



Corrosion Session Summary

National Centre for Upgrading Technology

4th Upgrading and Refining of Heavy Oil,
Bitumen, and Synthetic Crude Oil Conference



Conference Summary

- Session One: New Technologies for Bitumen Upgrading
- Session Two: Energy Independence and Increased Opportunities for Value Addition
- Session Three: Secondary Upgrading
- Session Four: Corrosion
- Session Five: Fouling

- Abstracts for all three days of the conference are available at:
 - www.ncut.com/whatsnew.htm



Presentations

Session Four: Corrosion

- Fourier Transform Ion Cyclotron Resonance Mass Spectrometry: The Platform for Petroleomics
 - Alan Marshall, NHFML (Florida State University)
- Naphthenic Acid Speciation in Bituminous Oils
 - Tim Blackmore, Omnicon Consultants
- Predicting Naphthenic Acid Corrosion
 - Saadedine Tebbal, SET Laboratories

Presentations

Session Four

- Identification of Corrosive Naphthenic Acids in Bitumen Fractions
 - Murray Gray, University of Alberta
- Corrosion: Know What's Eating You?
 - D. Clark, Honeywell Process Solutions
- Sensitivity Analysis for Modeling Overhead Chloride Salt Deposition and Corrosion Issues
 - Andrew Eisenhower, Nalco Canada Co.

Presentations

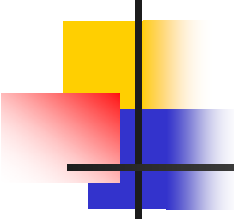
Session Four

- Environmental Fate and Quantitative Analysis of Oilsands Naphthenic Acids: A Review
 - Dena McMartin, University of Regina



Fourier Transform Ion Cyclotron Resonance Mass Spectrometry: The Platform for Petroleomics

- Presented by Alan Marshall
- Summarized operation of FT-ICR MS instrument
- Demonstrated the resolution of the FT-ICR MS and how it compares to the resolution required for positive differentiation of any two molecular formulae
- Provided several examples of differentiation of compounds with MW differences of less than 0.1
- Explained the applicability of ESI sample introduction for naphthenic acid speciation in bitumen without extraction from the matrix
- Discussed the association of naphthenic acids that is observable if no efforts are made to dissociate the multimers



Fourier Transform Ion Cyclotron Resonance Mass Spectrometry: The Platform for Petroleomics - continued

- Provided data showing the difference between asphaltenes produced as a result of pressure drop compared to those produced by solvent precipitation
- Discussed the utility of MS data for establishing biodegradation of oil
- Discussed the ability of APPI to ionize (detect) aromatics
- Anticipate the ability in the future to predict corrosivity based on acid speciation by MS
- Moving to higher power magnetic fields to provide higher resolution, making analysis with difficult resolutions easier to perform



Naphthenic Acid Speciation in Bituminous Oils

- Presented by Tim Blackmore
- Presented corrosivity data for the vacuum gas-oil fractions of five bitumenous oils to carbon steel
- Provided speciation summaries in graphical form for four of the five bitumenous oils
- Presented hydrogen sulphide release data for the two oils that were obtained in whole crude form



Naphthenic Acid Speciation in Bituminous Oils - continued

- Also provided TAN, wt% sulphur, and other associated data for the five subject oils
- Contrasted the corrosivity of the five samples with their TAN data, H₂S evolution, and total sulphur
- Concluded that oilsands bitumens, under the test conditions, show a markedly lower corrosivity than what might be expected based on the TAN



Predicting Naphthenic Acid Corrosion

- Presented by Saadedine Tebbal
- Conventional predictive tools, TAN and sulfur content (McConomy curves) not adequate for prediction
- H₂S evolution and naphthenic acid number (NAN) must be known
- Use of MS can provide NA boiling point distribution, similar to H₂S evolution data
- Knowledge of H₂S evolution potential and NA concentration in cuts facilitates accurate prediction of corrosivity
- Other required parameters for corrosivity prediction include shear stress, temperature and metallurgy



Identification of Corrosive Naphthenic Acids in Bitumen Fractions

- Presented by Murray Gray
- Tested the ability to speciate the NA species that are reactive with iron powder
- Reacted Athabasca bitumen VGO with excess iron powder at 150 & 200°C for one hour, filtered out solids, extracted with solid phase extraction resin
- Soluble iron naphthenates then washed from SPE resin, and restored to acid form
- Subsequently, unreacted naphthenic acids removed from SPE resin using acid wash
- Analysis of naphthenic acid species done on unreacted acids and acids that form soluble iron naphthenates by FT-ICR MS



Identification of Corrosive Naphthenic Acids in Bitumen Fractions - continued

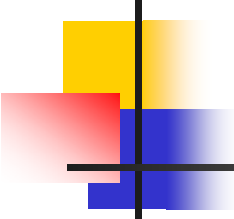
- Procedure validated using Fluka commercial NA, recoveries in excess of 90% for all samples
- Results show interesting differences between soluble iron naphthenate species and non-reactive NA species
- Simple carboxylic acid species that react with iron to form soluble molecules are higher in MW than the unreactive, particularly so for the Athabasca sample



Identification of Corrosive Naphthenic Acids in Bitumen Fractions - continued

■ Conclusions

- Technique is capable of separating soluble iron naphthenates from free (unreacted) naphthenic acid
- For Athabasca VGO, reactive/soluble NA species are higher MW than non-reactive acids
- Second non-Athabasca sample did not demonstrate this MW discrimination to nearly the same extent
- Work required to refine technique and further investigate



Corrosion: Know What's Eating You?

- Presented by Darren Clark
- Provided information on a new software product marketed by Honeywell for corrosion modeling, "Predict-SW 2.0"
- Model is focused on ammonia bisulfide, in concert with corrosion monitoring
- Also provided information on software ability to process real time corrosion monitoring in tandem with modeling to optimize mitigation costs and minimize corrosion



Sensitivity Modeling in Overhead Corrosion Control

- Presented by Andrew Eisenhower
- Discusses overhead corrosive species, their formation, and the need to model what cannot be directly measured
- Presents information on Nalco's software for overhead corrosion modeling, "Pathfinder"
- Discusses how and what to model, and the need for real time modeling, with examples



Environmental Fate and Quantitative Analysis of Oilsands Naphthenic Acids: A Review

- Presented by Dena McMartin
- Discusses the nature of oilsands NA, its water solubility, and natural concentrations in the Athabasca River
- Presents information on toxicity and bioavailability of oilsands naphthenic acids (NA)
- Discusses research on biological biodegradation of oilsands NA
- Discusses the potential of phytoremediation & wetlands
- Further research ongoing



Upgrading and Refining of Heavy Oil, Bitumen, and Synthetic Crude Oil Conference

- Held every three years in Edmonton, Alberta
- Sponsored and coordinated by the National Centre for Upgrading Technologies
- For further information, contact:
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