Kuwait 4th Flow Measurement Technology Conference

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CEO

Evaluation of New Mixing Method for Pipeline Sampling at NEL flow facility

by

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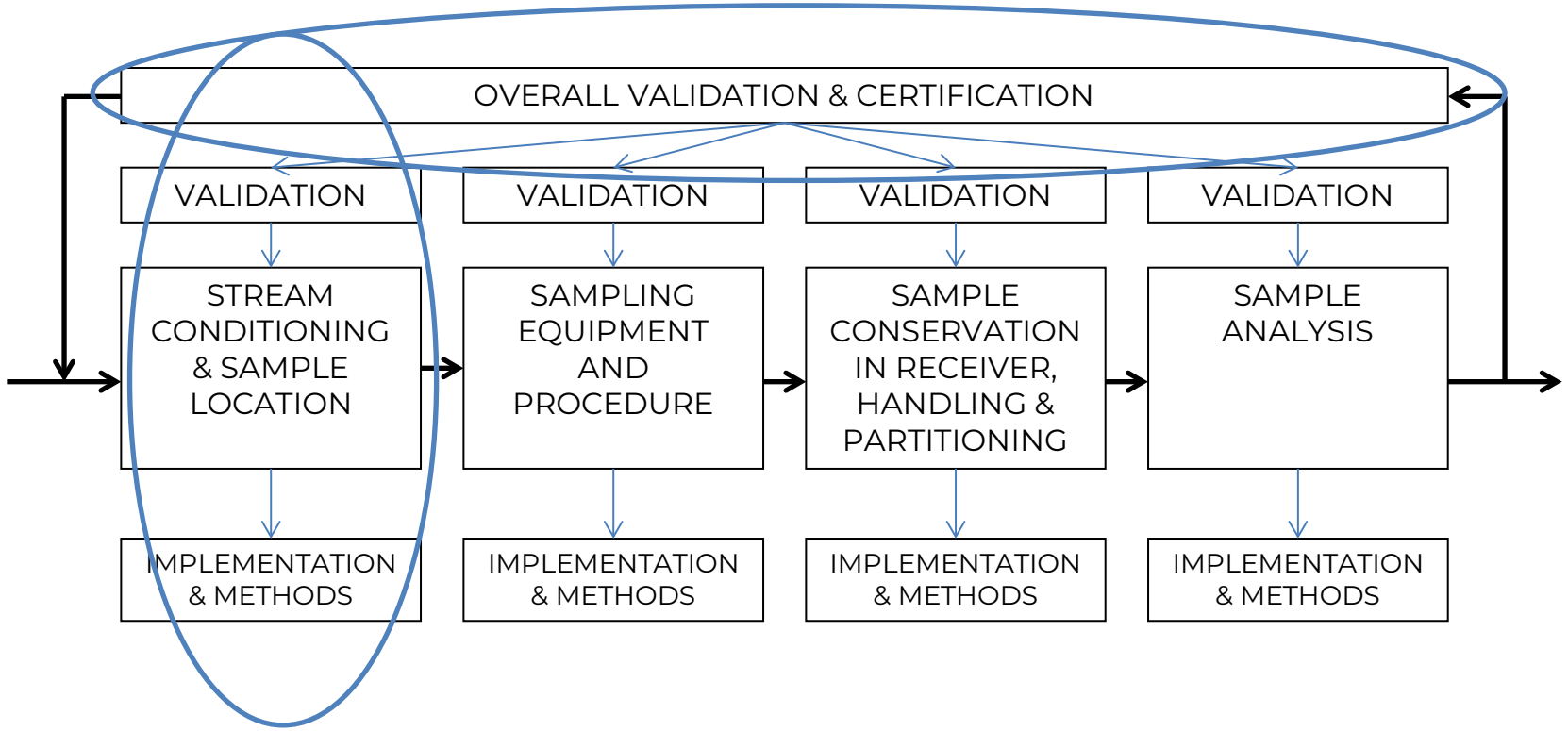
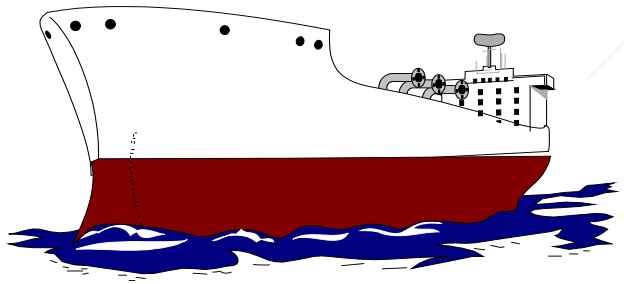
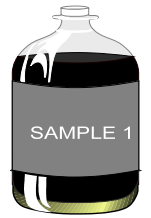
Automatic Sampling for Custody Transfer

Steps involved as described in the ISO 3171





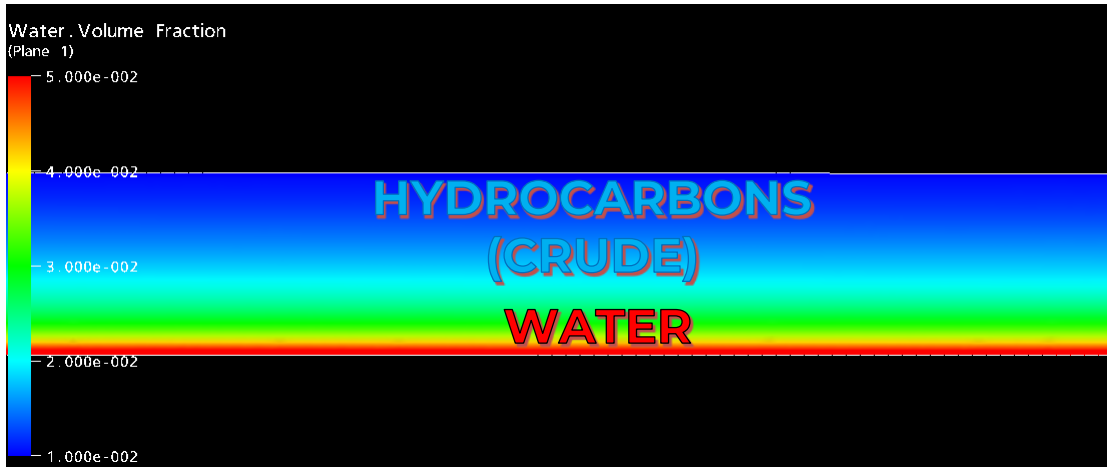


1 in 300,000,000,000

The Challenge: how to take a 10L representative sample from a 1.9 million barrel VLCC?

Automatic Sampling for Custody Transfer

Stream Conditioning



In order to achieve a representative sample, mixing of the crude and water is required!

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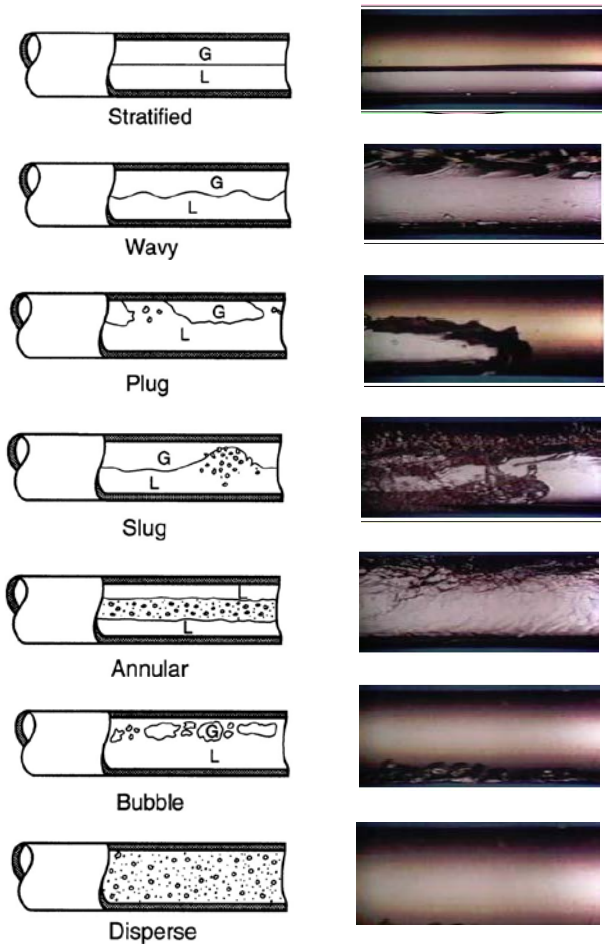
Stream Conditioning – Flow Types



TOO HIGH OR TOO LOW

PARTIALLY TOO HIGH OR TOO LOW

PARTIALLY TOO HIGH OR TOO LOW

PARTIALLY TOO HIGH OR TOO LOW

TOO HIGH OR TOO LOW

SOMETIMES TOO HIGH OR TOO LOW

PERFECT MEASUREMENT!

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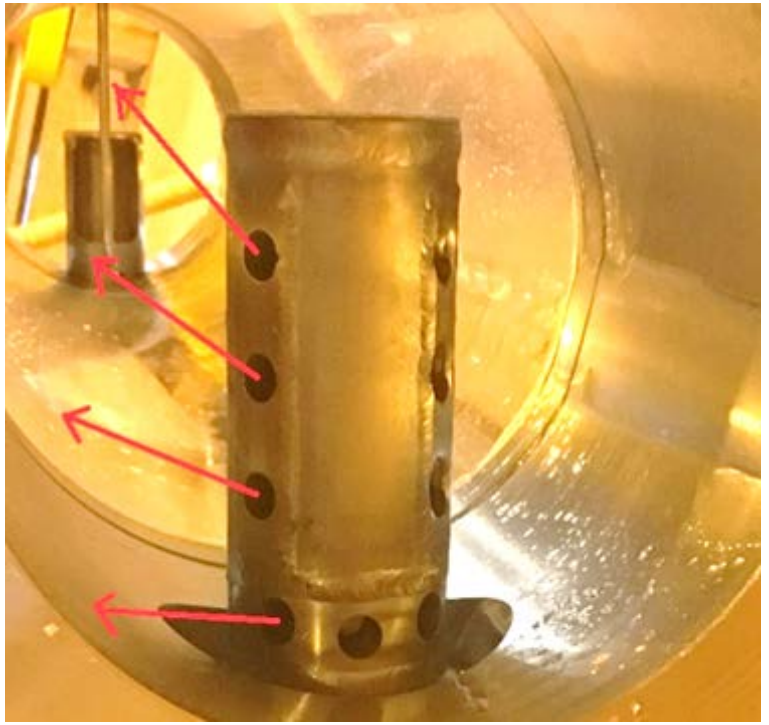
Stream Conditioning – Mixing Technology

In practice there are a two main alternatives:

- Static mixing
- Jet mixing



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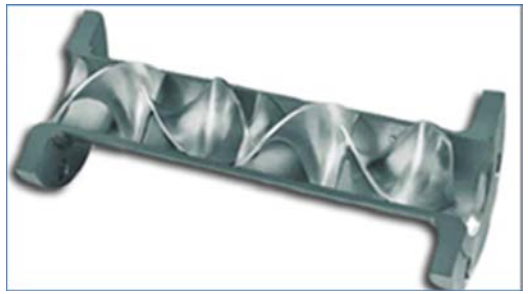
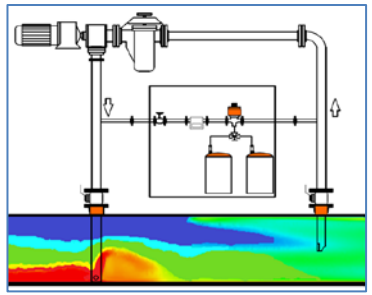
Stream Conditioning – Mixing Technology





Differences	Static Mixer	Jet Mixing
• Turn down ratio	Limited (~1:5)	High
• Pressure drop	Yes	No
• Pipeline Pigging	No	Yes

Challenges with Jet Mixing

- Electric Power Requirement (pump and motor)
- Large footprint
- Potential deteriorating mixing performance

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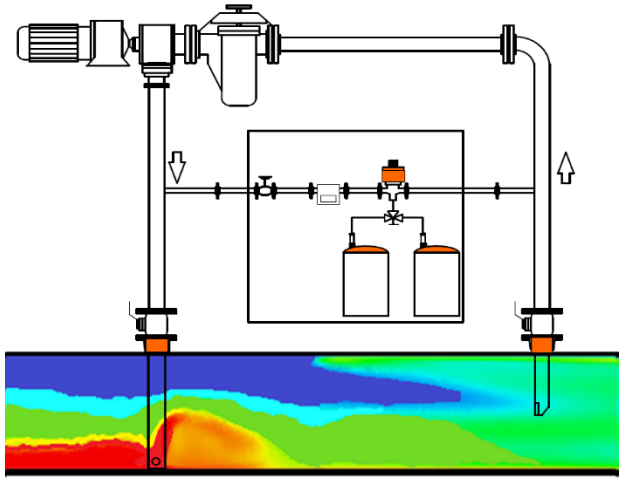
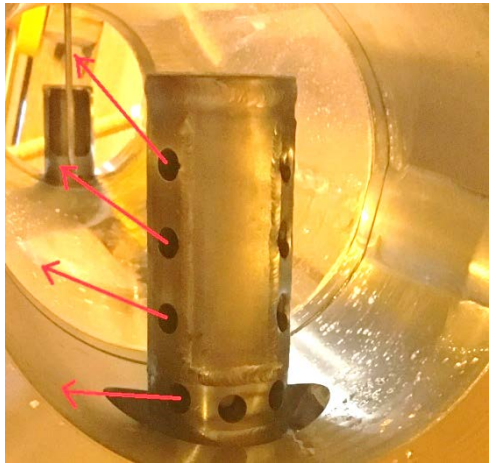
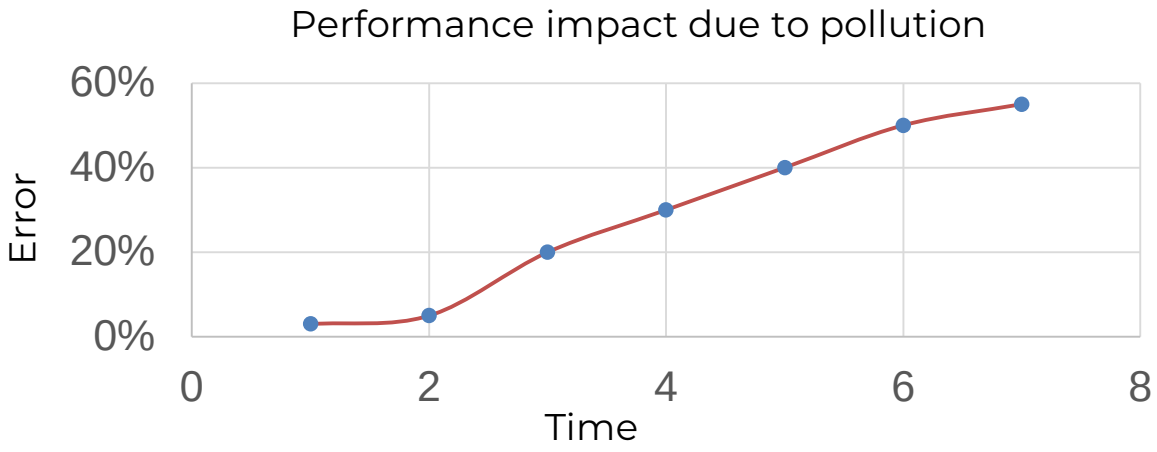
Stream Conditioning – Challenges with Jet Mixing







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Stream Conditioning – Addressing the Challenges of Jet Mixing

- How do we reduce the electric power requirements?
- How can we create a more compact design with smaller pump and pipe work?
- How do we address the deteriorating performance due to
  - Sediments?
  - Wax forming?
  - Unwanted materials (e.g. sand, etc.)?

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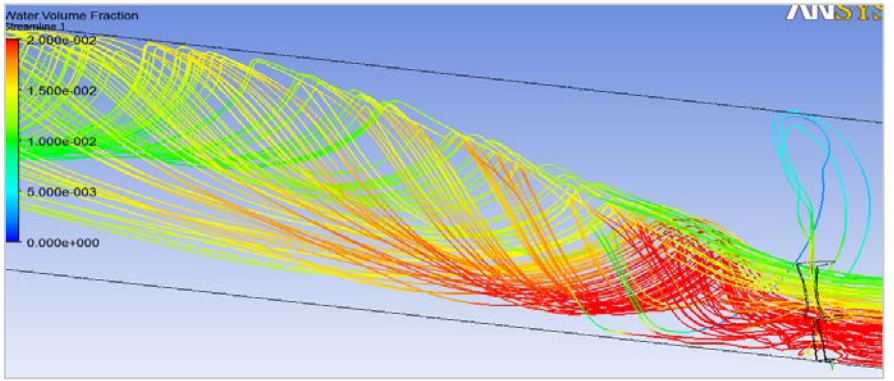
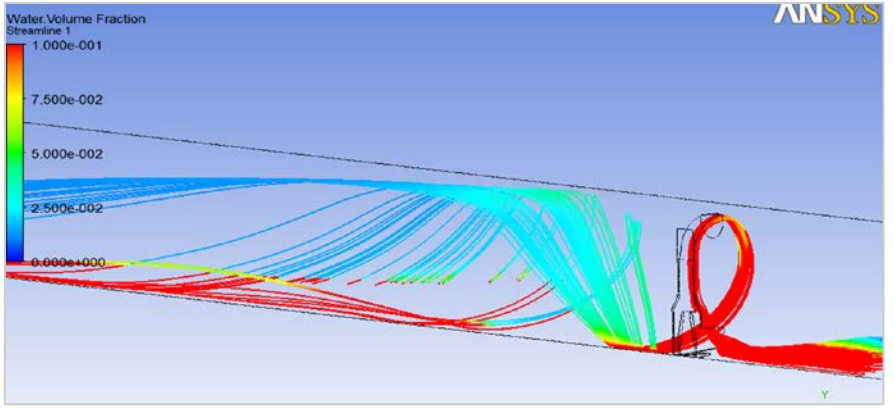
e-Jet Mixer – Addressing the Challenges of Jet Mixing

Eductor Type Mixer

Initial results based on CFD modelling





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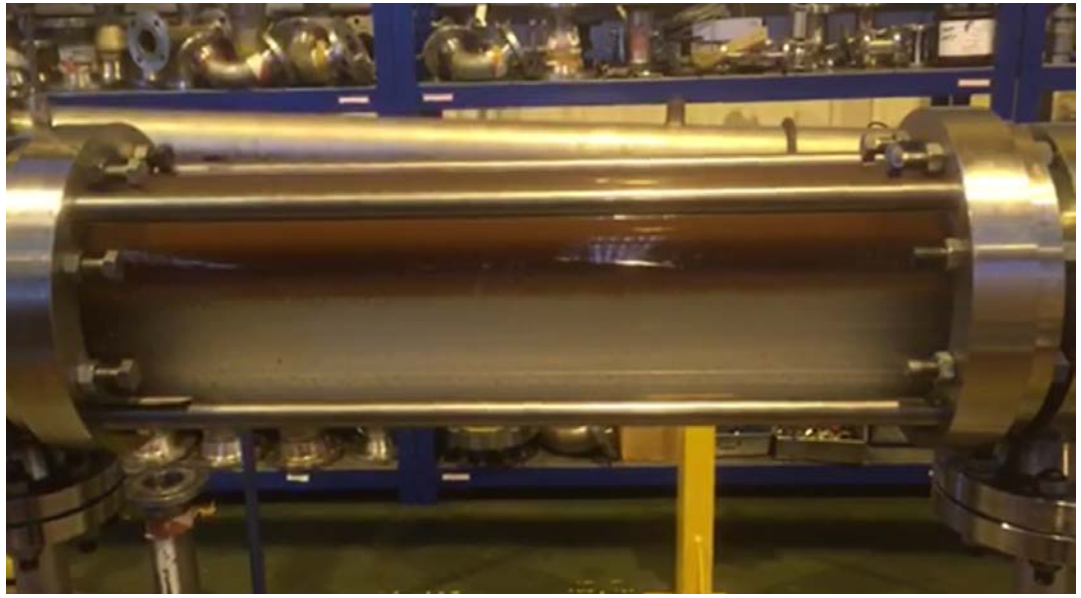
e-Jet Mixer - Lab Test

Mixing profile test conducted at the accredited TUV-NEL flow facility

Purpose: evaluation of traditional Jetmix versus e-Jetmix (with eductor)

- Horizontal and Vertical lines
- Watercuts: 0.1% - 60%
- Velocities of 0.1m/s - 1.0m/s



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e-Jet Mixer – Lab Test

No mixer

Insufficient mixing

Sufficient mixing

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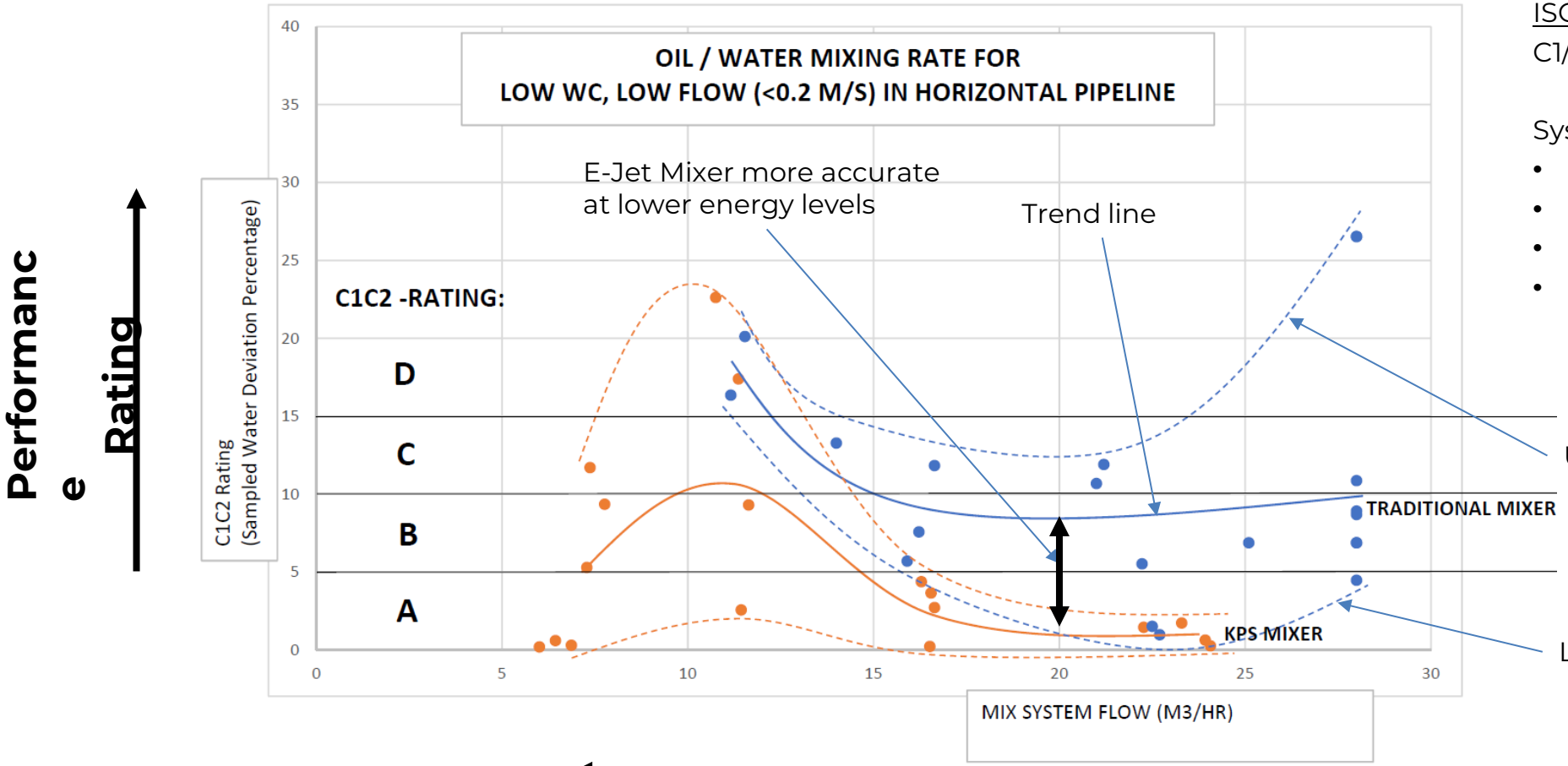
e-Jet Mixer – Lab results at low water cut (v < 0.2 m/s)



ISO 3171

C1/C2 <0.9

System ratings:

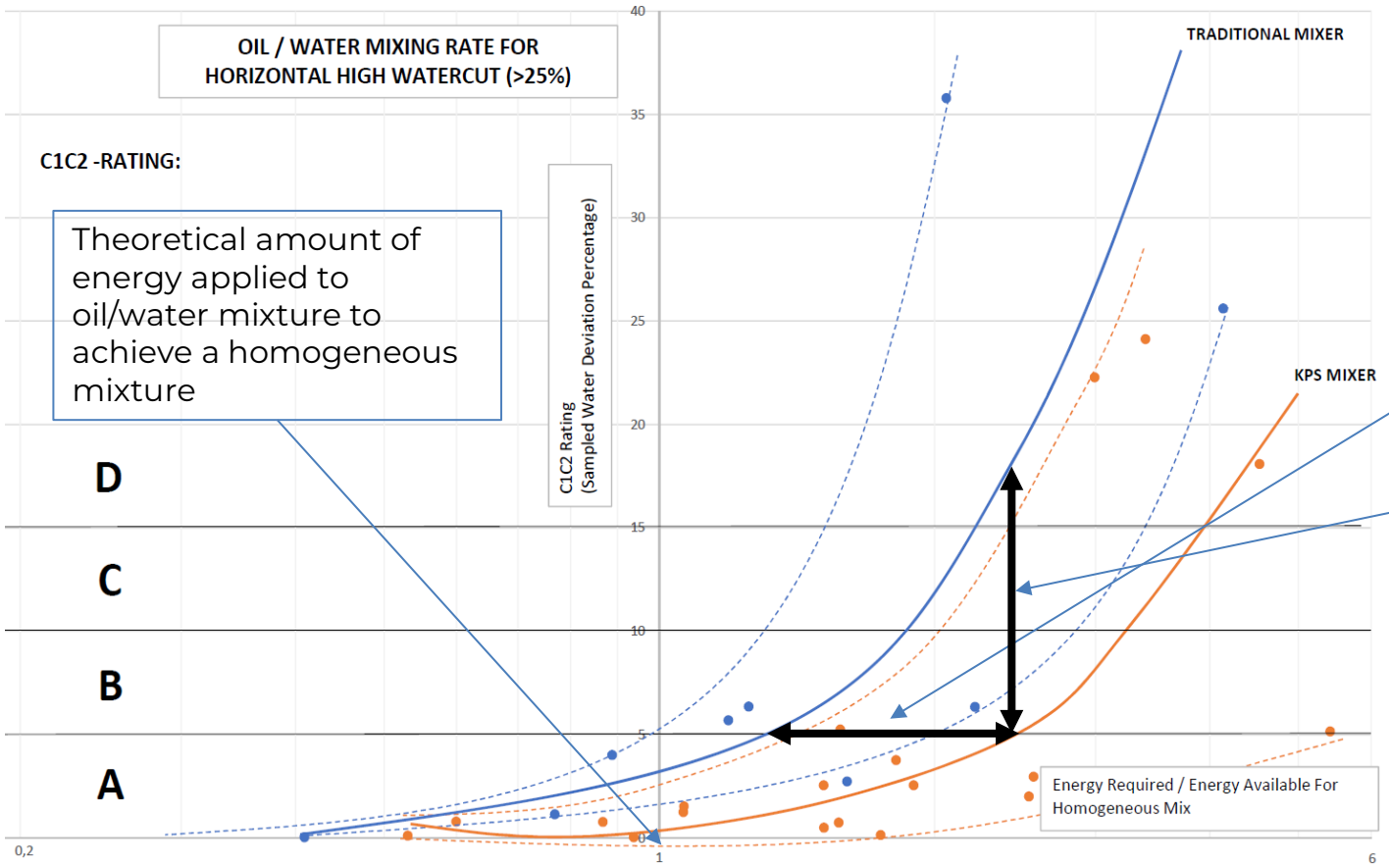
- A: <5%
- B: 5-10%
- C: 10-15%
- D: >15%

Upper limit of measurements

Lower limit of measurements

Automatic Sampling for Custody Transfer

e-Jet Mixer – Lab results at high water cut



Performance Rating

Energy decrease applied to mixing system

E-Jet Mixer more efficient at lower energy levels

E-Jet Mixer more accurate at lower energy levels

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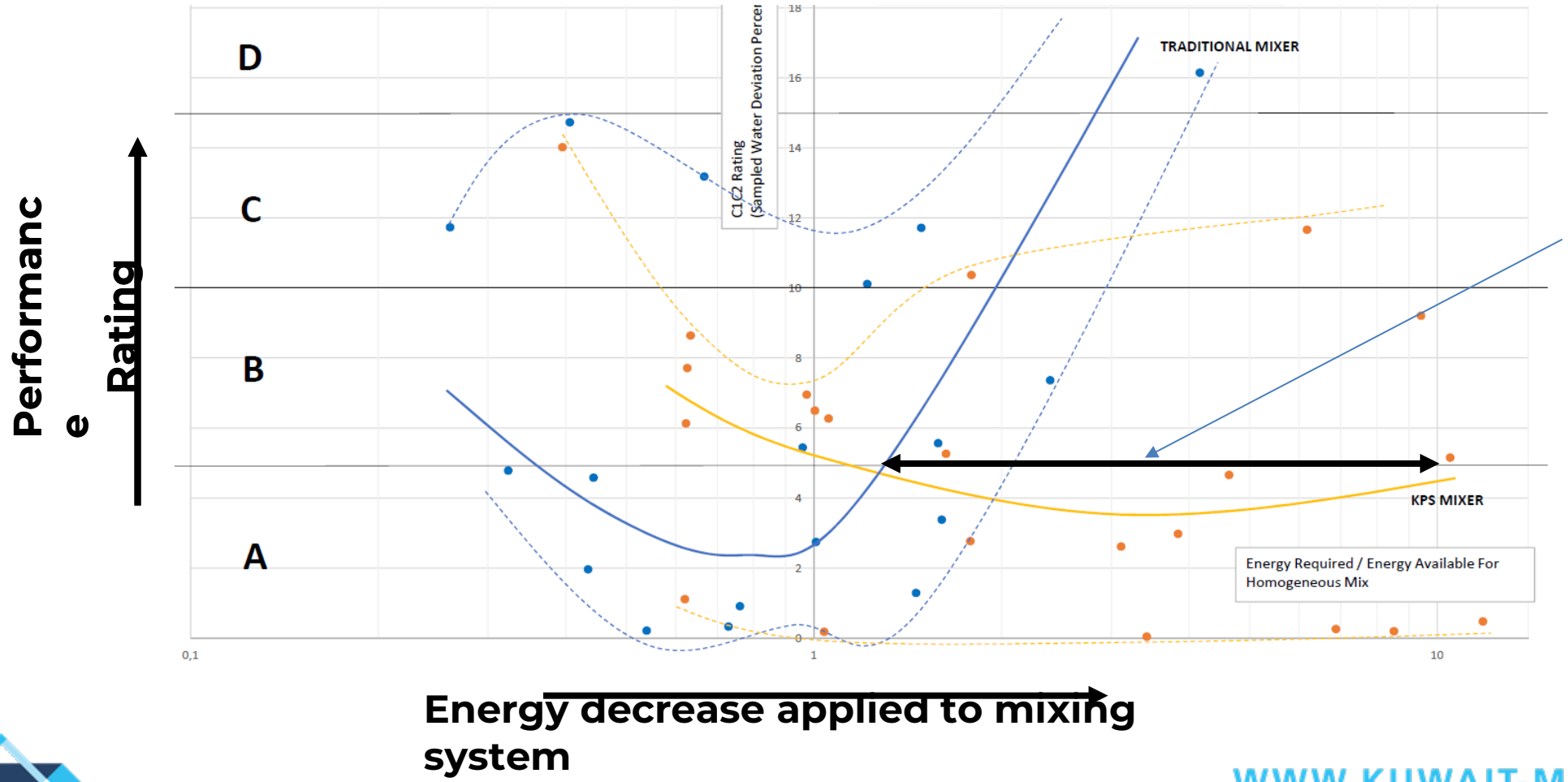
e-Jet Mixer - Lab results at low water cut (v = 0.1 – 1.0m/s)



E-Jet Mixer more efficient at lower energy levels

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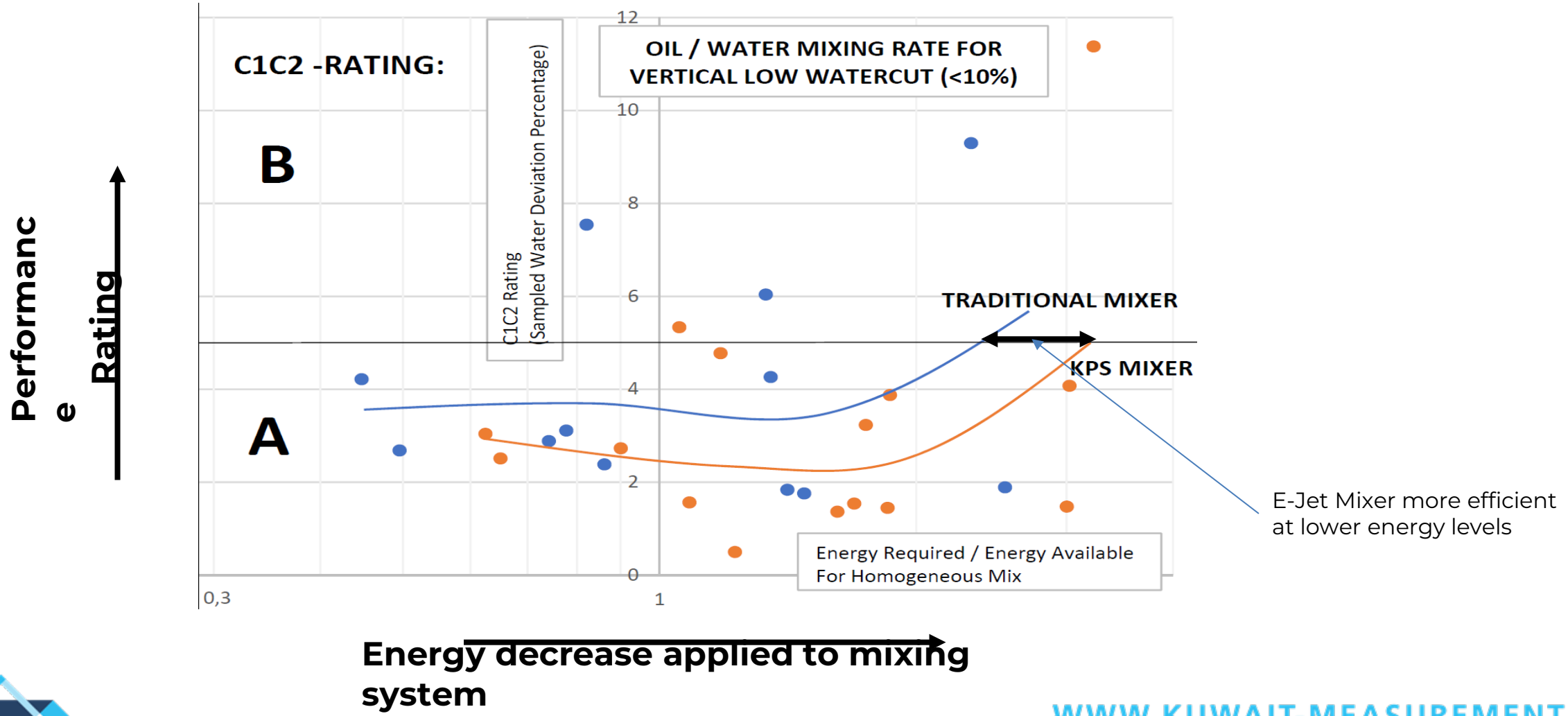
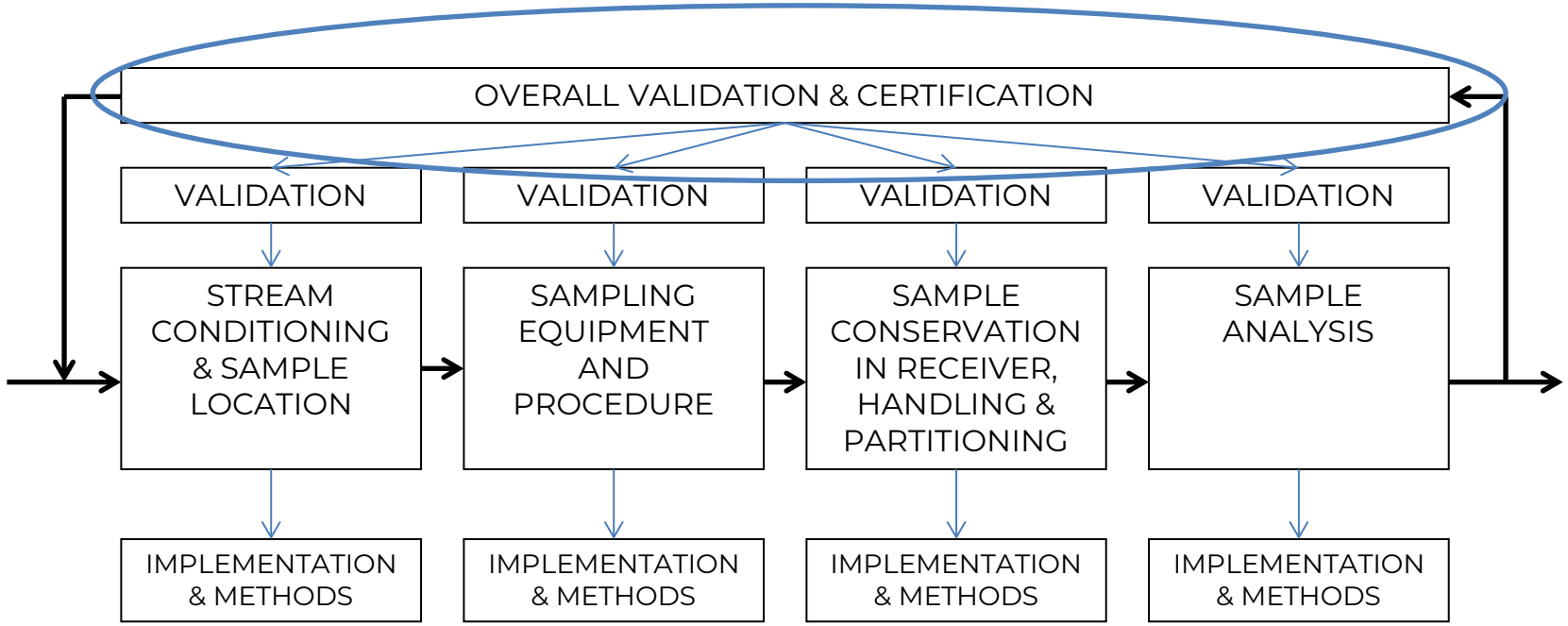
e-Jet Mixer – Lab results at vertical flow



Automatic Sampling for Custody Transfer

Steps involved as described in the ISO 3171



Automatic Sampling for Custody Transfer

Overall Validation & Certification

ISO 3171 – Proving the sampling system

System Rating

Rating	Accuracy
A	<5%
B	5% – 10%
C	10% - 15%
D	>15%

Water proofing Test

PURGE PIPELINE

BASELINE BEFORE

WATER INJECTION

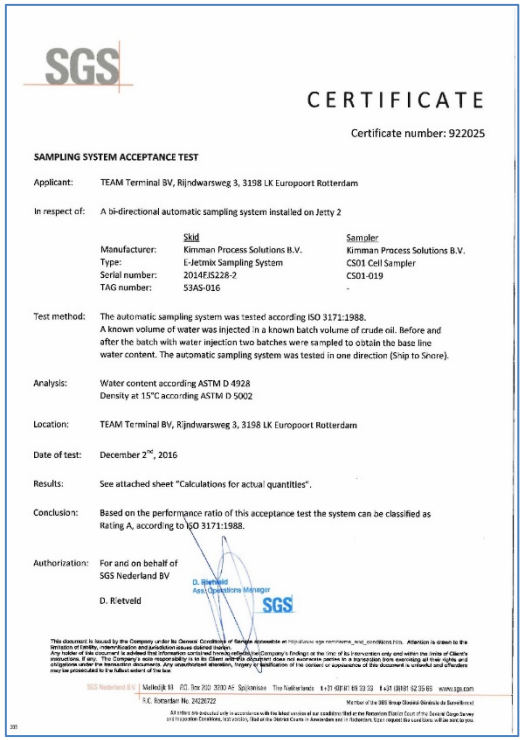
WATER ARRIVES

BASELINE AFTER

|--------SAMPLING PERIOD--------|

Three samples
1. Baseline before
2. Actual water injected sample
3. Baseline after

Certification



SGS

CERTIFICATE

Certificate number: 922025

SAMPLING SYSTEM ACCEPTANCE TEST

Applicant: TEAM Terminal BV, Rijndwarsweg 3, 3198 LK Europoort Rotterdam

In respect of: A bi-directional automatic sampling system installed on Jetty 2

	Skid	Sampler
Manufacturer:	Kimman Process Solutions B.V.	Kimman Process Solutions B.V.
Type:	E-Jetmix Sampling System	CS01 Cell Sampler
Serial number:	2014F.IS228-2	CS01-019
TAG number:	53AS-016	-

Test method: The automatic sampling system was tested according ISO 3171:1988.
A known volume of water was injected in a known batch volume of crude oil. Before and after the batch with water injection two batches were sampled to obtain the base line water content. The automatic sampling system was tested in one direction (Ship to Shore).

Analysis: Water content according ASTM D 4928
Density at 15°C according ASTM D 5002

Location: TEAM Terminal BV, Rijndwarsweg 3, 3198 LK Europoort Rotterdam

Date of test: December 2nd, 2016

Results: See attached sheet "Calculations for actual quantities".

Conclusion: Based on the performance ratio of this acceptance test the system can be classified as Rating A, according to ISO 3171:1988.

Authorization: For and on behalf of SGS Nederland BV

D. Rietveld

D. Rietveld
Asst Operations Manager
SGS

Automatic Sampling for Custody Transfer

SGS

Applicant
Subject
Location
Date
Cert. no.

Calculations for actual quantities

Owner of sampling system	
Supplier of sampling system	Kimman Process Solutions B.V.
Manufacturer of sampling system	Kimman Process Solutions B.V.
Serial number of sampling system	2014EJS228-2
Tag number of sampling system	53AS-016
Type of grab sampler	CS01 Cell Sampler
Serial number of grab sampler	CS01-019

Manufacturer water meter	Liquid Controls
Type	M30
Serial number	480431
Identification number (TAG number)	MM20
Capacity [l/min]	130 - 1300
Calibration certificate	16/MM20/1

Volume injected water during water injection	V_1	53.332 [m^3]
Volume of oil during water injection	V_{oil}	3345.805 [m^3]
Volume total	V_2	3399.137 [m^3]

Water percentage in "before" sample	W_{bef}	0.020 [%]
Water percentage in "after" sample	W_{aft}	0.050 [%]
Base water percentage	W_{base}	0.034 [%]

Water percentage in "test" sample	W_{test}	1.620 [%]
Water percentage "injection"	W_{inj}	1.569 [%]
	W_{dev}	0.017 [%]

Performance ratio	**0.010**

The volume of oil during water injection was calculated as following using the calibrated and certified Level Indicator (LI) on tank 963: $V_{oil} = LI_{start} - LI_{end} - 75m^3$

The $75m^3$ is a fixed line displacement, after this line displacement the sampler starts automatically.

All samples were obtained by mixing the cans from the sampler and dividing into bottles.
All samples were analyzed by SGS at their ISO9001 and ISO17025 accredited laboratory in Spijkenisse.

Average density @ 15°C of before and after samples:	0.7703 [kg/l]
Average density @ 15°C of the test sample:	0.7736 [kg/l]

D. Rietveld
Ass. Operations Manager

SGS

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R.C. Rotterdam No. 24226722

Volume of oil
Volume of water

Water in base line: 0,034%

Water injected : 1.569%
Water measured: 1.620%

Performance ratio: 0.01
(A-rating <0.05)

Condensate with an
API>50

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e-Jetmixer - Field Results

Application	% Water Injected	Viscosity	Density	Accuracy
30-inch crude oil pipeline	1,56%	1,3 cSt	770kg/m3	A-rating
36-inch crude oil pipeline	1,46%	6,4 cSt	840kg/m3	A-rating
40-inch crude oil pipeline	1,94%	1,4 cSt	780kg/m3	B-rating*

Automatic Sampling for Custody Transfer

e-Jetmixer - Offshore Application

Platform: ULA (North Sea)

Operator: AkerBP

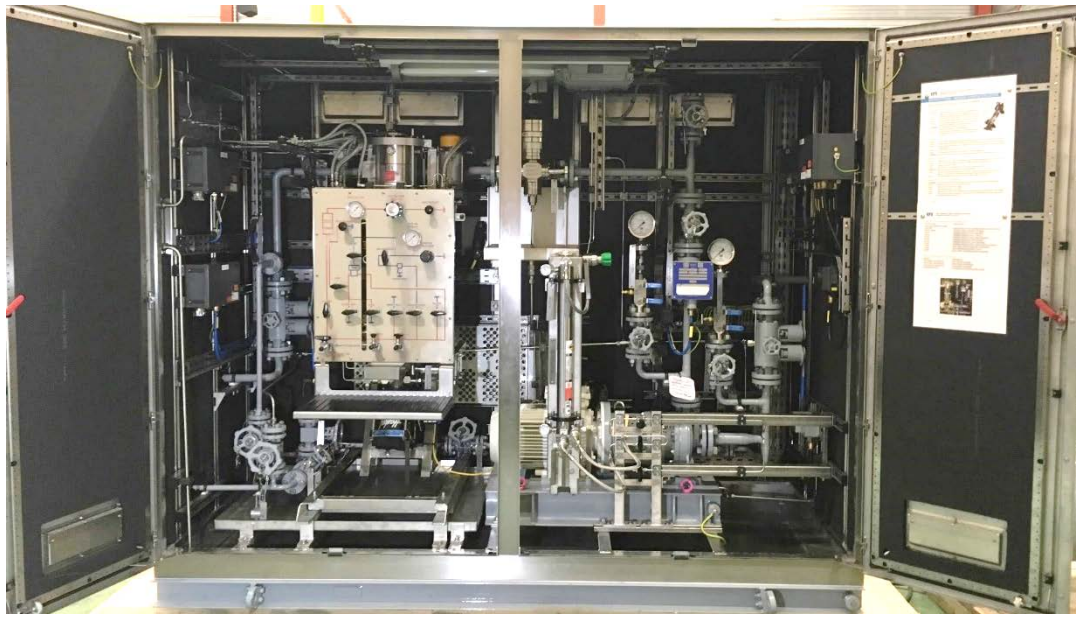
Challenges:

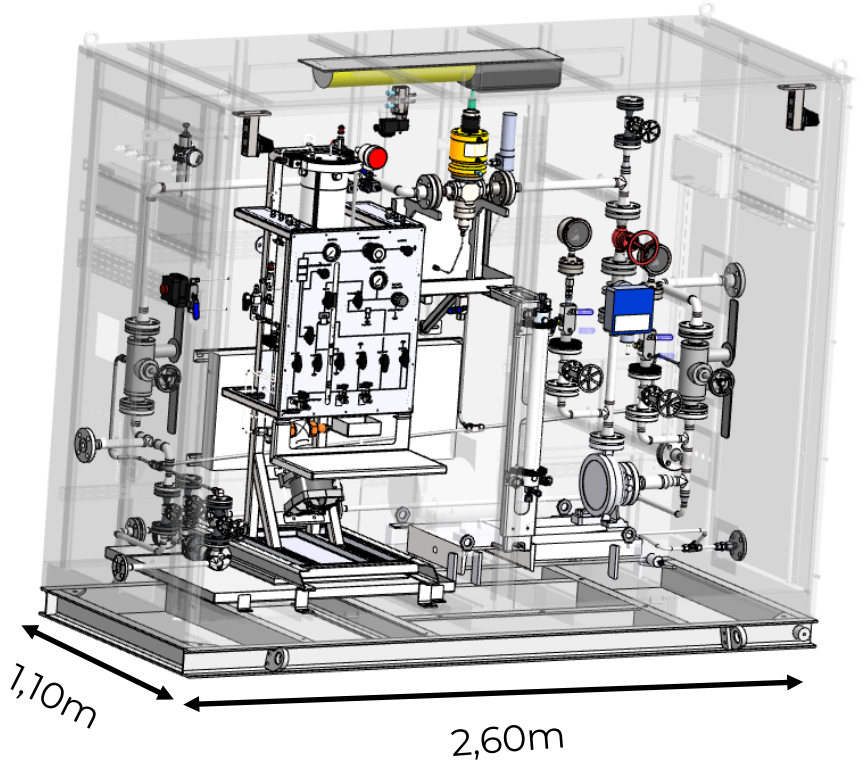
- Limited available footprint
- Maturing fields (asphaltenes & sand)
- Lower pipeline velocities (resulting in poor mixing)

Automatic Sampling for Custody Transfer

e-Jetmixer - Offshore Application

- Compact design
- Suitable for maturing field conditions





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e-Jetmixer - Summary

- e-Jetmixer contains an eductor mixing nozzle which proves to be an very promising technology for pipeline sampling applications.

- Requires in general less electrical power than traditional jet mixing technologies

- Higher accuracy than traditional methods in cases where:
  - Less energy is applied than required
  - Low velocities in the main pipeline

Automatic Sampling for Custody Transfer

e-Jetmixer – Customer Benefits

- Accurate performance for crude oils containing:
  - Sediments
  - Wax formation issues
  - Other unwanted materials

- Less required footprint and power

Automatic Sampling for Custody Transfer

More Information

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KPS
KIMMAN PROCESS SOLUTIONS B.V.

THANK YOU