Novel Compact Flotation Unit for Treating High OiW Concentration Produced Water

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STAUPER
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TÜV SÜD National Engineering Laboratory
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Produced Water Workshop 2021

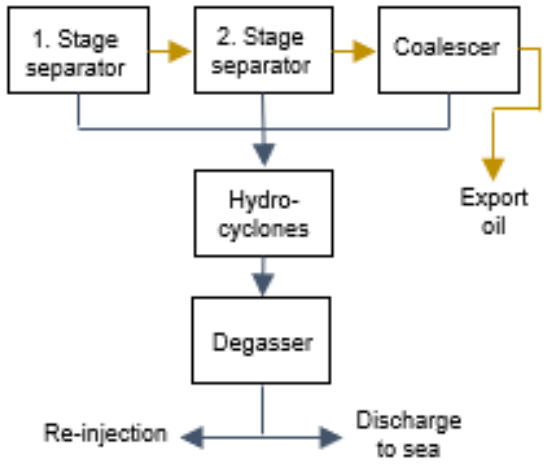
24-25 November 2021

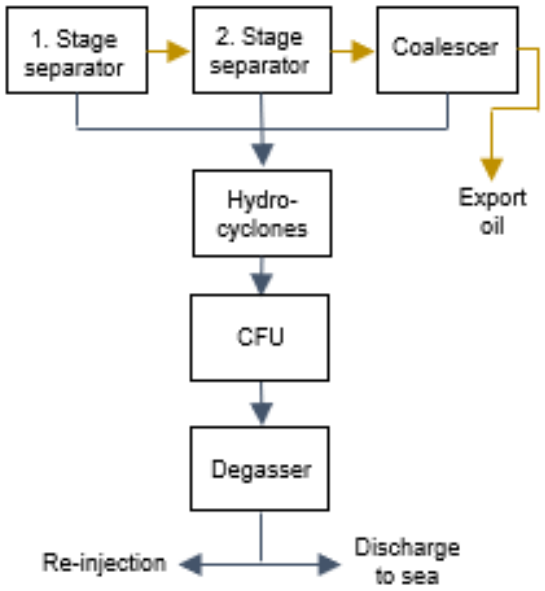
Online Event

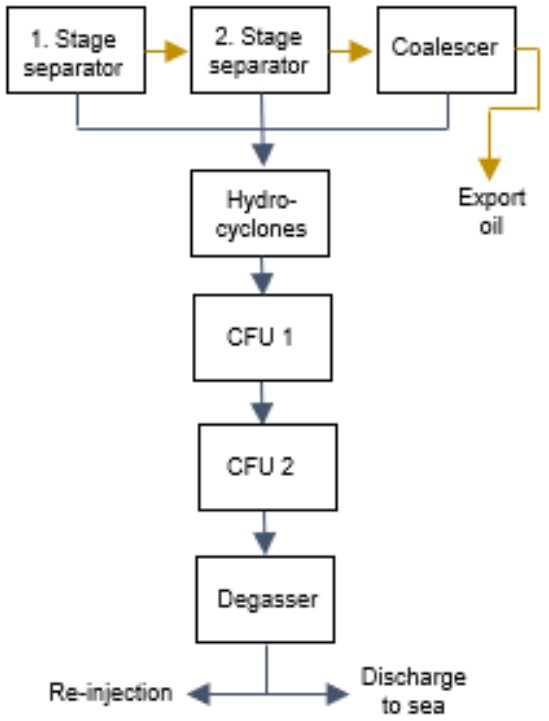
PRESENTATION OUTLINE

- ❑ Simplification of traditional PW system set up
- ❑ Benefits of new CFU design
- ❑ Case studies – utilizing the new CFU technology as single de-oiling technology
- ❑ Weight and footprint reduction
- ❑ Conclusion

TRADITIONAL PW SYSTEM SET UPS







Technology building blocks:

- ❑ **Hydrocyclone**
- ❑ **CFU**
- ❑ **IGF**
- ❑ **DAF**
- ❑ **Degasser**
- ❑ **CPI**
- ❑ **WOSEP**
- ❑ **PW Treater**
- ❑ **Nutshell filter**
- **++**

Different technologies combined

- ➢ Overall high complexity
- ➢ Many systems / vessels required

⇨ High footprint, weight & cost

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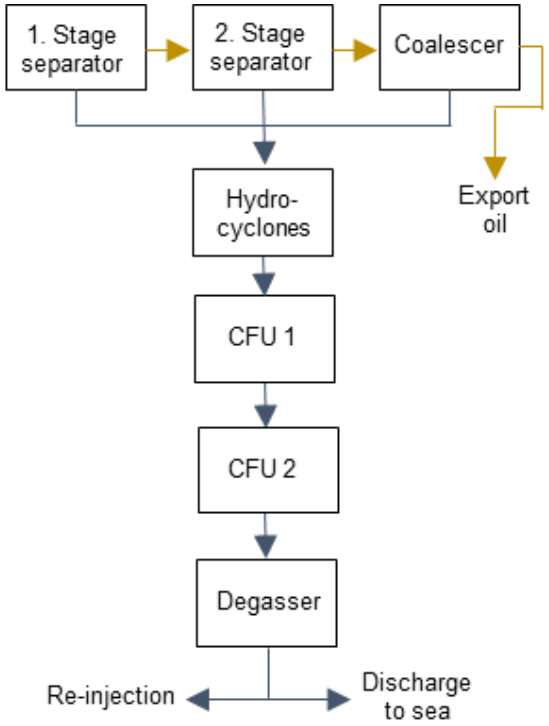
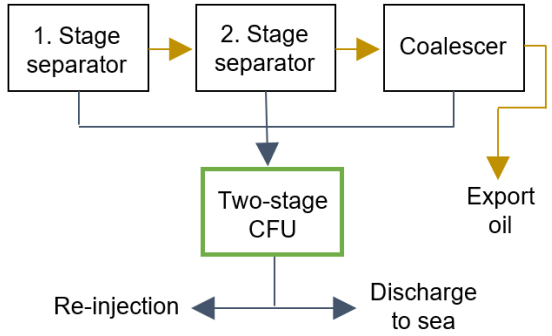
PW System Simplification





Two-stage CFU as single de-oiling technology

- Less complexity
- Single system / pressure vessel required

⇨ Savings on footprint, weight & cost

Two-stage CFU

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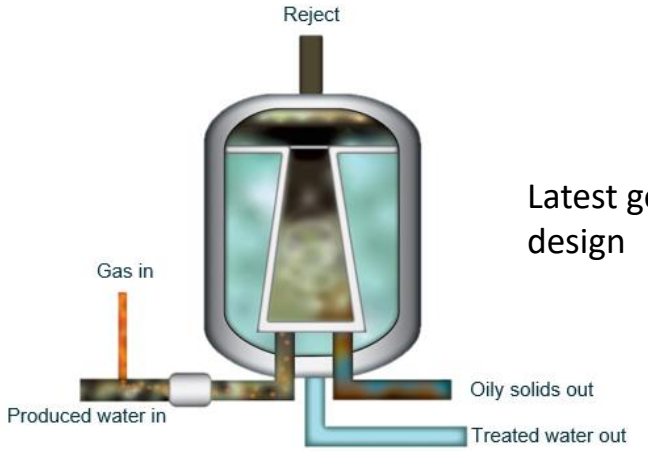
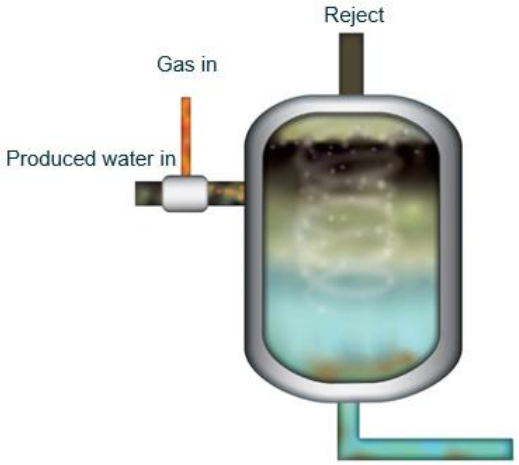
Benefits of Latest Generation CFU Design



Latest generation CFU design



Earlier/traditional open vessel design

- ✓ Higher efficiency
  - Co-current flotation (flow direction bottom up)
    - ➢ less entrained oil droplets/gas bubbles to clean discharge
  - Separate inlet chamber
    - ➢ avoid polluting discharge water with inlet water
    - ➢ maximize oil droplet / gas bubble interaction
  - Calm separation zone
    - ➢ enhanced separation
- ✓ Solids removal
- ✓ High robustness
  - No small bore openings
    - ➢ No clogging

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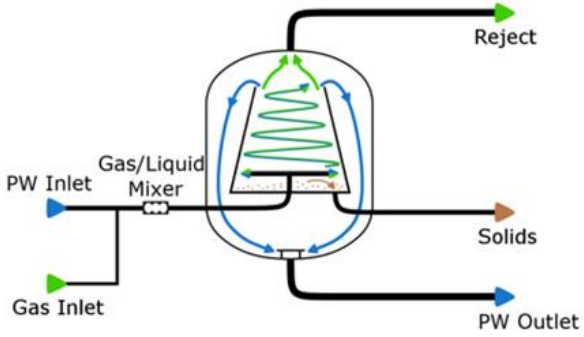
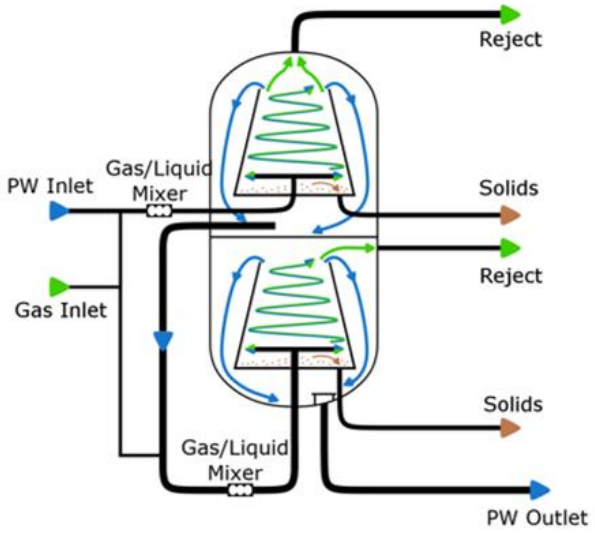
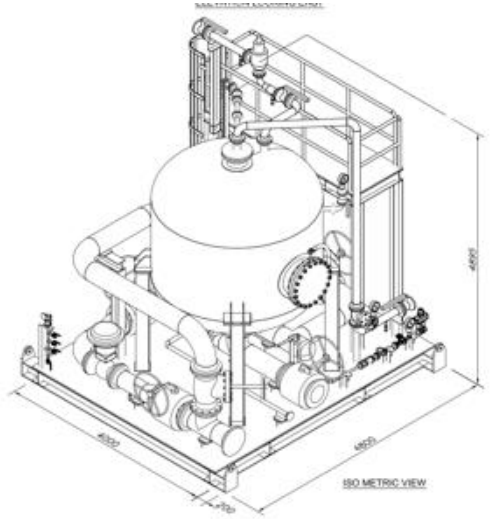
Benefits of Latest Generation CFU Design

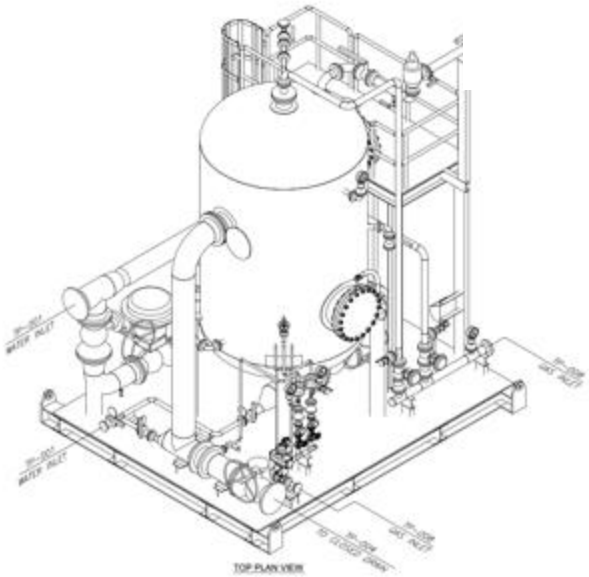




Two-stage CFU



Single-stage CFU



- ✓ Enables several **complete** flotation steps in one pressure vessel
  - Saving cost, footprint and weight

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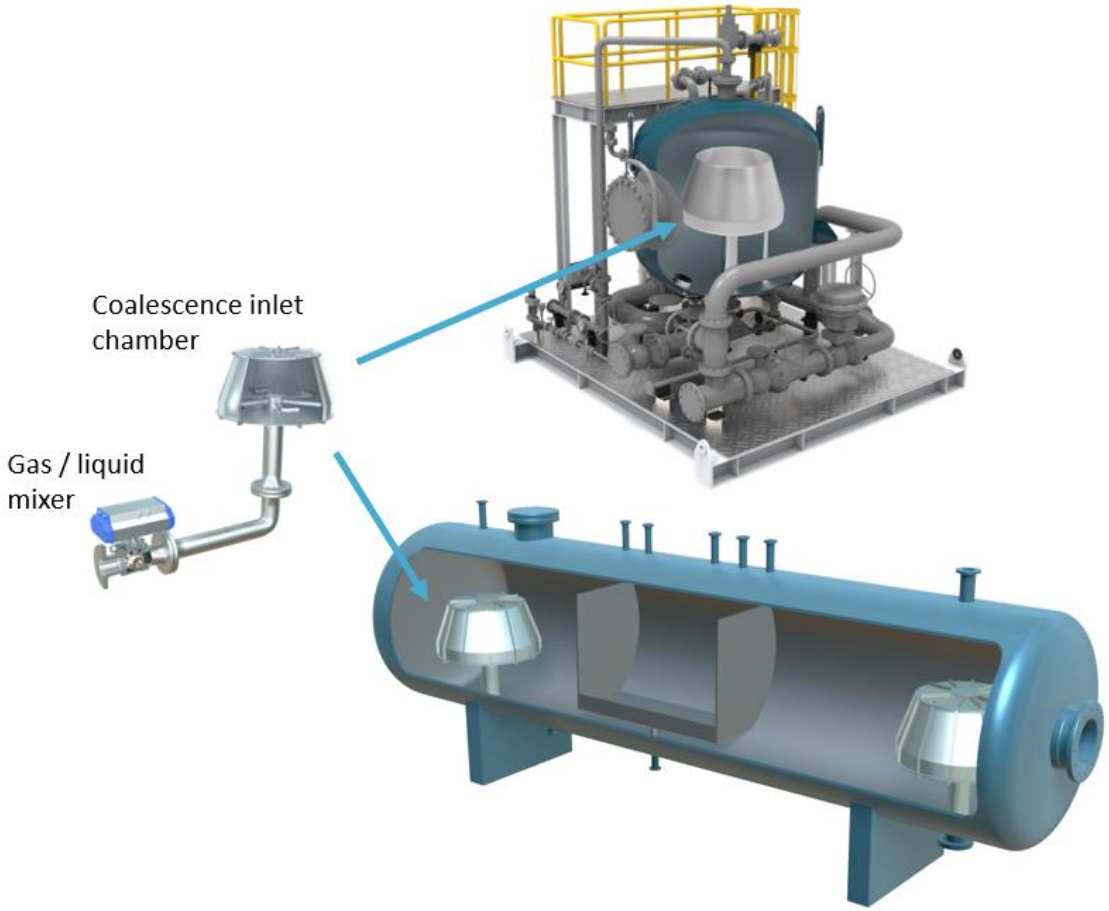
Benefits of Latest Generation CFU Design



The Retrofit Concept

The design of the developed CFU allows for bringing the core CFU technology into existing vessels

- Enhances de-oiling efficiency
- Allows for increased capacity

⇨ Cost efficient approach for debottlenecking of existing PW systems

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LATEST GENERATION CFU APPLIED AS SINGLE DE-OILING TECHNOLOGY

TEST UNIT SYSTEM

Two single-stage CFUs
Serial configuration

ID: 400 mm
TT: 500 mm
Capacity: 6 m^3/h (each)
Weight: 70 kg (each)

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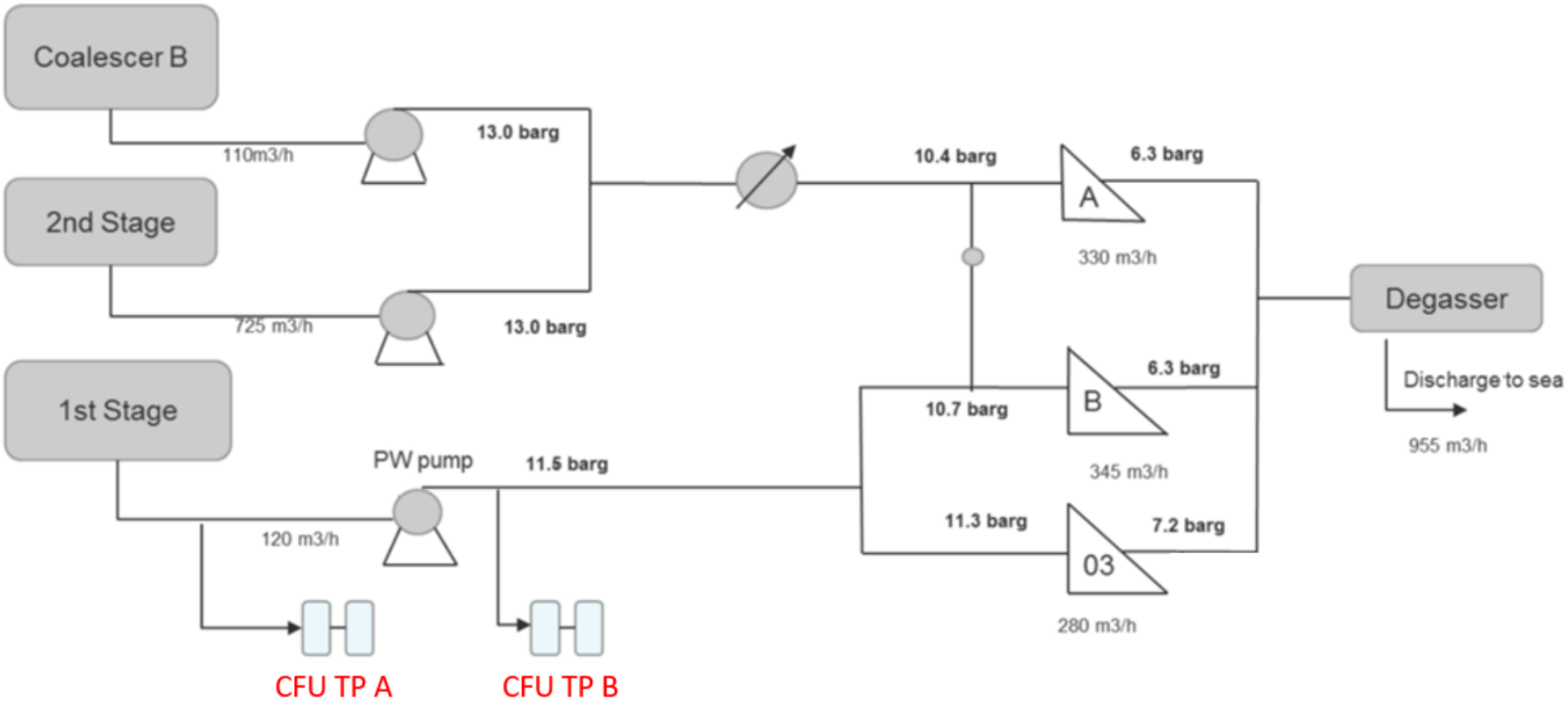
CASE STUDY 1 – OFFSHORE NORWAY



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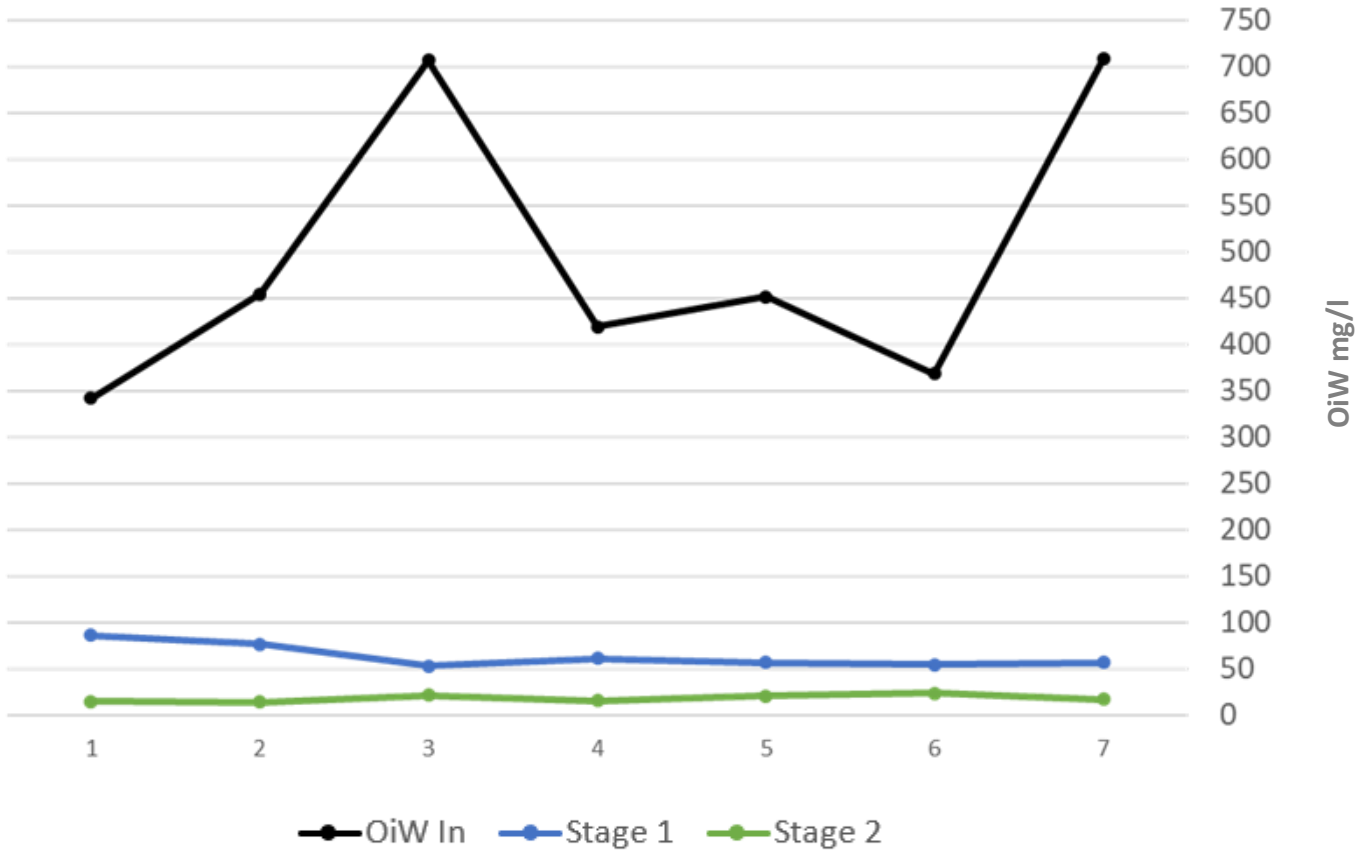
Case Study 1 – Offshore Norway

Oil API	**19 °**
PW temp	**55 – 90** °C
Dv50 (oil)	**5.0 - 6.2 µm**
Flocc added	**No**

	OiW (mg/l)	Eff (%)
Inlet	493	
Outlet CFU1	64	87
Outlet CFU2	18	71
CFU1 + CFU2		96



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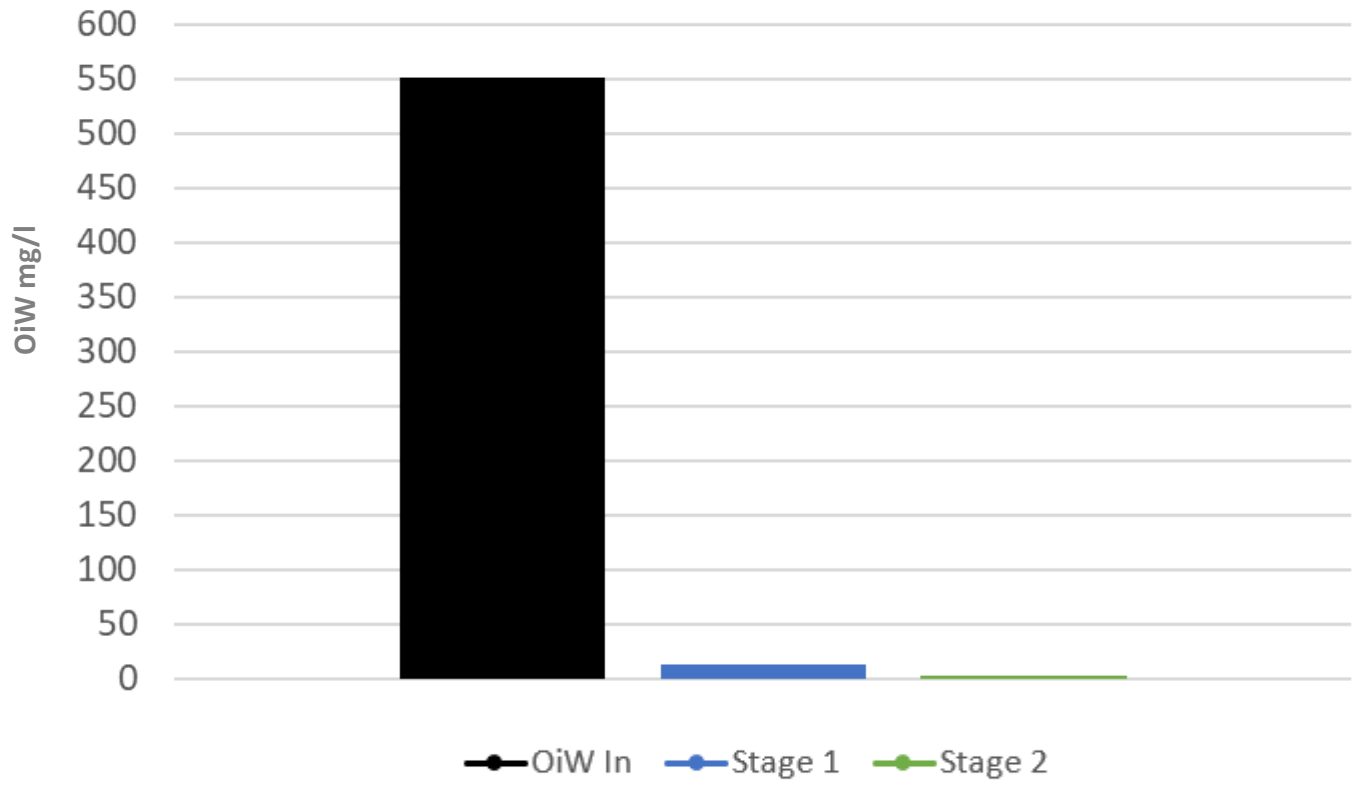
Case Study 1 – Offshore Norway

Oil API	**19 °**
PW temp	**55 – 90** °C
Dv50 (oil)	**5.0 - 6.2 µm**
Flocc added	**10 ppm**

	OiW (mg/l)	Eff (%)
Inlet	551	
Outlet CFU1	11.6	98
Outlet CFU2	2.5	78
CFU1 + CFU2		99.5



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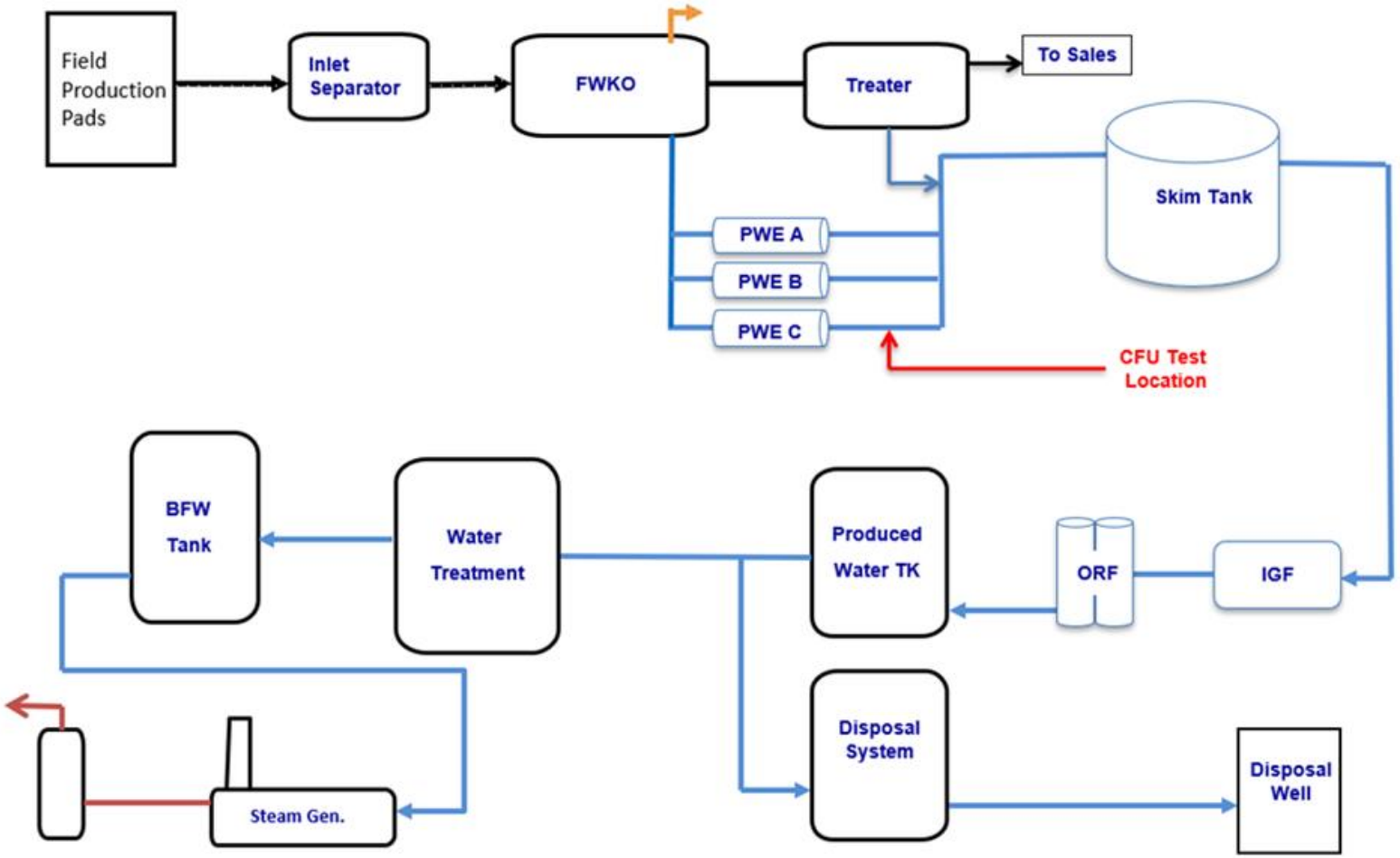
CASE STUDY 2 – ONSHORE CANADA (SAGD)



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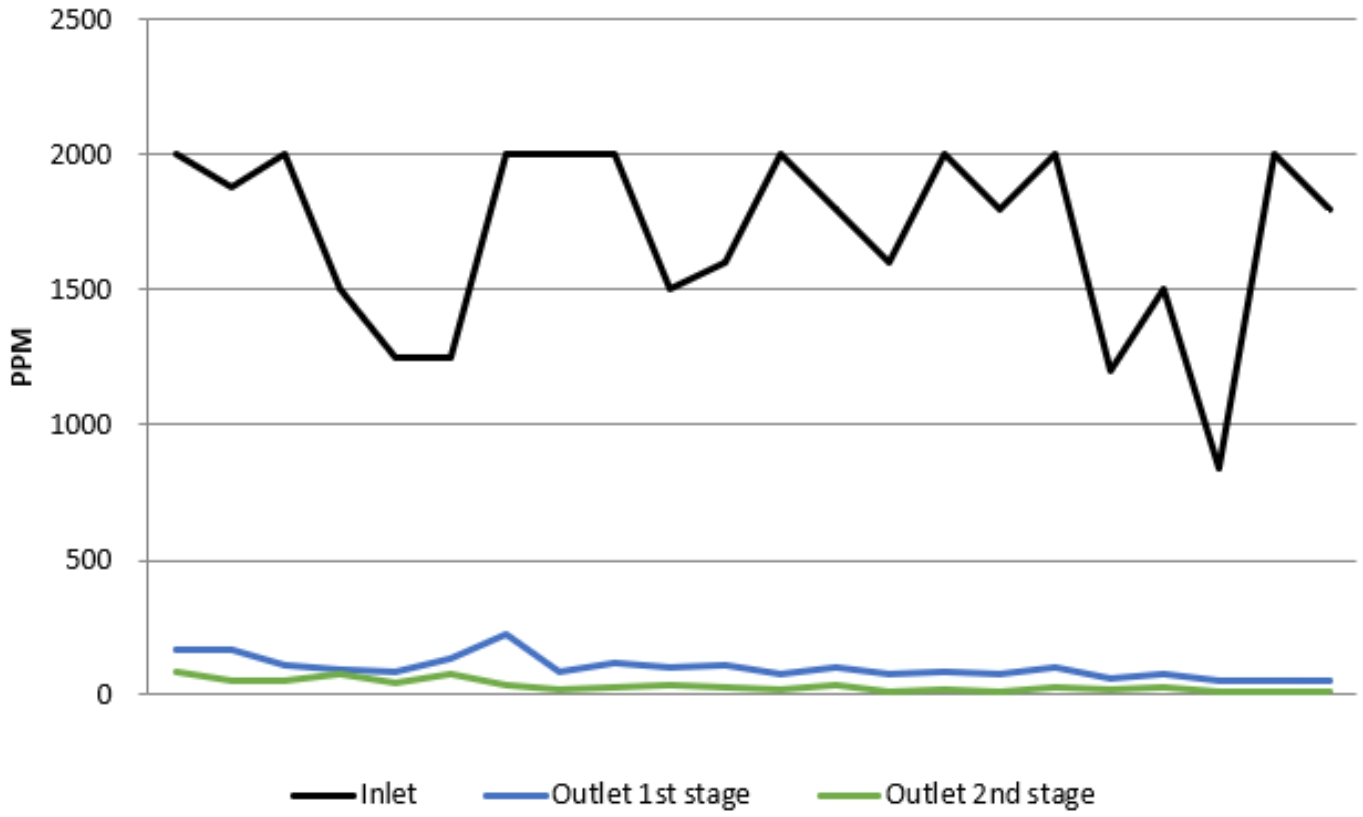
CASE STUDY 2 – ONSHORE CANADA (SAGD)

Oil API	**10.8 °**
PW temp	**80 – 90** °C
Dv50 (oil)	**NA**
Flocc added	**No**

	OiW (ppm)	Eff (%)
Inlet	1685	
Outlet CFU1	76	95
Outlet CFU2	21	72
CFU1 + CFU2		98.7



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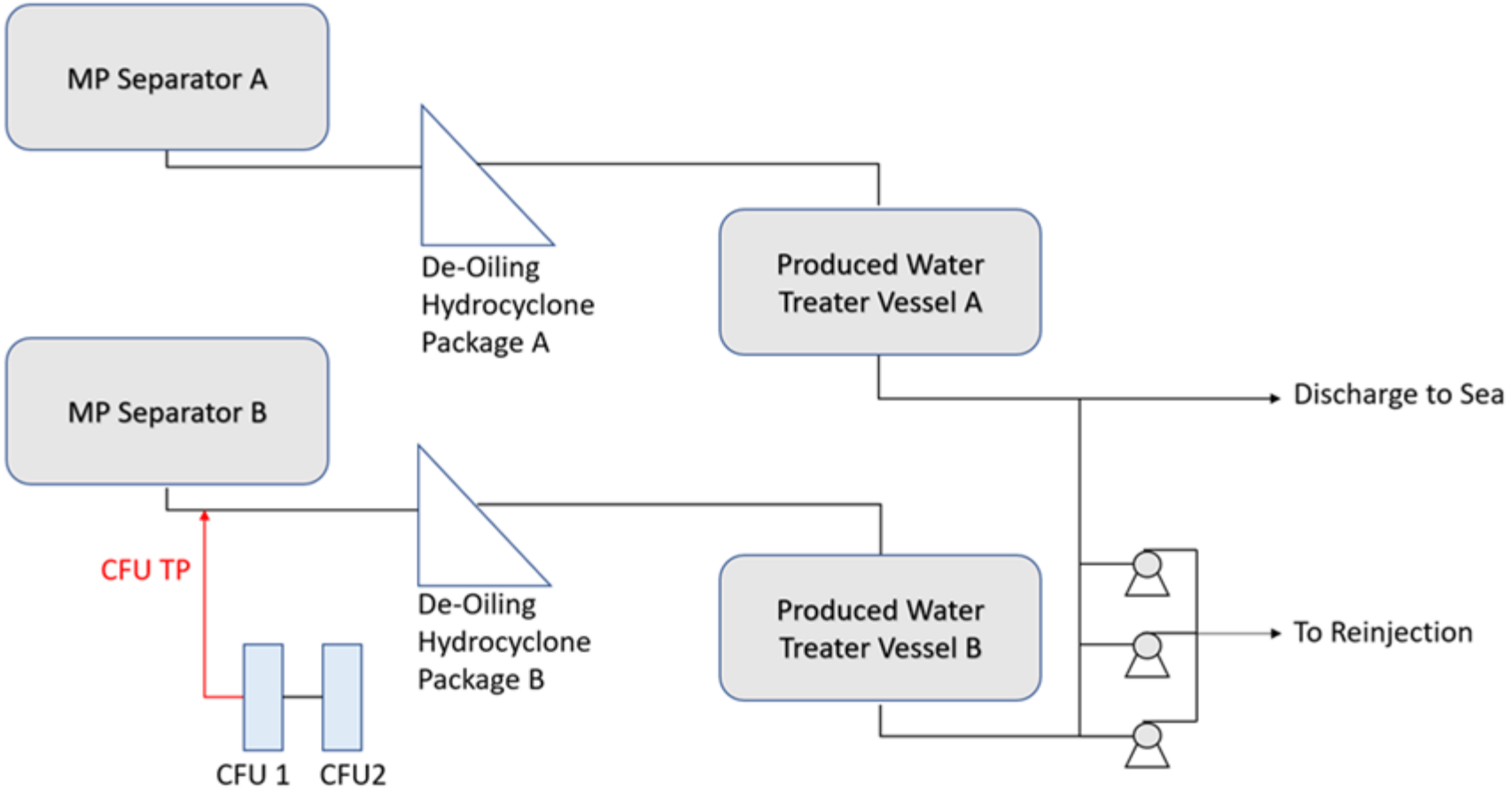
CASE STUDY 3 – OFFSHORE INDONESIA



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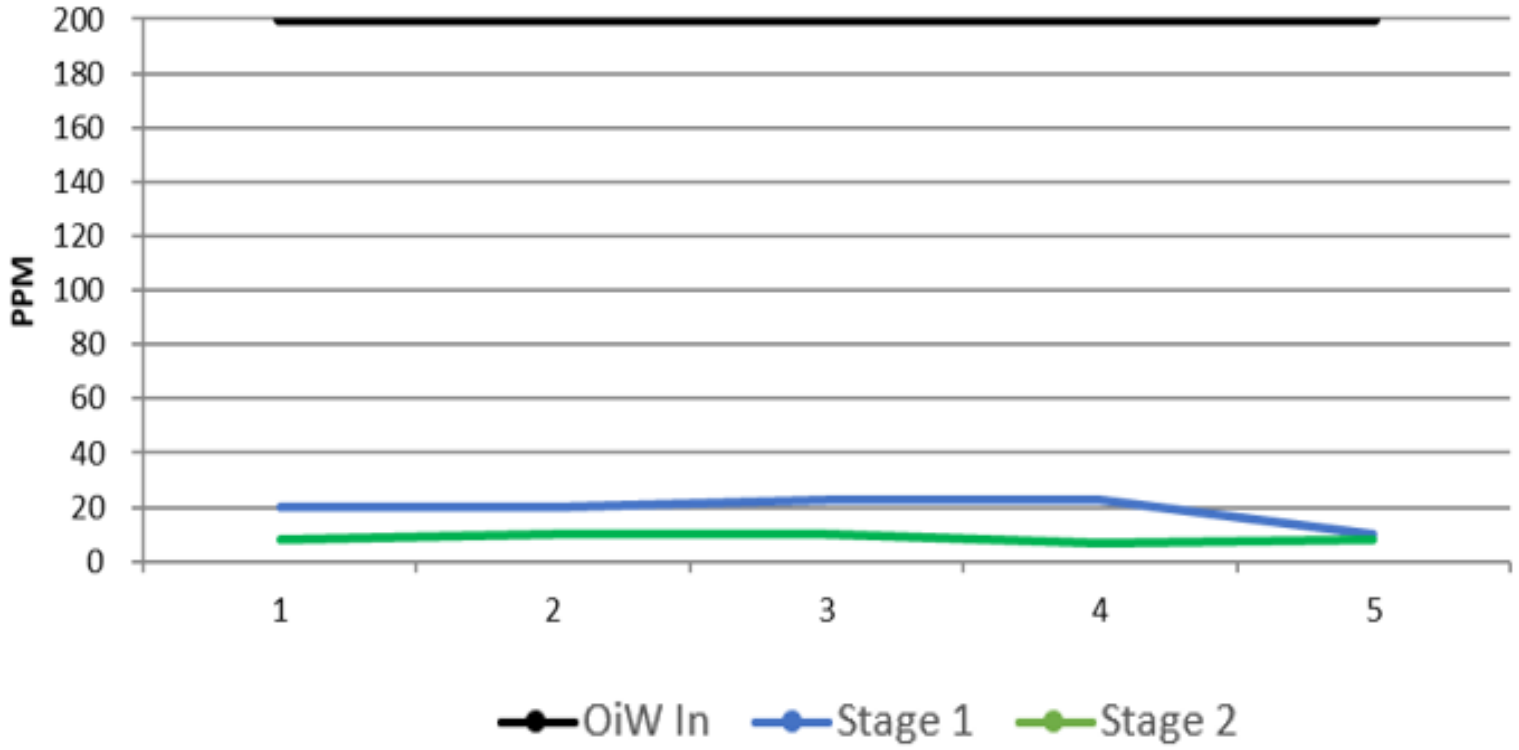
Case Study 3 – Offshore Indonesia

Oil API	**38 °**
PW temp	**~50** °C
Dv50 (oil)	**NA**
Flocc added	**Yes**

	OiW (ppm)	Eff (%)
Inlet	200	
Outlet CFU1	19	90
Outlet CFU2	9	51
CFU1 + CFU2		96



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SAVINGS ON FOOTPRINT AND WEIGHT

Flow bpd (m3/h)	2 stage Stauper CFU			Hydrocyclone + Degasser		Total saving	
	Capacity [m3/h]	Footprint [m2]	Weight Dry / Operational [kg]	Footprint [m2]	Weight Dry / Operational [kg]	Footprint	Weight Dry / Operational
22,500 (150)	150	9.2	8900 12500	26.7	9000 16500	65 %	0 24%
76000 (503)	500	20	16000 27 600	43.3	30000 59000	54 %	46% 53%

Flow bpd (m3/h)	2 stage Stauper CFU			Hydrocyclone + single stage CFU + Degasser		Total saving	
	Capacity [m3/h]	Footprint [m2]	Weight Dry / Operational [kg]	Footprint [m2]	Weight Dry / Operational [kg]	Footprint	Weight Dry / Operational
22,500 (150)	150	9.2	8900 12500	35.2	16800 27900	74 %	47% 55%
76000 (503)	500	20	16000 27 600	62.5	44 400 84 800	68 %	64% 67%

Material: 316SS
Design rating: #150

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CONCLUSION

The developed CFU technology
- unlocks the potential for savings on cost, complexity, footprint and weight.

Single De-oiling Technology
- Separator to discharge / re-injection

THANK YOU!