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Managing Integrity of Feed Condensate Pipeline: Online Internal Corrosion Monitoring via Electric Field Mapping (EFM)/Field Signature Method (FSM) Technique

by

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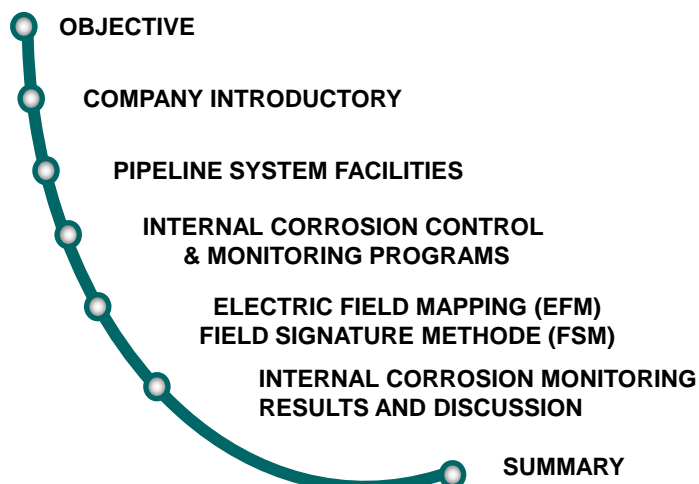
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PRESENTATION OUTLINE





The objective of our presentation is...

- To share PETRONAS Gas Berhad's experiences in managing integrity of condensate pipeline particularly for internal corrosion threat

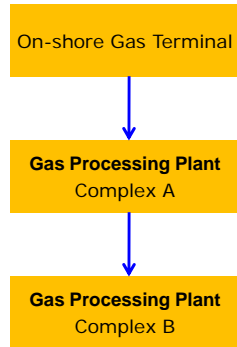


Our Pipeline System



- PGB operates and maintains 82 pipeline sections
- 1,658 km Gas Mainline
- 357 km Liquid Pipeline
- 378 km Lateral Lines
- 116 km GPP Interconnect
- 45 km Miri Gas Distribution System
- Total 2,554 km
- Pipeline size ranges from 2" to 48"
- 2 compressor stations
- 119 metering stations and city gates
- 33 customers i.e. TNB, IPPs, GMSB & Petrochemical plants
- Transmits on the average : 2,000 MMSCFD of sales gas, 132,000 GJ/day of ethane, 3,700 MT/day of Propane & 2,400 MT/day of Butane

PETRONAS  The 10" pipeline transports condensate from offshore to gas processing plant to produce sales gas, liquid propane & butane




- Commissioned in year 1998
- OD: 10.75 inches
- Length: 15.1 Km
- Grade: API 5L X 65
- Type: Seamless
- Nominal wt: 11.0 mm & 8.70 mm
- MAOP: 153 bar
- Max inlet P: 80 bar
- Min inlet P: 73 bar
- Operating inlet T: 30 deg C
- Scraper launcher and receiver
- External corrosion protection: 3-layer PE coating and Cathodic Protection
- Internal corrosion protection: CI Program comprises internal cleaning, CI filming and continuous CI injection

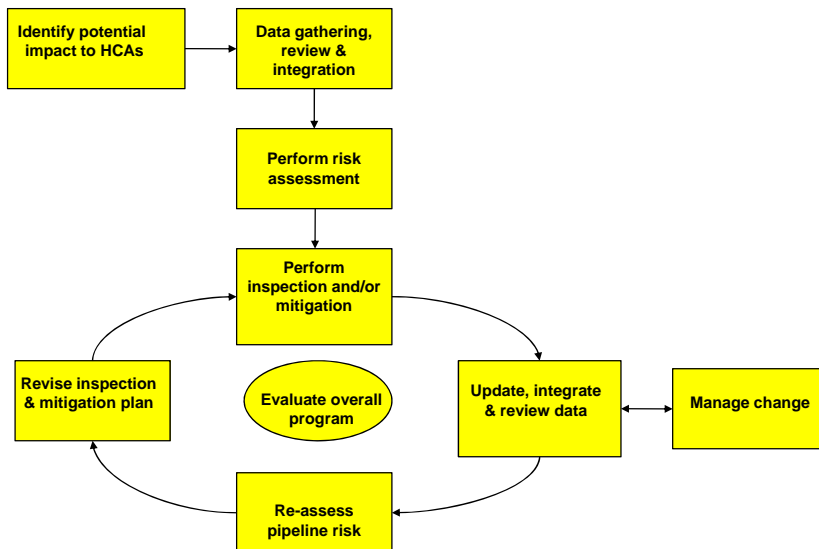
PETRONAS  The condensate is corrosive as it contains free water & CO₂


Type of Hydrocarbon	Composition in Feed Condensate (mol %)
N2	0.01
CO2	10.45
C1	6.27
C2	5.5
C3	7.88
iC4	3.78
nC4	4.17
iC5	4.31
nC5	1.51
C6+	56.12
Total	100%

Contaminant	NPS10 Feed Condensate
Chloride	1.27 mg/L
Total Sulfur	49.06 mg/L
Total Mercury	Min : 0.02 ppm Max : 0.08 ppm (from sludge at receiver)
pH (average)	4 to 7

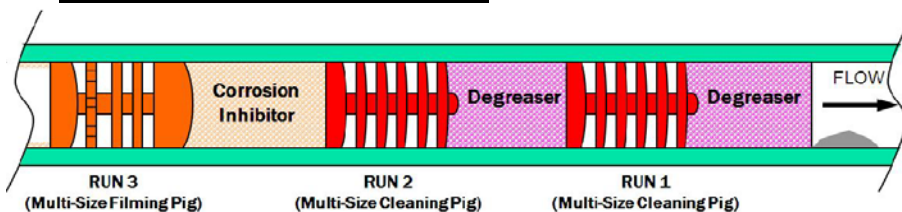
Water in Feed Condensate	62.3 ppm
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PETRONAS  The integrity of the pipeline is managed via best practices of API 1160 standard



PETRONAS  Major risk is of internal corrosion and comprehensive internal corrosion control program is implemented to mitigate the risk

Internal Pipeline Cleaning and CI Batching



Continuous CI Injection System

- A total of 30 liter volume of CI with 35% concentration is being injected into the pipeline daily
- To path CI film imperfection due to flow regime



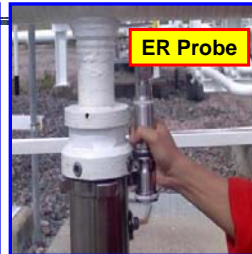
A comprehensive internal corrosion monitoring program is also implemented as well



FSM



Corrosion Coupon



ER Probe



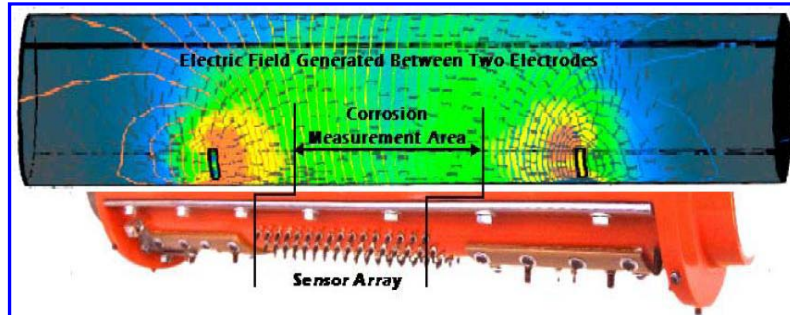
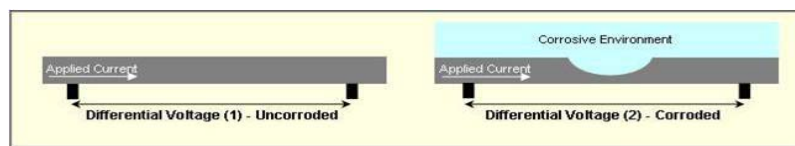
EFM

Pipeline Diameter	NPS 10, Results, ppm	
	April	August
Chemical/metal		
Manganese	1580	1728
Iron	89000	94862
Calcium	1520	164
Sulfur	23300	-
Arsenic	< 0.5	-
Sulfate	69900	-
Chloride	-	-
Mercury		
PH		
SRB		
APB		

Product Sampling & Analysis

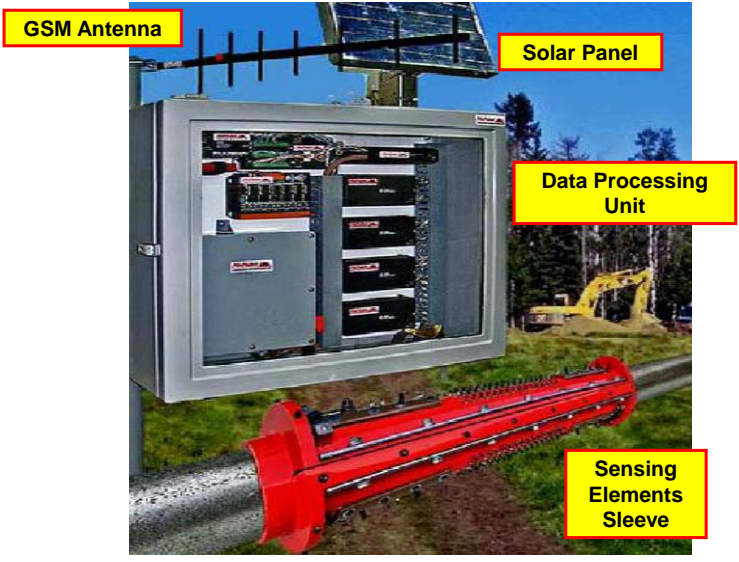


The working concept of EFM/FSM™



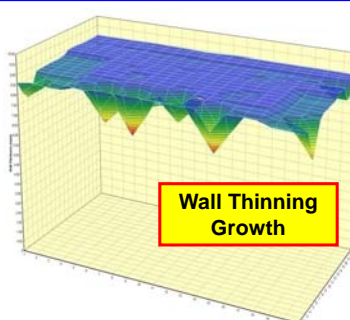
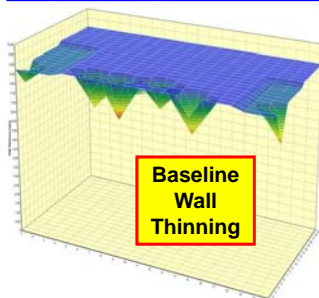


On-line Monitoring System of EFM/FSM™



EFM/FSM™ measures actual wall loss, corrosion growth rates and generates 3-D images

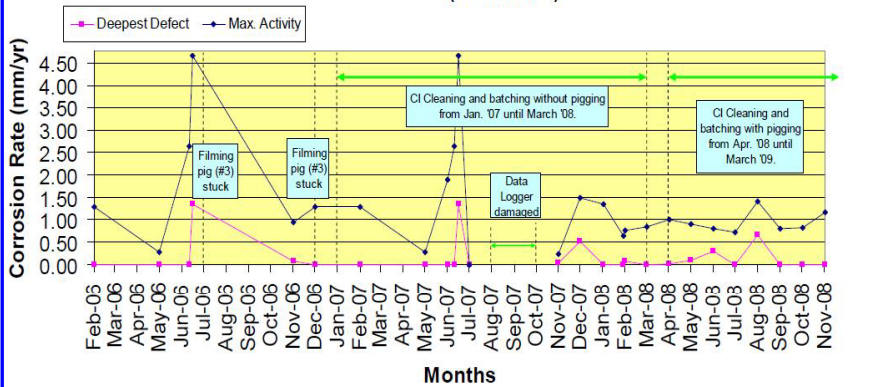
DEFECT ID	Defect Location in Sensor Grid (Row,Column)	Baseline Pipe Wall Thickness (UT C-Scan - mm)	Original Pit Depth (mm)	Original % Wall Loss	EFM Wall Thickness Jan 31/08 (mm)	Accumulated New Wall Loss (mm)	% Change	Total % Loss	Long Term Corrosion Rate During Period (mm/yr)	Long Term Corrosion Rate During Period (mpy)
D1 (Pre-Existing)	(1,3)	7.81	1.16	12.9%	7.642	0.17	1.87%	14.80%	0.186	7.3
D2 (Pre-Existing)	(7,3)	7.23	1.74	19.4%	7.073	0.16	1.75%	21.15%	0.174	6.9
D3 (Pre-Existing)	(9,3)	6.84	2.13	23.7%	6.704	0.14	1.52%	25.26%	0.151	5.9
D4 (Pre-Existing)	(12,4)	7.62	1.35	15.1%	7.559	0.06	0.68%	15.73%	0.068	2.7
D5 (Pre-Existing)	(15,2)	7.04	1.93	21.5%	6.812	0.23	2.54%	24.06%	0.253	10.0
D6 (Pre-Existing)	(21,4)	7.04	1.93	21.5%	7.012	0.03	0.31%	21.83%	0.031	1.2





EFM/FSM trending results is used a guideline to modify the corrosion control programs accordingly

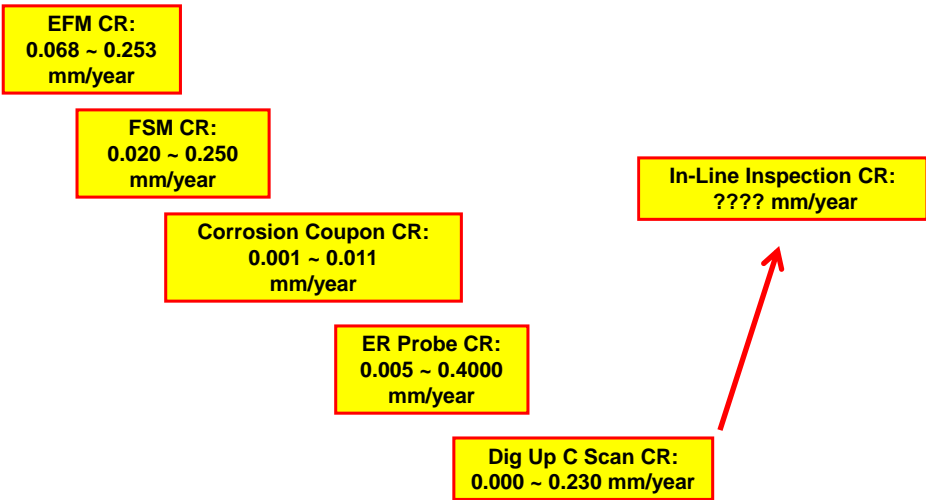
Petronas, FSM-IT Matrix #2 - Maximum Corrosion Rates & Rates of the Deepest Defect (Scenario 3)



FSM



Can we rely on a single monitoring system?





To summarize and conclude our presentation...

- EFM/FSM™ is much more efficient in determining the internal corrosion growth due to the fact that it measures directly on the pipe body as oppose to coupon and probe that measures on reduction of the weight of the coupon/probe which is not part of the pipeline.
- The on-line monitoring capabilities of EFM/FSM enables data to be retrieved on daily basis hence data integrity is safe guarded since no human intervention.
- Based on a conclusive results of EFM/FSM™ the internal corrosion control programs can be altered or changed accordingly
- In-line inspection can further confirmed the effectiveness of the corrosion control on top of the localised monitoring systems



THANK YOU