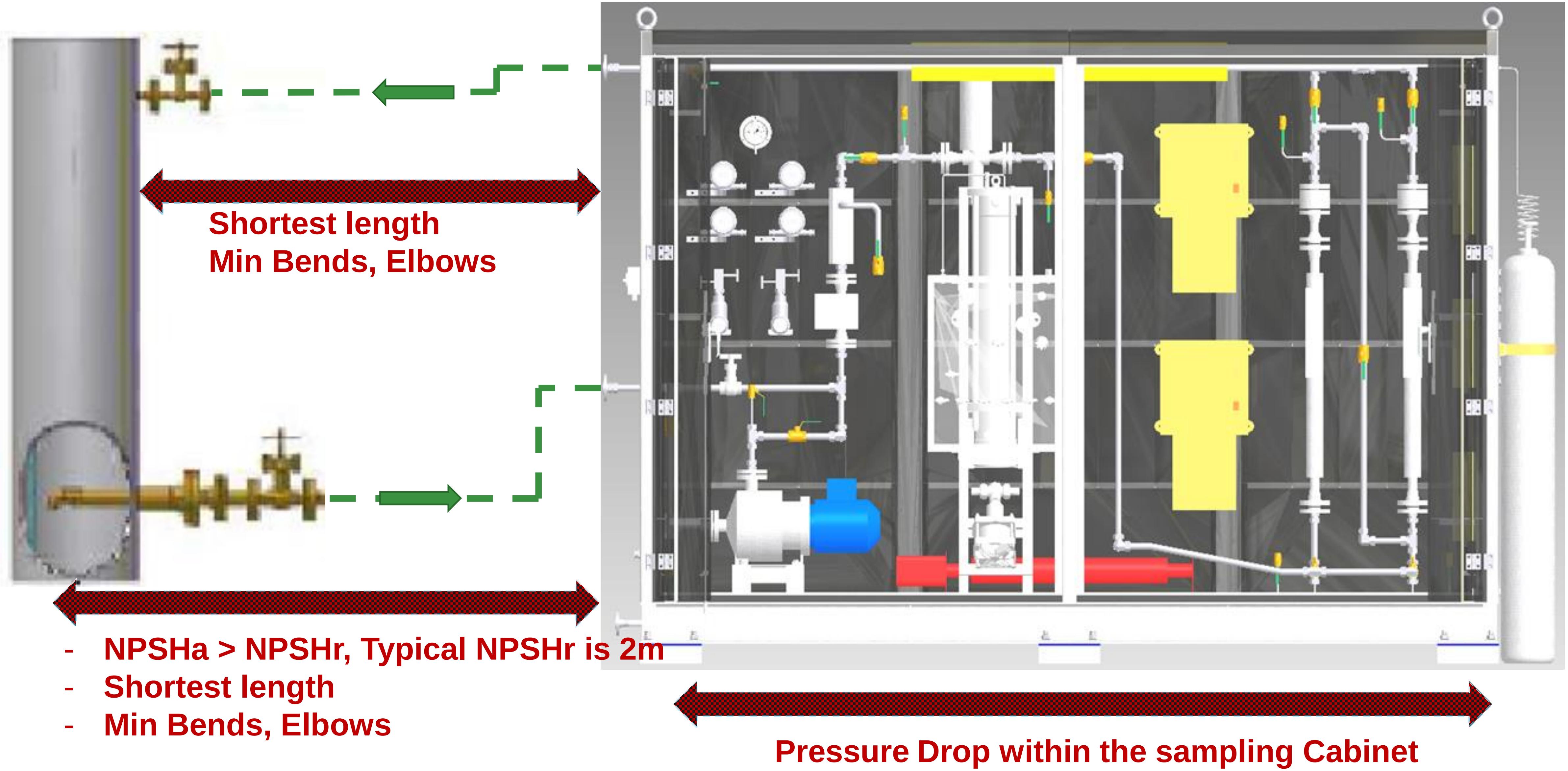
Pressure Drop On Fast Loop System

- Take off point & sampling cabinet.
  - Inlet piping, Probes, Valves, Other piping components
- Within the sampling cabinet.
  - Inline Instrument, Bends, Valves, Tee
- Sampling cabinet & return point.
  - Return Piping, Valves, Other piping components

Total pressure drop influence the sizing of the pump, eventually the cost.

Pressure Drop Fast Loop System



Pressure Drop Calculation

Inlet Piping: 1”, 5m long
Outlet Piping: 1”, 5m long
25mm tubing in the sampling cabinet
Density: 840Kg/m3,
Viscosity: 4cP
Flow Rate: 2,65m3/h

	Inlet Piping	Sampling Cabinet	Outlet Piping
Pressure drop (bar)	0,3	3,7	0,15

PipeFlo Report

Pressure Drop Calculation

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25mm tubing in the sampling cabinet
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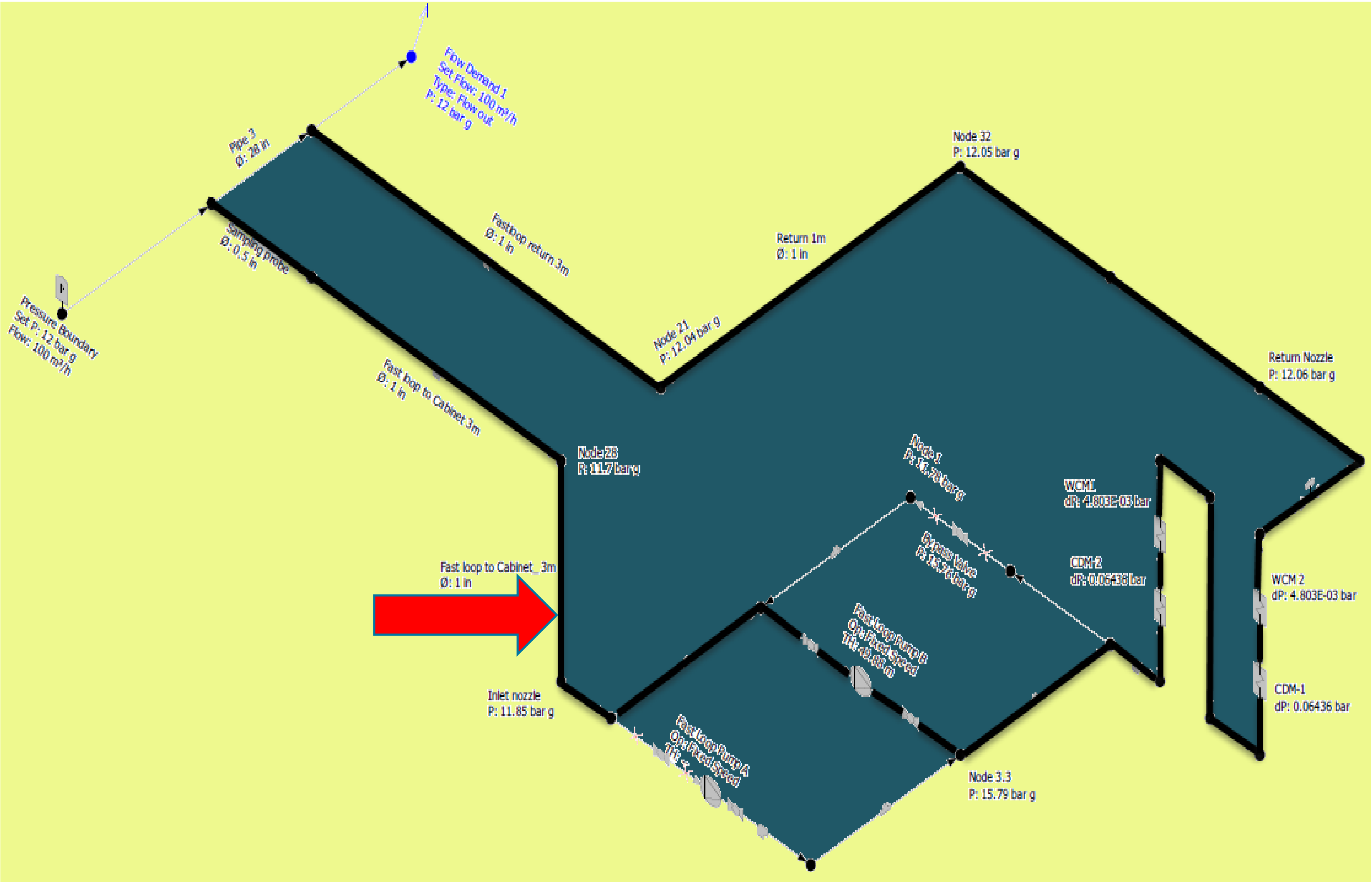
PipeFlo Report



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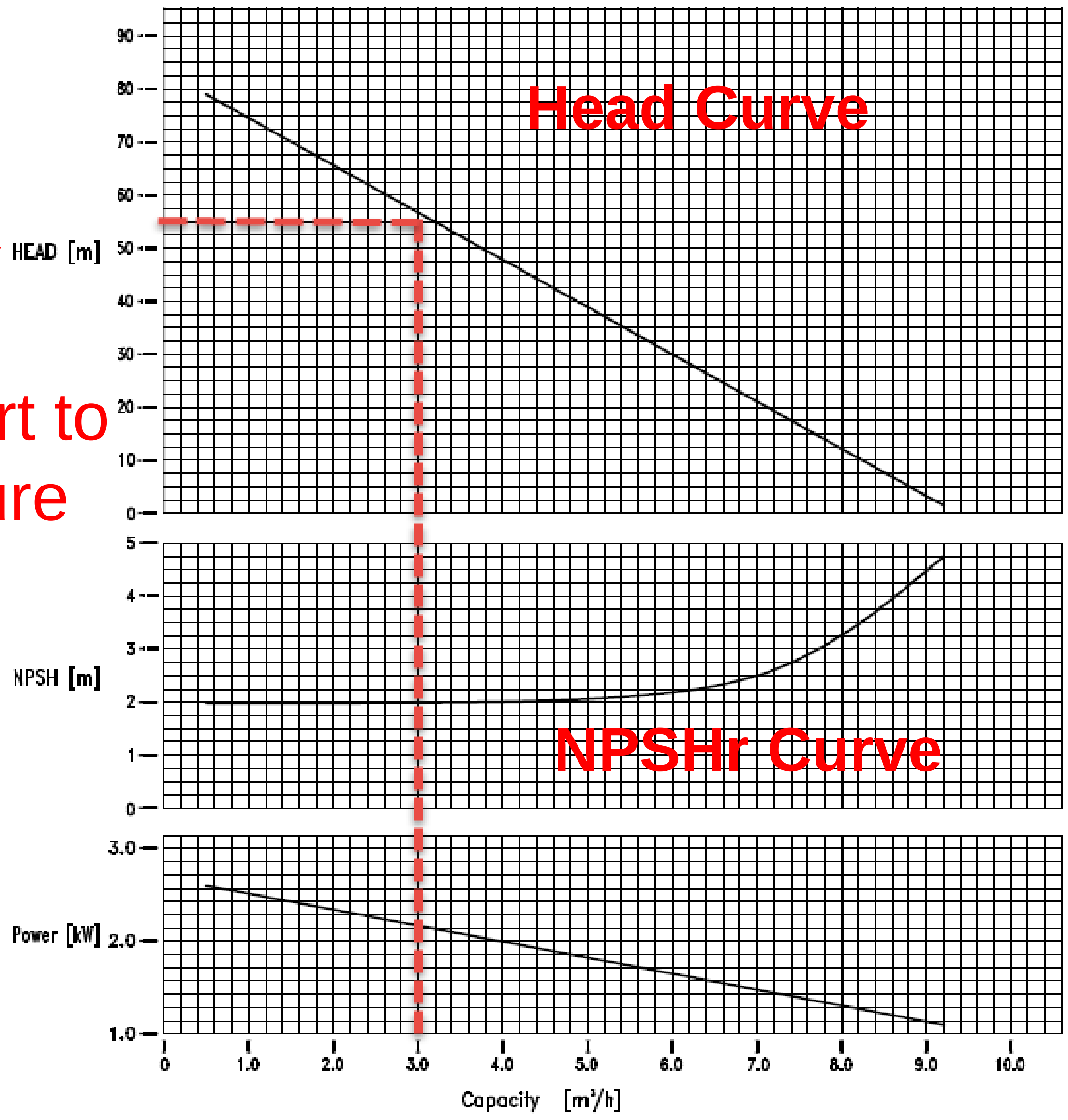
Role of Fast Loop Pumps

- Maintain critical velocity / flow in fast loop.
- Provide enough head to ensure positive flow
- Provide additional mixing

Pump Curve

Convert to Pressure



Other Challenges

- Size Envelope & Weight
- Material Selection
- Wax Temperature Vs ATEX compliance

Questions / Comments

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