Enhanced High Acid Corrosion Control with Innovative Chemical Additive

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Academic Qualifications	MS Chemical Engineering, Illinois Institute of Technology MBA Harvard Business School
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Outline

- High TAN Opportunity Crudes
- Innovation Summary
- Risk of Fouling with Conventional Chemical Additives
- Key Technology Differentiator and Test Results
- Operational Benefits of “P-Efficient” HTCI
- Case Study
- Conclusion

Old Ways vs. New Ways

phone circa 1979

phone circa 2014

High TAN Opportunity Crudes

High TAN Crudes : Discounted Price : Higher Profit Margins

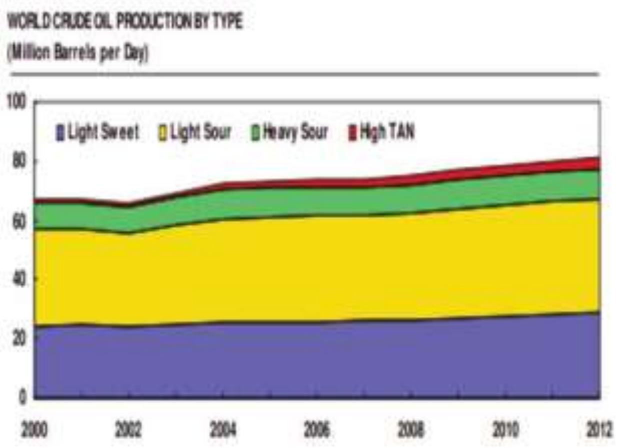
Naphthenic Acids = High Temp Corrosion = Corrosion $ Control

CORROSION MITIGATION

METALLURGY UPGRADE
(HIGH CAPITAL COST)

CHEMICAL PROGRAM
(LOW CAPITAL COST)

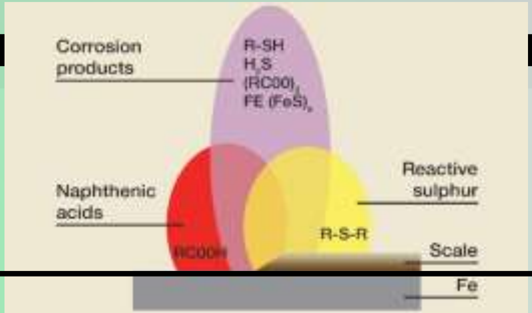
Crude	Origin	API Gravity °API	Total Sulfur wt %	TAN mg KOH/g
Doba	Chad	21.1	0.12	5.18
Merey16	Venezuela	17.9	2.15	1.46
Dar	Sudan	24.5	0.11	4.1
Albacora	Brazil	19.4	0.55	2.37



PRODUCTION ESTIMATES

1.2 MM BPD in 2000
to
4.5 MM BPD in 2020

Outline



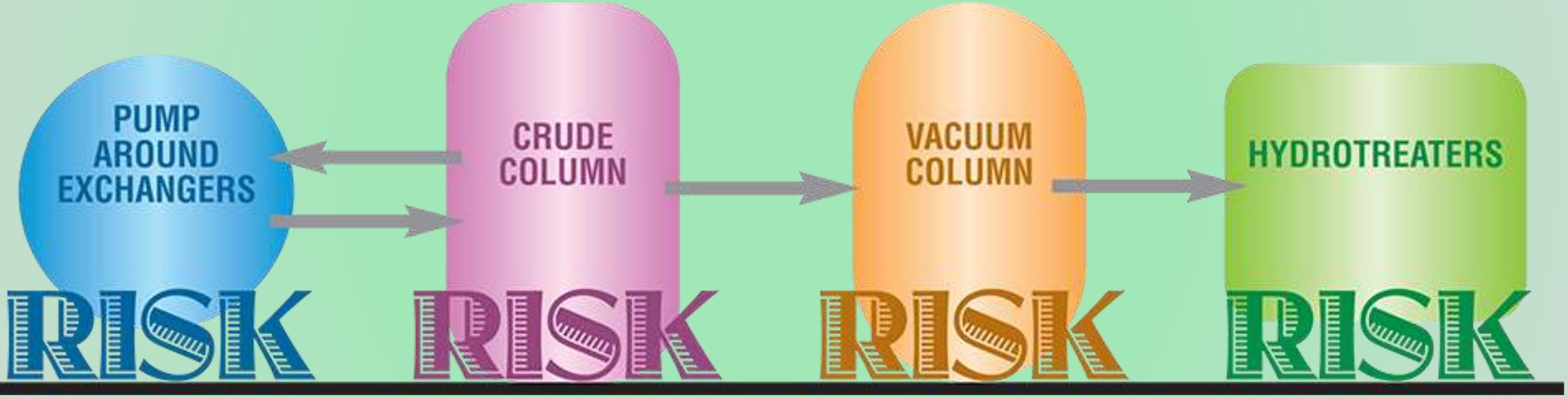
CONVENTIONAL PHOSPHATE ESTER MECHANISM

Fe(PO)x PRECURSOR → DELIVERY → TARGET METAL SURFACE

- Inefficient phosphorus delivery due to low “P-efficiency”
- Low “P-efficiency”: Potential fouling problem
- Innovative TANscient™ LP additive with improved “P-efficiency”
- Requires 50% to 80% less phosphorus for equivalent protection
- Superior TANscient™ LP additive: new benchmark for refinery HTCI

Risk of Fouling from Conventional HTCI

Low "P-Efficiency" = Degradation & Phosphorus Fouling



Exchanger Fouling from Dislodged Scale

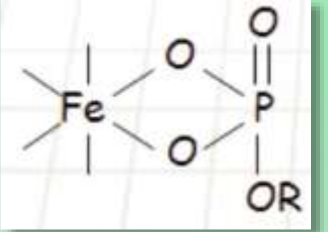
Column Fouling from Residual Product

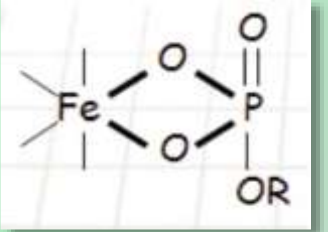
Coking from Iron Pick Up due to Acidic Nature

Catalyst Impairment and Fouling, Reduced Run Length

Risk of Fouling from Conventional HTCI

CONVENTIONAL PHOSPHATE ESTER CHEMISTRY	INNOVATIVE TANscient™ LP CHEMISTRY
Traditional phosphate esters	Breakthrough additive
(mixed mono-& di-alkyl esters) with 7-8% P	mainly tri-esters with ≤ 1.2% P
Decompose to phosphoric acid below 290 °C	Low corrosivity
Low “P-efficiency”	Enhanced “P-Efficiency”
Needs reactive sulfur to generate iron sulfide layer	Effective without reactive sulfur
Poor iron polyphosphate stability	Stable iron polyphosphate film





Key Technology Differentiator

TEST CONTAINS 1% OF EACH PRODUCT AT 290 °C

Chemistry	Phosphorus Content (%)	% P Converted to Precipitate	Photo	Observation
Innovative TANscient LP	*TANscient™ is “P-efficient”* 1.2	4.2		No adherence to the wall
Conventional phosphate ester additive	7.5	97.3		Blackish deposit adhered to the wall
Low phosphorus thio-phosphate ester additive	2	74.4		Blackish deposit adhered to the wall

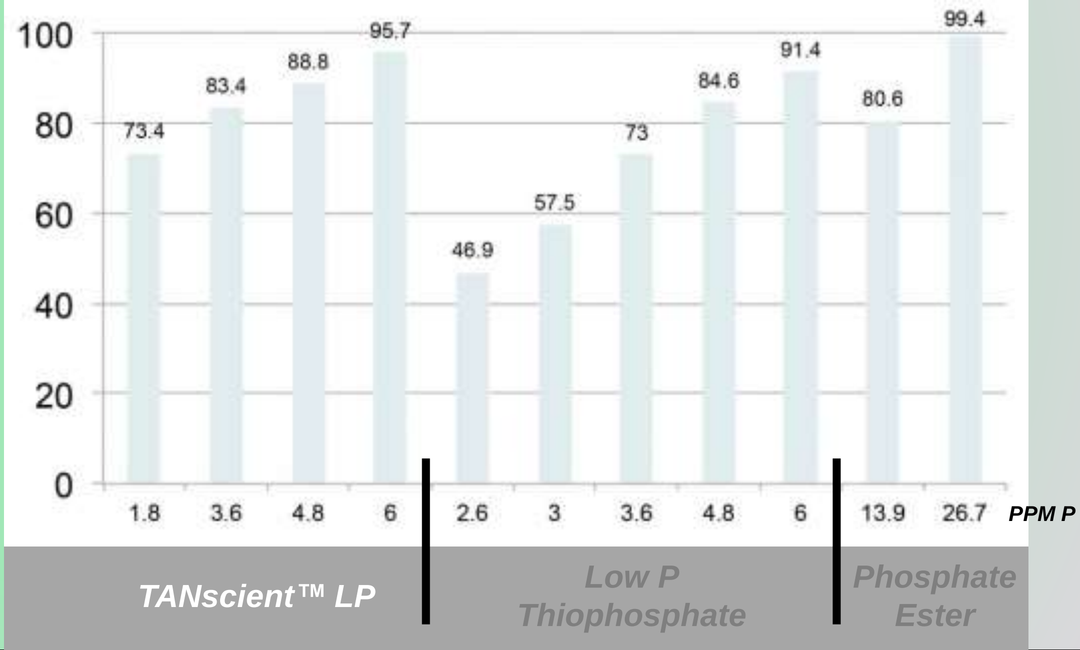
Cleanliness of the flask indicates higher soluble phosphorus and better thermal stability

Differences in P Required for Equal Corrosion Rates

CORCON 2014

UNTREATED CORROSION RATE = 463 MPY, STATIC TEST

Sample .... D130 (Distilled Residue)
Nap Acid .... Commercial
Tan .... 1.3 mg KOH/g
Temp....................... 290 ° C (Passivation & Test)
Time (Passivation) .... 1 hr 30 min
Time (Test) .... 4 hrs
Purging................... Nitrogen (110 ml/min)

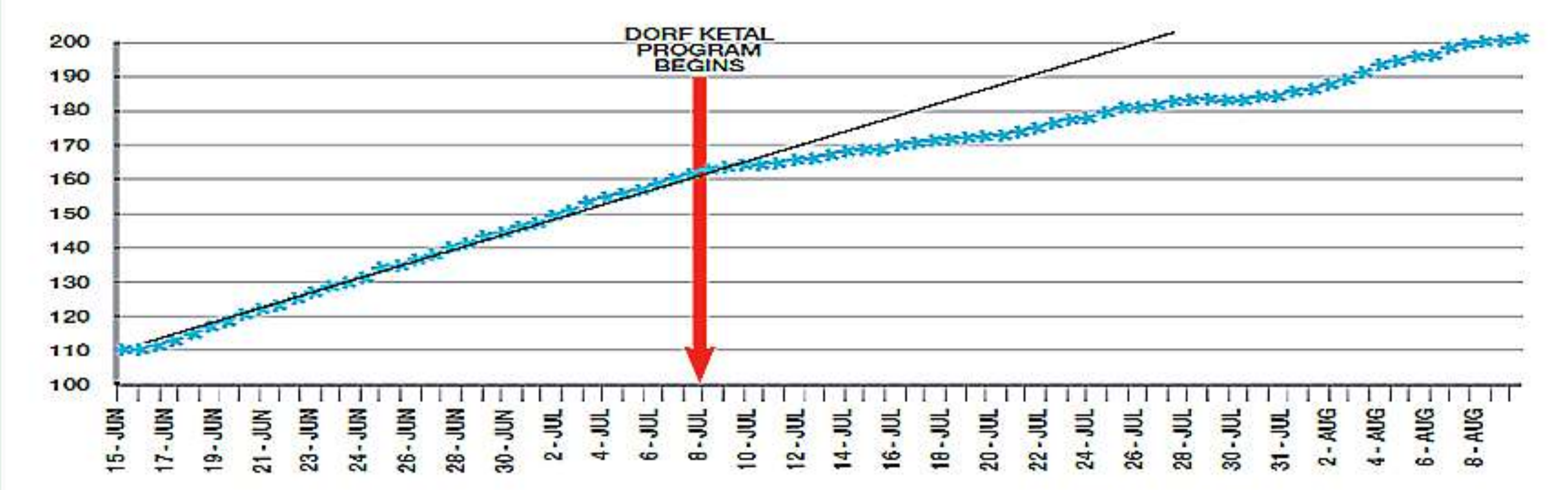


Operational Benefits of "P-Efficient" TANscient™ LP HTCI

- Less risk of fouling and deposits
- More effective at all critical temperatures, down to 200 °C.
- No slipstream cooling required for chemical injection
- Less complex quill design required for low acidity HTCI
- Effective passivation at far lower dosages
- More flexibility to respond to TAN upsets

Operational Benefits
of "P-Efficient" TANscient™ LP HTCI

PROBE - Mass Loss



- Atmospheric residue with TAN 0.7-1.6 mg KOH/g
- Corrosion-susceptible areas: Vacuum furnace inlet, furnace tubes and furnace outlet
- TANscient™ LP additive reduced the rate of mass loss
- Benefit: Flexibility in processing high TAN crude

Conclusions

- Conventional inhibitors have serious drawbacks and limitations
- Current HTCI users now have a much better alternative
- This new corrosion control chemistry is easy to substitute without risk
- Advantages are easily demonstrated in the lab and in the field
- No chemical supplier “black box”

  We have a strong IP position
  and we can fully explain the chemistry under NDA.

Discounted High Acid Crudes are Increasingly Available

Superior Corrosion Control

Reduces Risk of Fouling

Sustains Unit Reliability

Flexibility in Crude Blend Slates

Enhanced Profit Margins

CAPTURE THAT DISCOUNT WITH TANscient™ LP HTCI CHEMISTRY!

DORF KETAL™

Thank You