Challenges in Managing Mercury in Field Development and Production

8–9 JULY 2025 | KUALA LUMPUR, MALAYSIA

Mercury Management In Condensate Production

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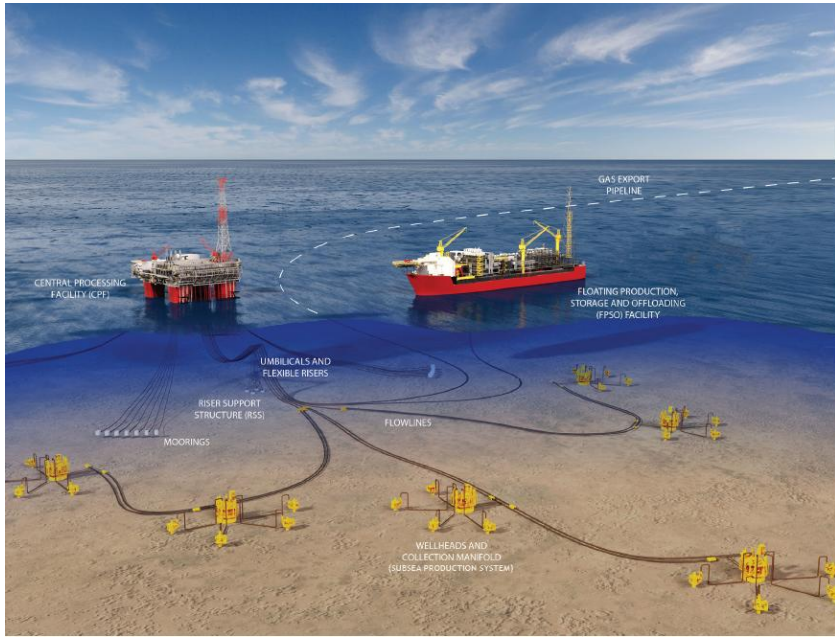
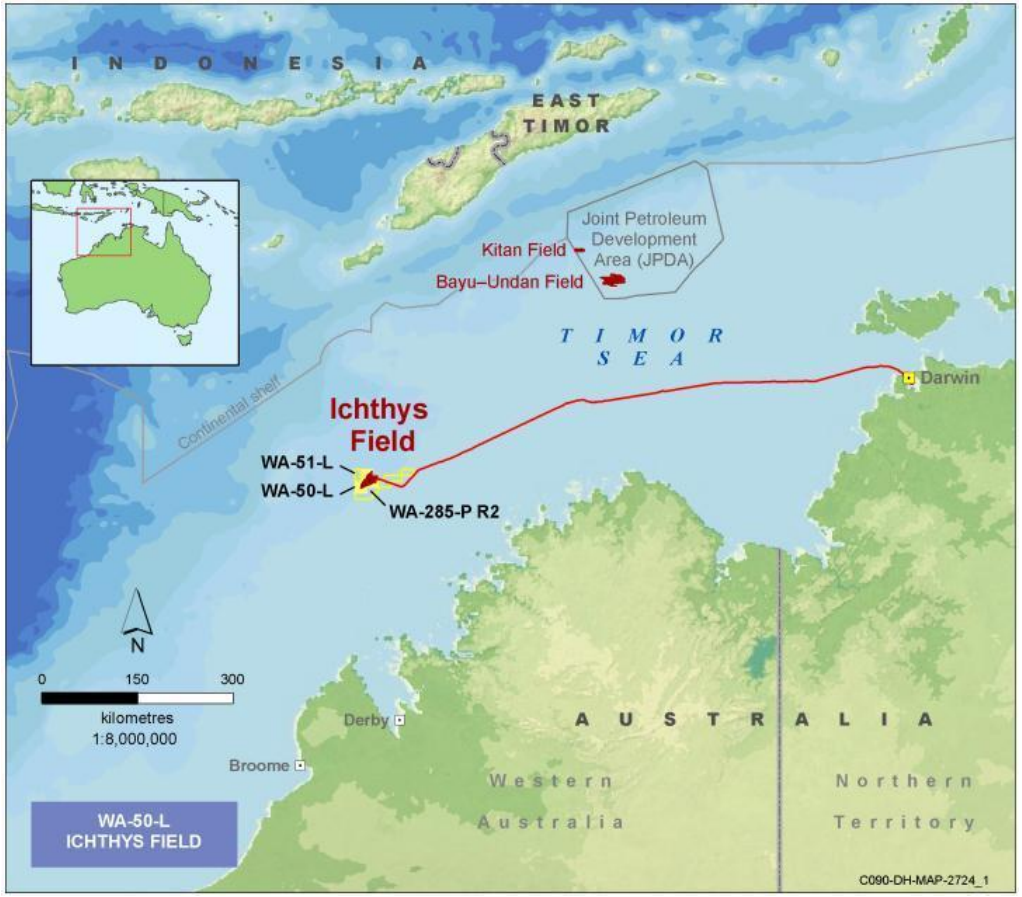
ICHTHYS FIELD

Field is 220 km NW of mainland Western Australia:

- Located 820 km SW of Darwin.
- Connected to LNG Plant in Darwin, by dry 890 km Gas Export Pipeline (GEP).





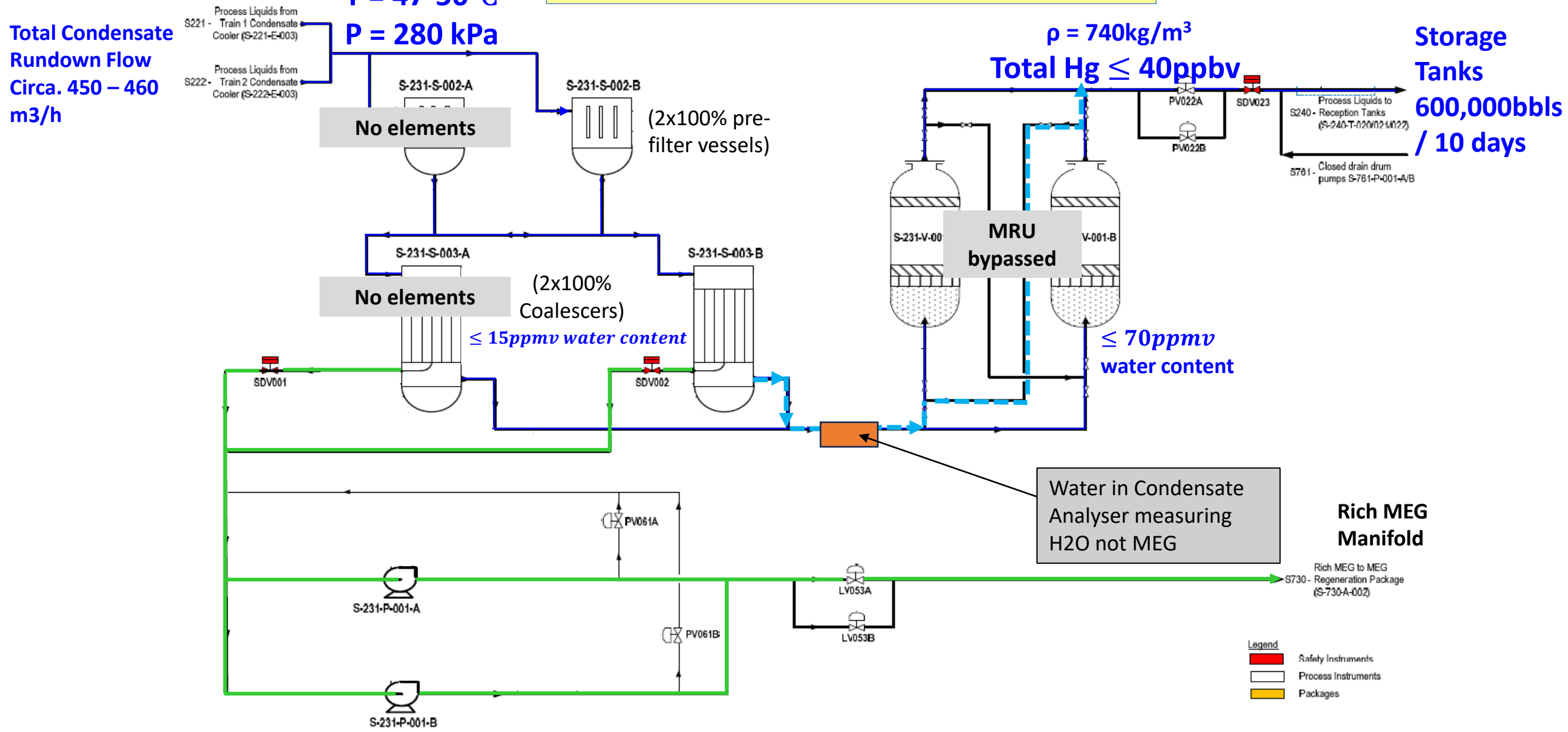
Central Processing Facility (CPF)

- Gas and Condensate/MEG Separation
- Gas Export Compressors

Floating Production and Storage Offtake (FPSO)

- Condensate & MEG Separation, and MEG Pre-Treatment, Regeneration, Reclamation Systems
- Condensate Mercury Removal System
- Flash Gas Mercury Removal System

S231 Condensate Mercury Removal System



Problem Statement & Trial Objective

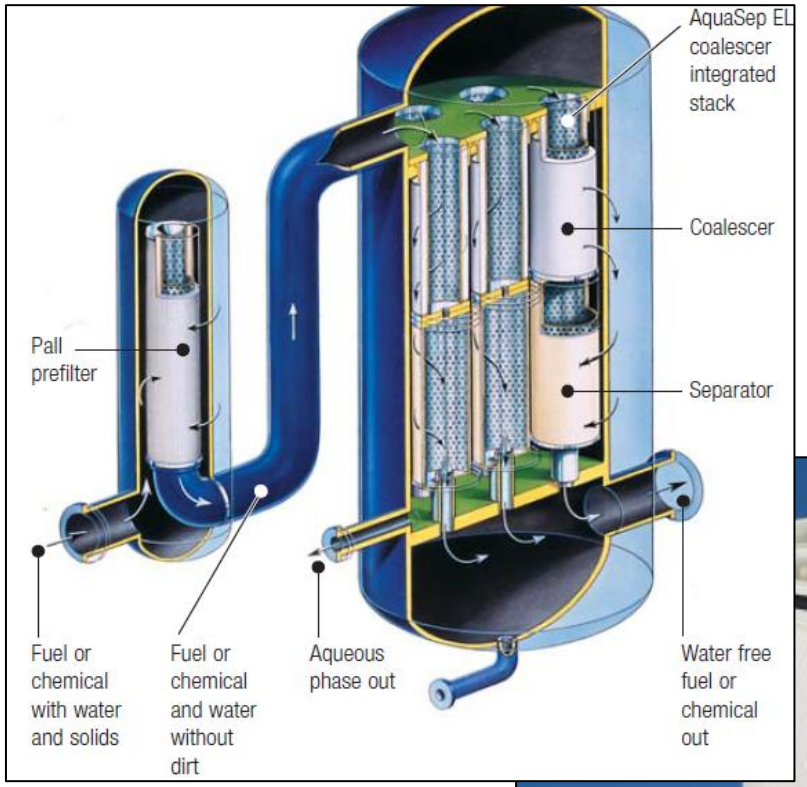
- Pre-filter elements are blocking frequently, with replacement rates higher than the benefit of keeping the MRU online
- MRU only removes elemental mercury but not particulate mercury
- Risk of blocking the internal pores of MRU adsorbent pallets – reduction in *Hg* removal performance
- Glycol carryover will permanently degrade the bed
- Downstream Coalescer has a low DP limit and is costly to maintain (circa. 500K **$AUD** per changeout).
- Ichthys Field elemental mercury levels are relatively low (20-50 ppbv), but may increase to ~200ppbv in later field life

Pre-Filter Selection & Trials

Year / Trial		Changeout frequency	Filtrate sample
Year 1 Trial #1	**Facility Start up** 10 micron polypropylene filter • 99.98% removal efficiency	24 hourly (unmanageable)	Inorganic material, Iron Sulphide, corrosion product, trash (bush wire etc)
Trial #2		2 - 4 days	>95% of particles less than 20 micron
Year 2 Trial #3 & #4	20 micron polypropylene filter 20 micron glass fibre filter	4 days	
Trial #5	10 micron glass fibre filter	7 – 8 days	High BTEX content
Trial #6 & 7	10 micron polypropylene filter	3 days	Iron sulphide from Rich MEG Stream partitioning into condensate
Year 3 Trial #8	40 micron polypropylene filter	9 days	
Year 4 Trial #9	**Marksman PFT High Flow** 70 micron polypropylene filter (Nominal) • Depth Style Filter *(Less surface area, less dirt holding capacity)* • 99.98% removal efficiency	N/A Filter is too coarse for application	Iron Sulphide, Mercury Sulphide particulate solids

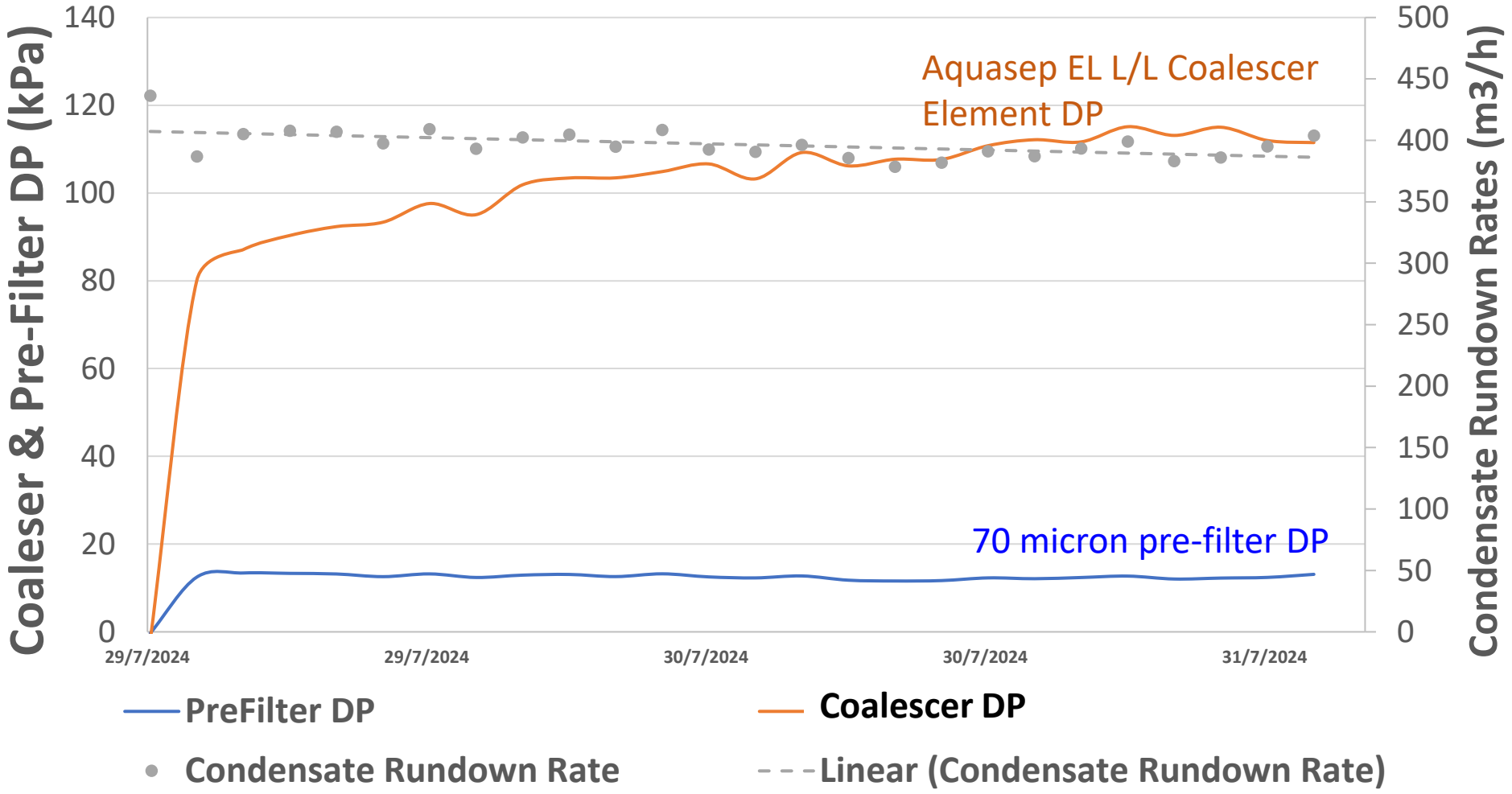
Rapid Fouling in Mercury Pre-treatment System

- Rapid fouling of condensate pre-treatment filters
- **Pre-Filter changeout takes approximately 1.5 days** (3 shifts)
- **Coalescer Element changeout takes 2 weeks +** including isolation, permits, draining, and purging
- Extended downtime impacts production
- H&S Risks due to BTEX and Mercury Exposure to personnel
- Offshore: **4 Operations Technicians** required, under full PPE and Breathing Apparatus

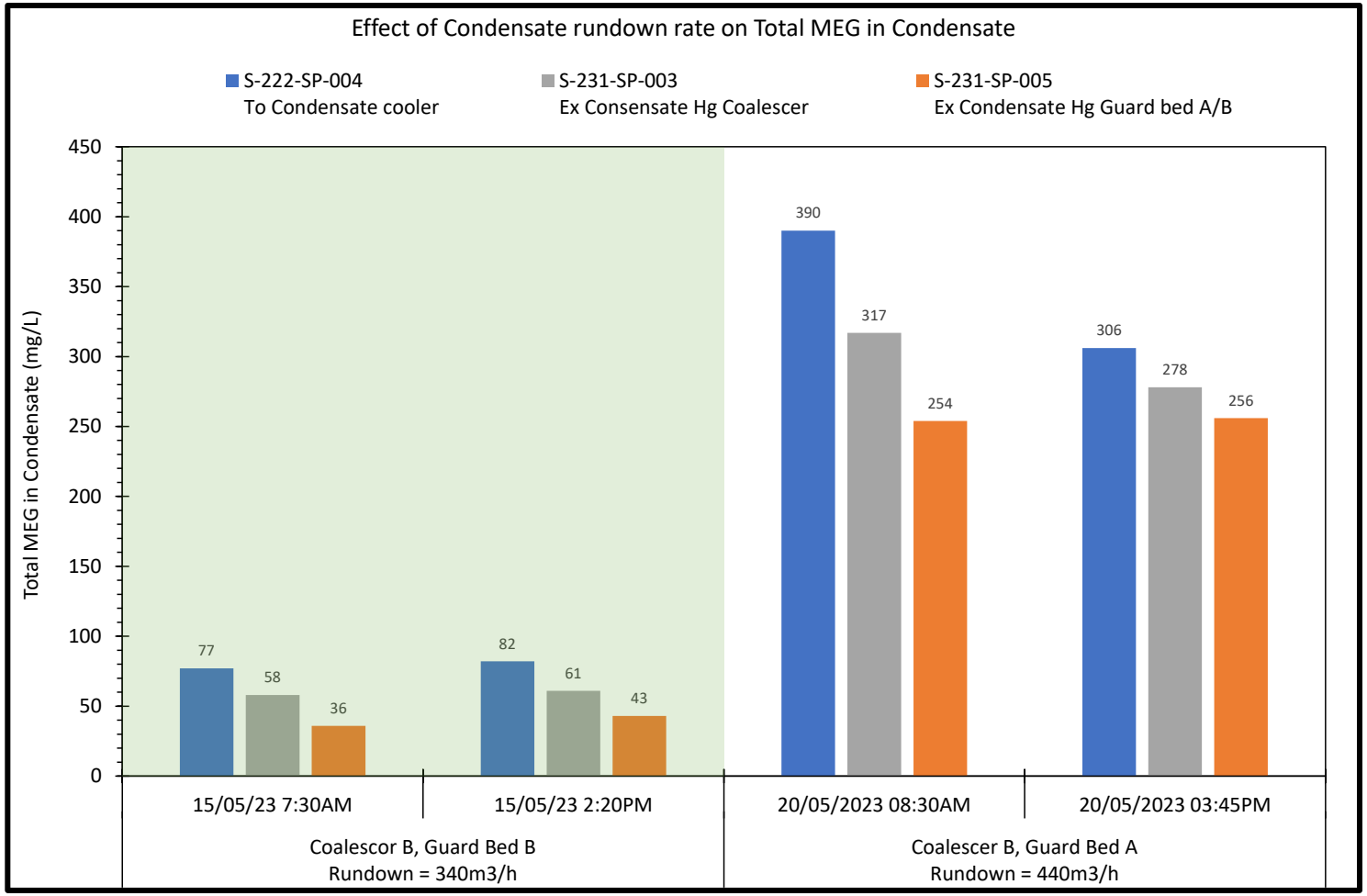


Coalescer Element Changeout

Coalescer DP vs Pre-Filter DP



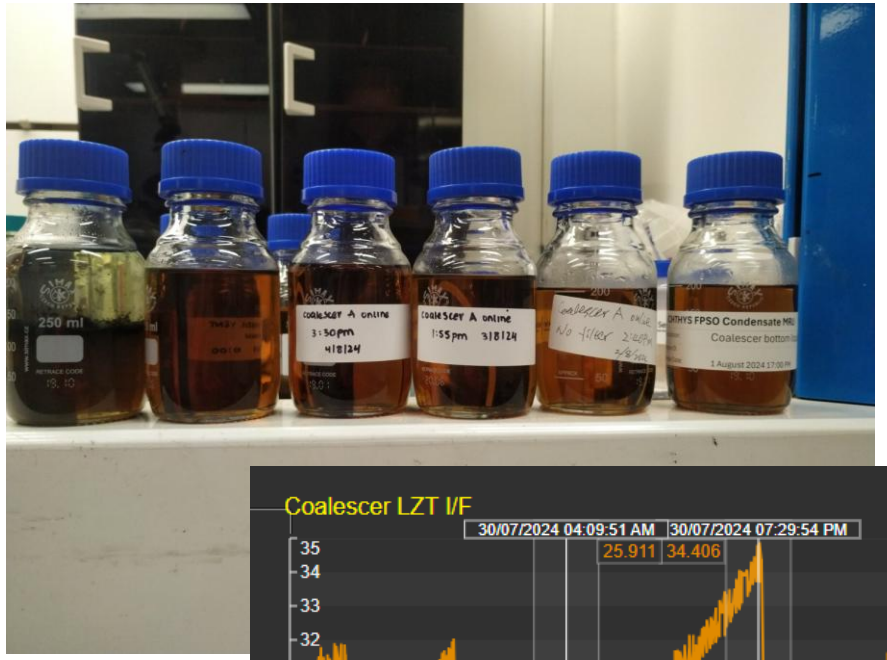
MEG in Condensate Impact to Total Mercury

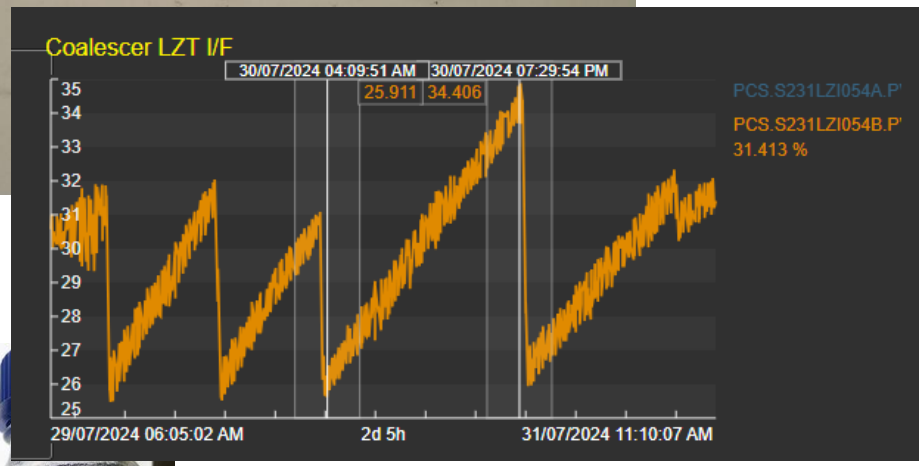


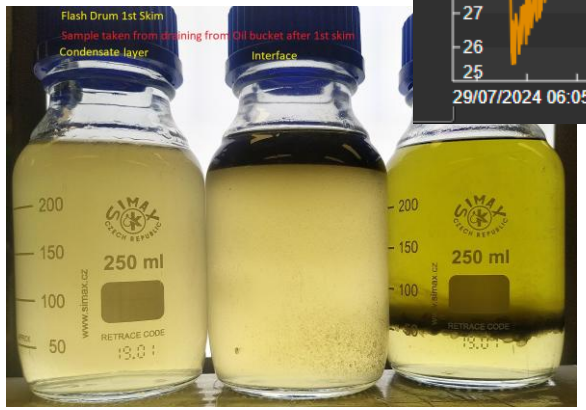
- Rundown rates significantly impact MEG in condensate
- Presence of particulate solids in the MEG Phase
- Coalescer is designed to remove free and dispersed MEG **NOT dissolved**
- Accumulation of free and dispersed MEG (plus water) in coalescer boot

Free MEG in Coalescer

- MRU Inlet Limit is 75 ppmv - free aqueous (water + MEG)
- MEG drained from the coalescer boot showing approx. 8-9 v/v% water content
- Particle size distribution analysis of solids in the MEG sample showing majority of the solid sizes >6 µm , and <15 µm
- Observed Particulate mercury are < 0.22 µm and/or present in organic/elemental form







Summary

- Managing total mercury in a closed-loop MEG-condensate system is challenging
- Both undersized and oversized filters can be ineffective, leading to operational challenges
- Maintain good quality in recycling MEG system, in particular low divalent ion content,
- Avoid iron sulfide (FeS) formation that can partition into the condensate and contribute to filter/coalescer blockages.
- High aromatic content in the system may cause polypropylene materials in pre-filters to swell
- **Key is maintaining condensate product value and managing the costs and (H&S) risks associated with filter element and catalyst bed changeouts**

Thank You

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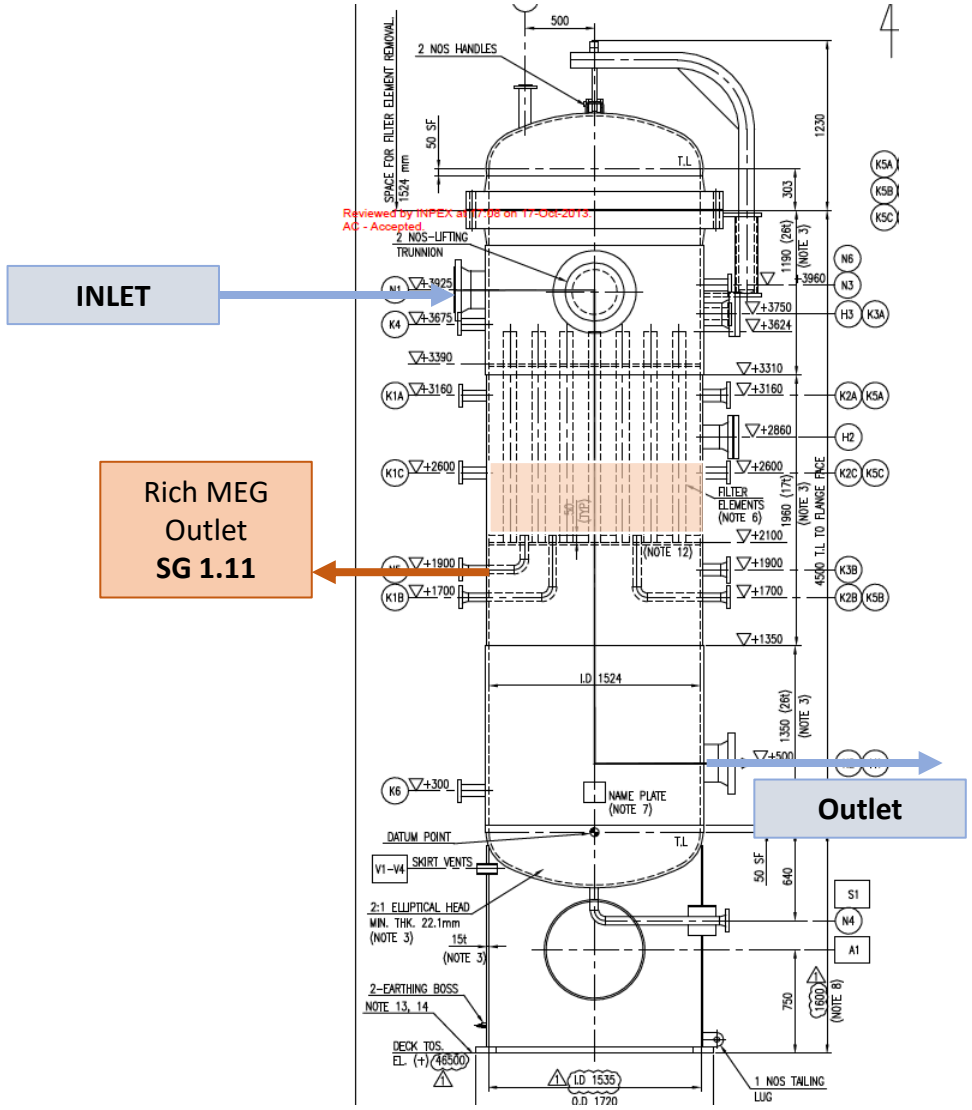
Operations Process Engineer (FPSO)

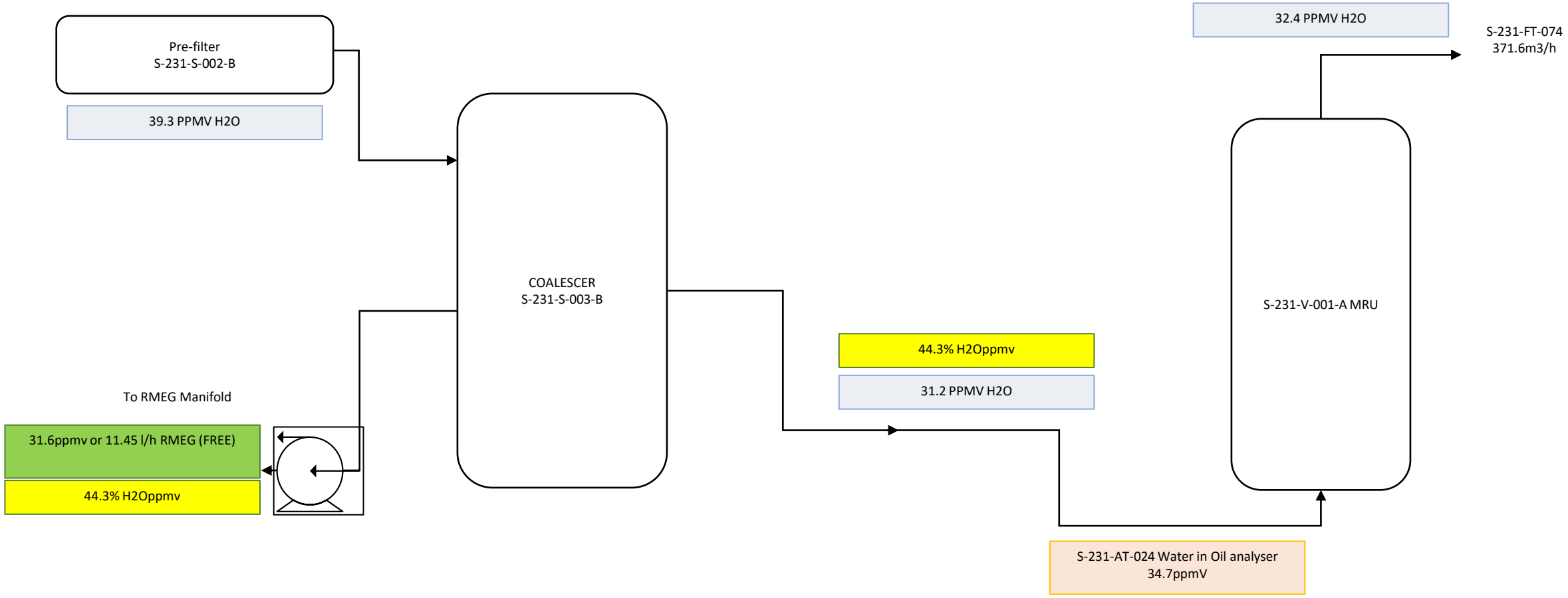
Coalescer Design

- Design Flow 562 m3/h Condensate
- 102 No. of Elements
- Total Filtration Area 109m^2
- Filter Dimension 0.95m x 1.524m
- Designed to achieve free water content of 15 ppmv
- Interface liquid level in the filter coalescer is controlled via LCV



Water Balance in Hg Pre-Treatment

CORRECTED Rev B Calculation – REV B31/07/2024 Sample Set Trial 4



Management of low solubility salts