

Diglycolamine® Solvent Quality Improvement with Thermal Reclaiming

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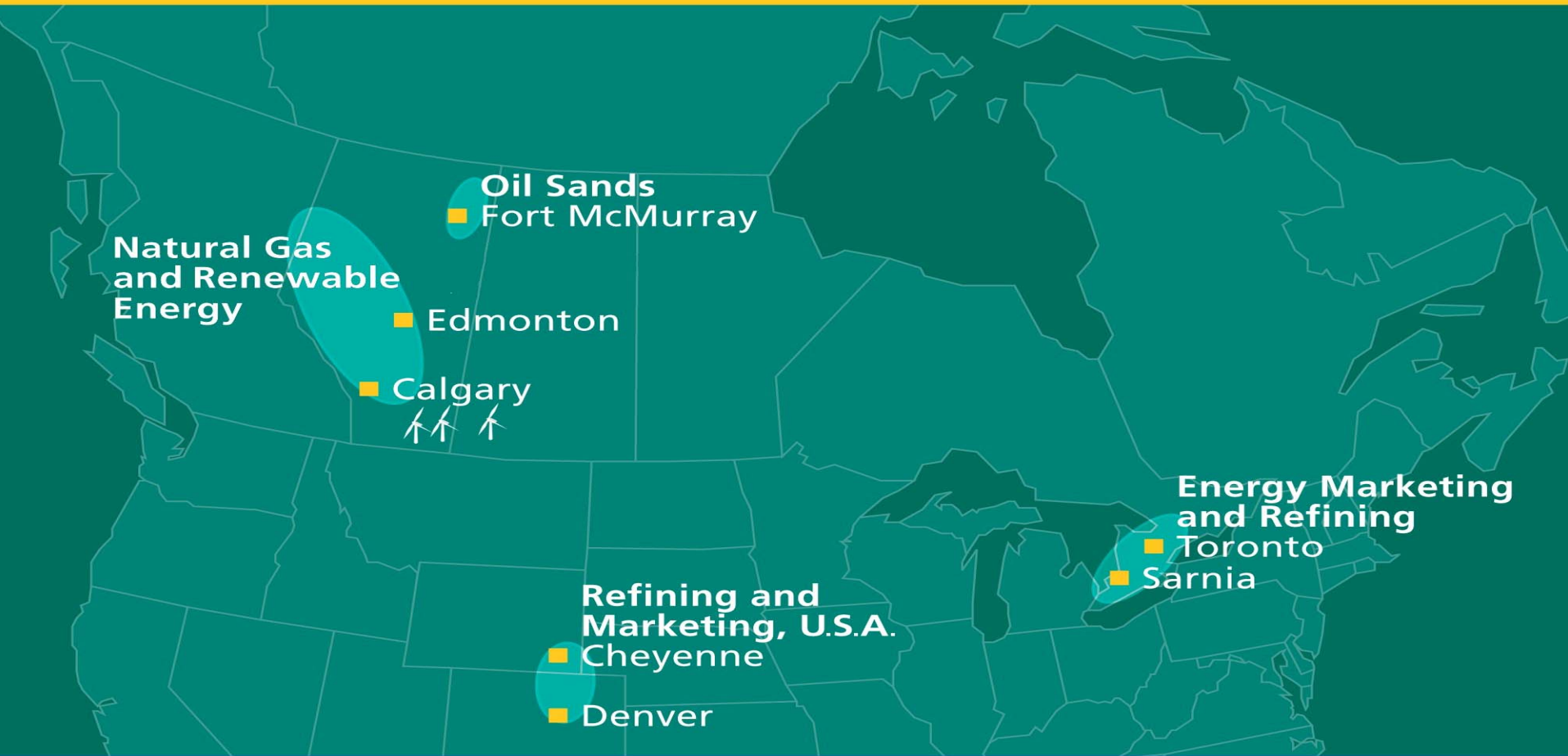
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Outline

- Plant Overview
- Operations Prior to Thermal Reclaiming
- Merchant Reclaiming
- Thermal Reclaimer Design
- Operations After Thermal Reclaimer Installation
- Conclusions
- Recommendations

Suncor Plant Location



Oilsands Mining/Extraction



Millennium Upgrader



Plant Overview

- Millennium Amine Unit (Plant 53) Start up in 2001
- Main Fuel Gas Absorber, Primarily Coker Gas, 77 MMSCFD, 15% H₂S, 1% CO₂
- 3 Hydrotreater Absorbers, 540 MMSCFD Total, 0.4 to 1.8% H₂S, no CO₂
- 1 Liquid C₄ Treater, 30 gpm, 100 ppm H₂S
- Common Regenerator for all Absorbers
- Total Circulation Rate 2500 gpm DGA® at 35 to 40 weight percent

Plant Overview

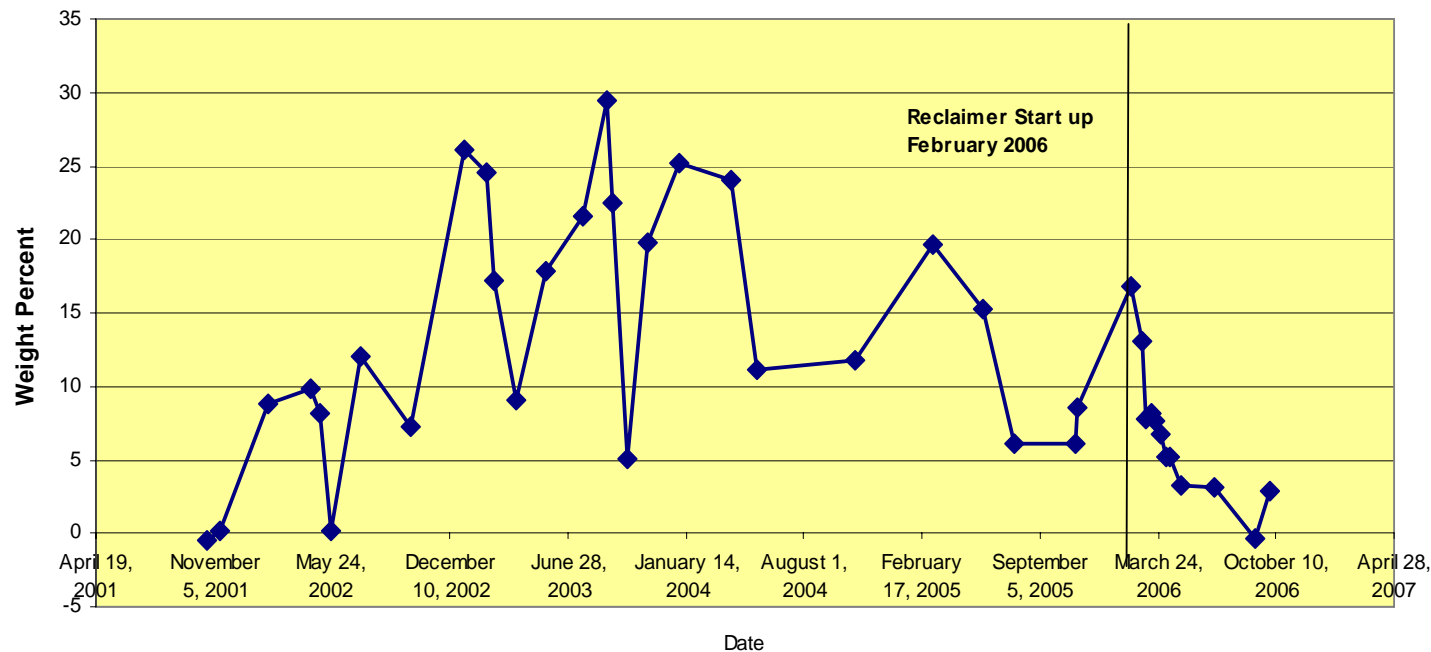
- DEA For Original Plant Design
- DGA® Chosen to Achieve Future Expansion Capacity, Fuel Gas Total Sulfur at Low Operating Pressure
- Existing DEA Unit Has High HSS and CO₂/COS Degradation
- Expected Need to Reclaim - Tie in Points Added

Operations Prior to Thermal Reclaimer

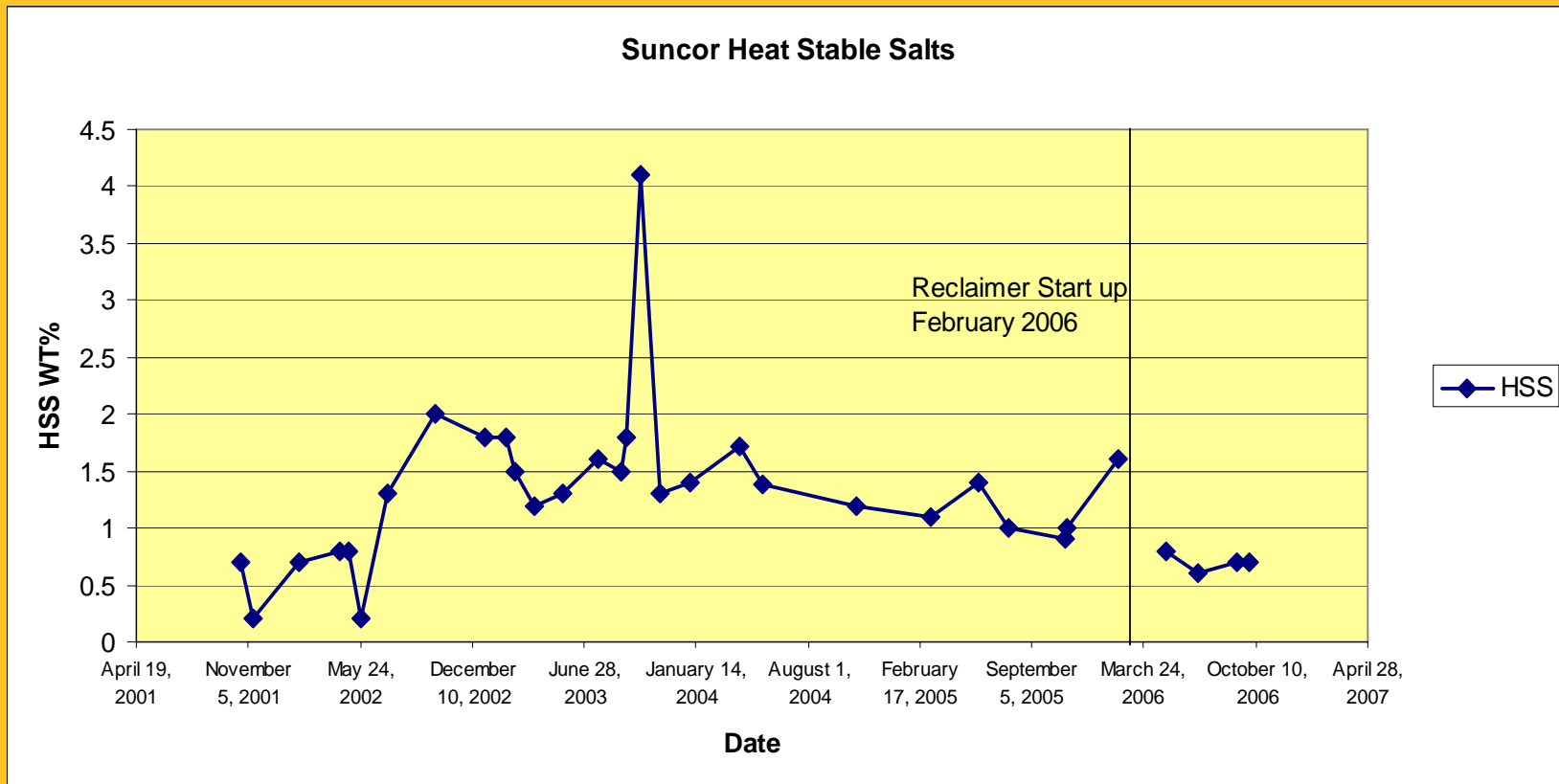
- Amine Degradation Did Occur
- BHEEU Formation at 2 WT%/Month due to COS Removal, Maximum Over 20 WT%
- Heat Stable Salts Were < 2 WT%
- No Significant Operating Problems Due to BHEEU
- Merchant Reclaiming Used to Maintain Amine Quality

BHEEU History

Suncor BHEEU



Heat Stable Salt History



Merchant Reclaiming

- Merchant Reclaiming Needed 2 Times per Year
- BHEEU Content Range 10 to 25 Weight %
- Minimal BHEEU Conversion
- 50 MT of 80% Nitrogen Waste per Reclaim – Environmental Concern
- Expansion Capacity Needed 50 Weight % DGA®
 - High Viscosity Issues at High Amine WT%
- Permanent Operation With < 10% Degradation Needed

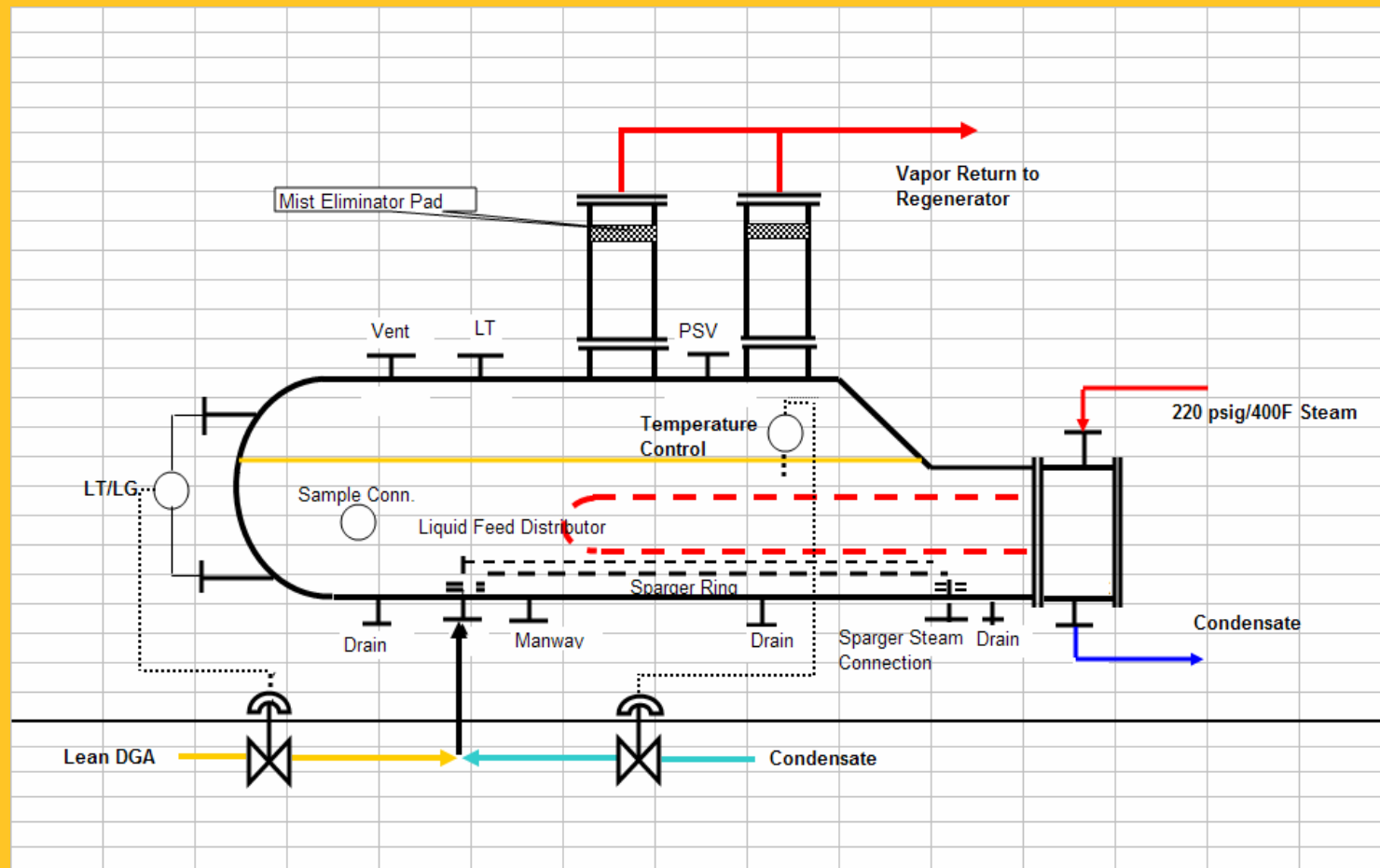
Thermal Reclaimer Design

- BHEEU Reversed/Recovered In Thermal Reclaimer at 360°F
- $2^* \text{DGA}^{\circledR} + (\text{CO}_2 \text{ or } \text{COS}) \leftrightarrow \text{BHEEU} + (\text{H}_2\text{O} \text{ or } \text{H}_2\text{S})$
- 2 Control Loops
 - Temperature Control at 360°F Using Water Feed
 - Level Control With Lean Amine Feed
- Vapor Returned to Regenerator
 - Reclaimer Heat Input = Regenerator Reboiler Reduction
- 300 Day Cycle Time, Depending on Solids/Non-Volatile Accumulation

Thermal Reclaimer Design

- Design for Current DGA® Unit (Plant 53) and Future Plant 68
- Maximum Heat Duty 41 MMBtu/hr
- Maximum Amine Feed Rate 49 gpm Total
 - 27 gpm Plant 53 and 22 gpm Plant 68 (2008 Start up)
- 12' ID X 24' T/T, 15,000 Gallon Capacity
- Target BHEEU 3 WT%

Suncor Reclaimer Schematic



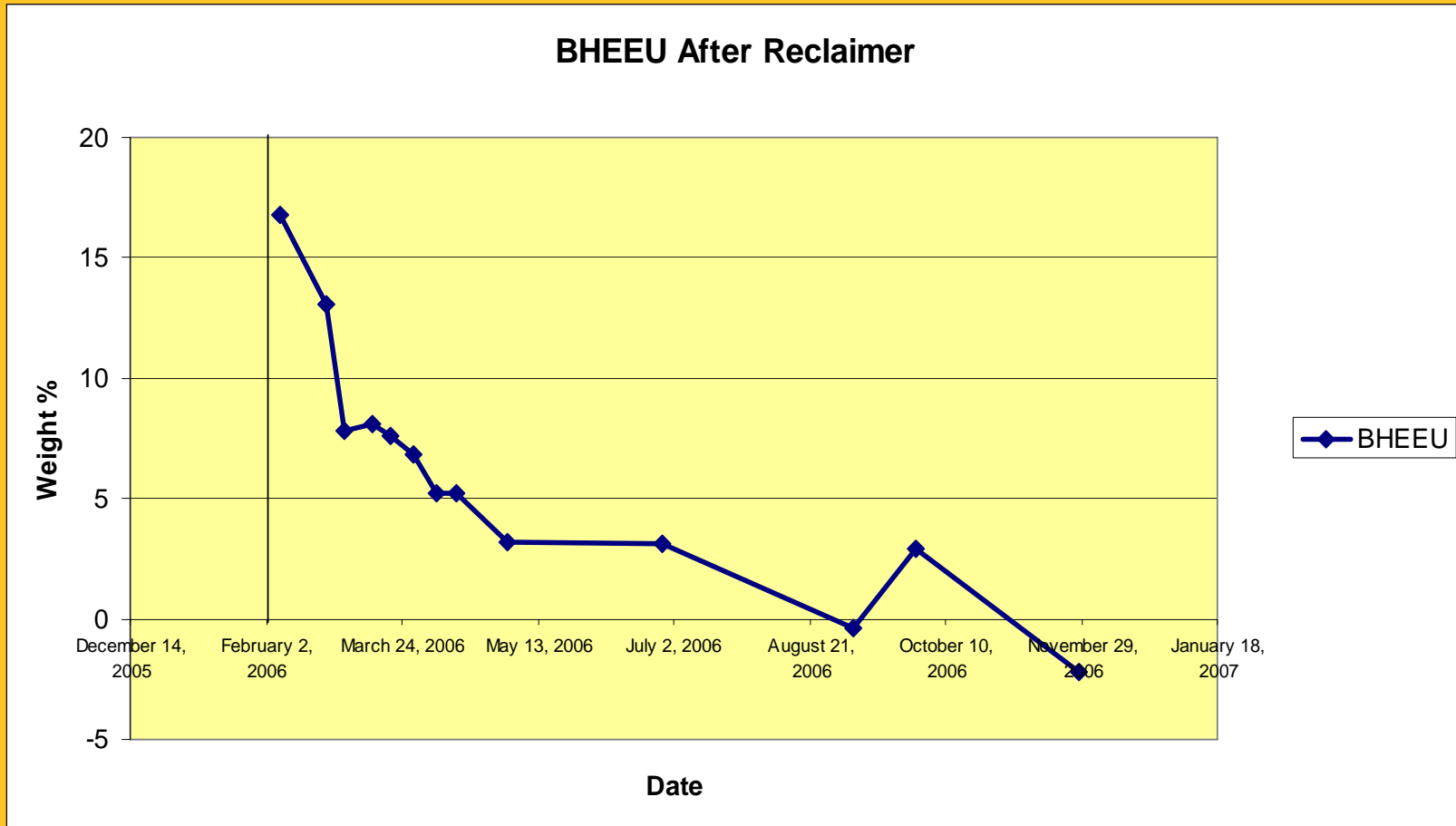


Operations After Thermal Reclaimer Installation

- Start Up February, 2006
 - Steam Trap/Condensate Return Problems
 - Temperature Controller Calibration Issues
 - Level Control Range Conflicts
- BHEEU Reduced from 17 WT% to 3 WT% in 3 Months
- Amine Consumption Reduced Due to Conversion of BHEEU to DGA®



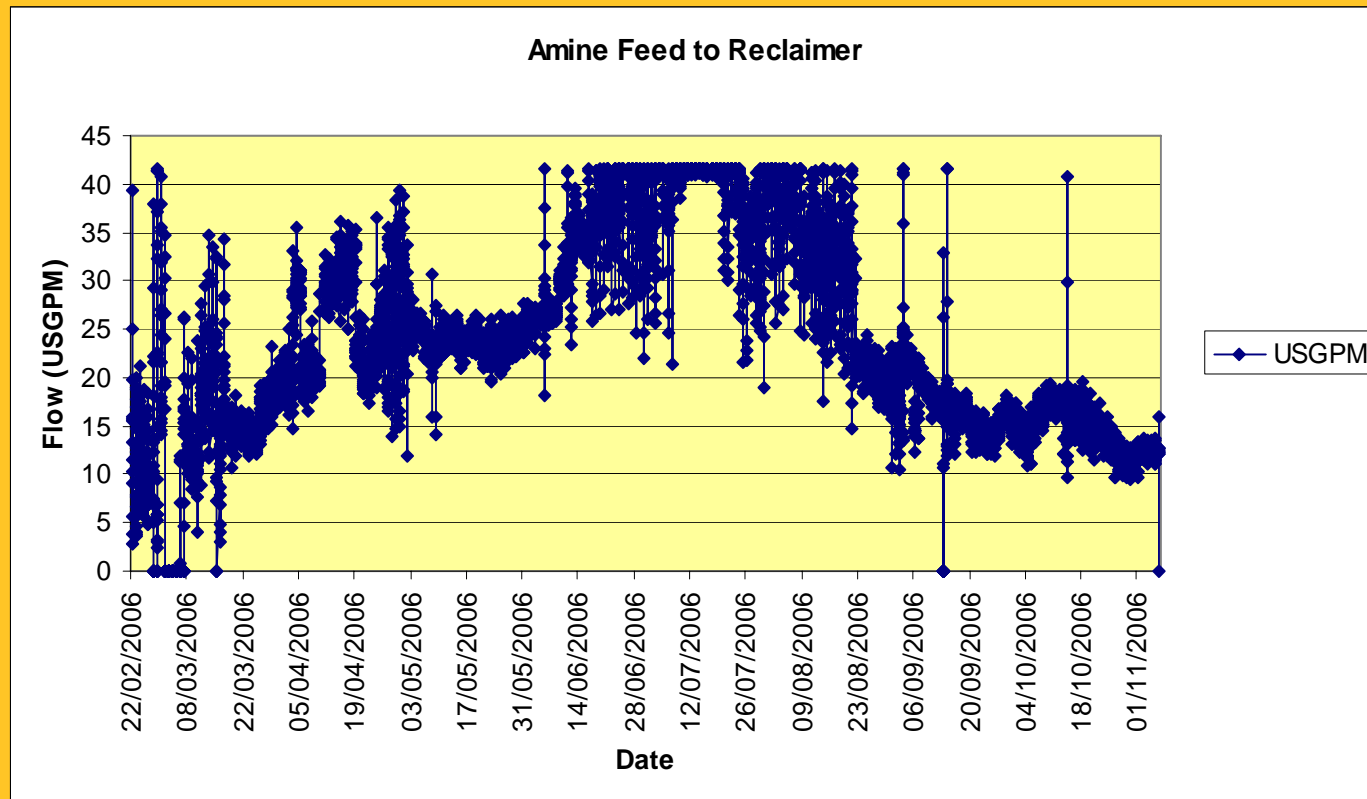
BHEEU After Reclaimer Start up



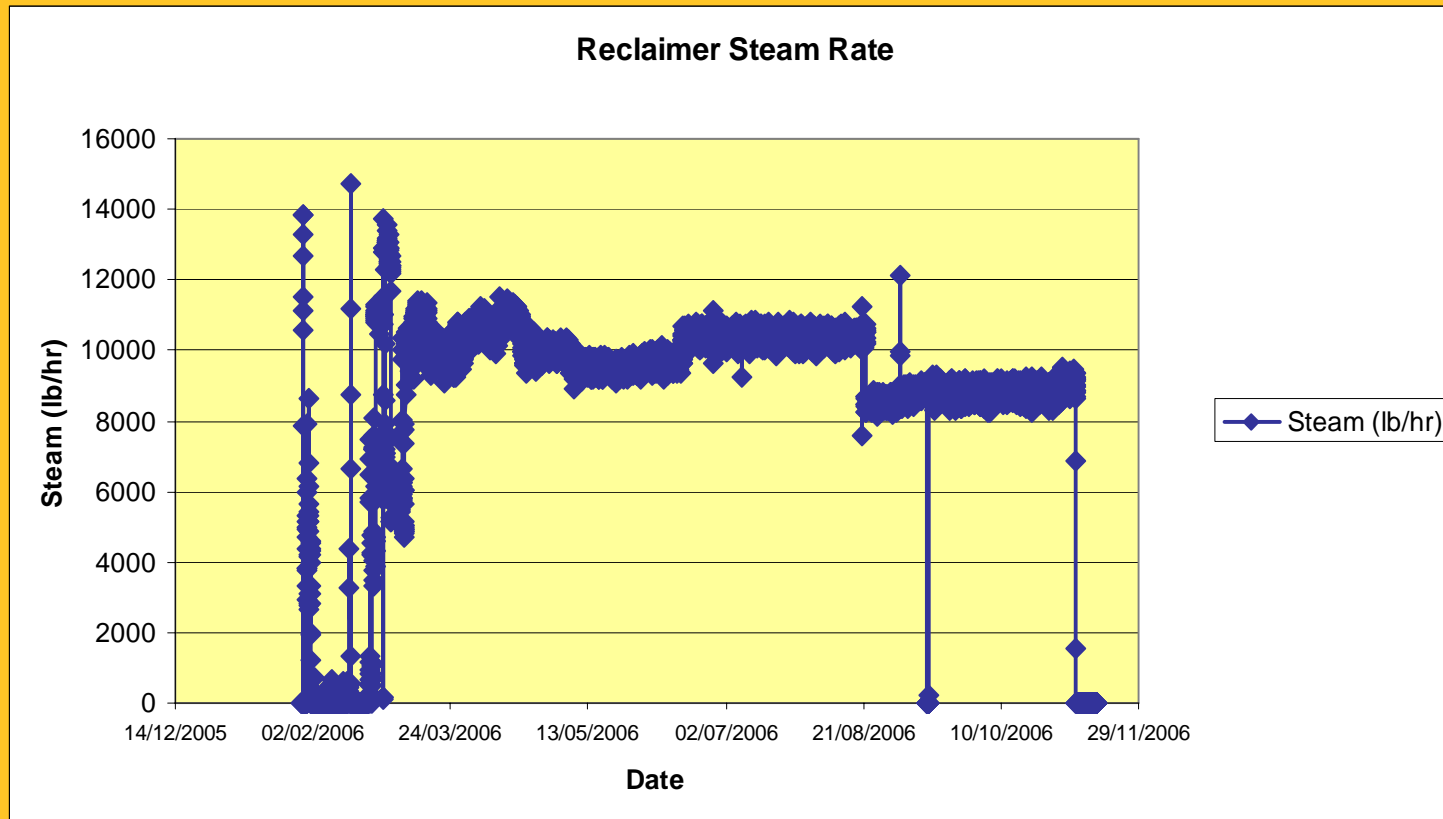
Operations After Thermal Reclaimer Installation

- Particulate Filter Replacement Reduced by 50%
- 2:1 Length to Diameter Ratio was Effective in Eliminating Carryover Out of Reclaimer
- Regenerator Reboiler Temperature Reduced Due to Higher Water Content in Amine Solution
- First Reclaim Cycle was 9 Months
 - Steam Coil Leak Was Found – Vibration Was Main Cause, Possibly Due to Changes to Inlet Distributor

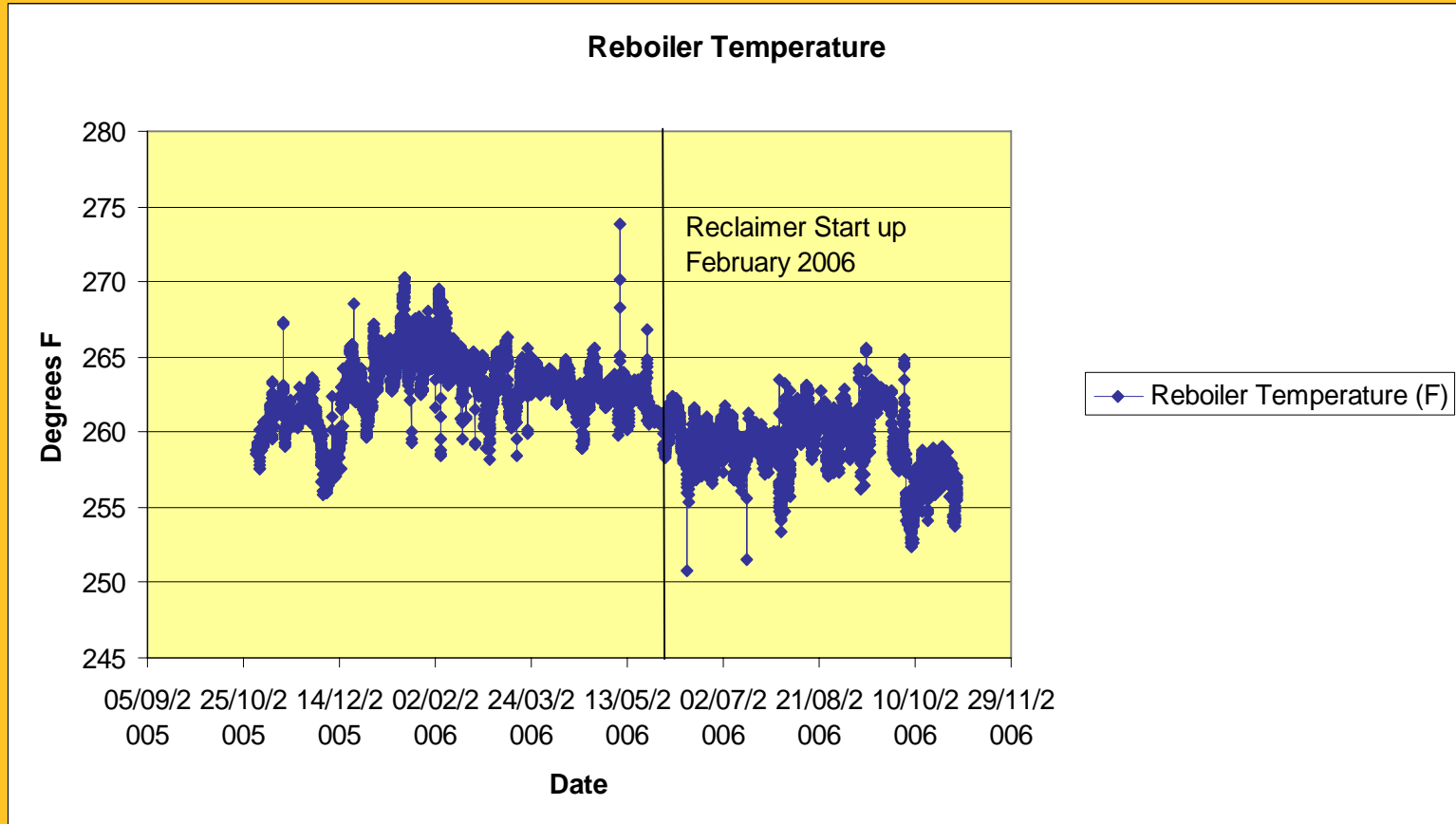
Amine Feed Rate To Reclaimer



Steam Rate To Reclaimer



Reboiler Temperature



Conclusions

- BHEEU and Degradation Targets Met with New Thermal Reclaimer
- Increase in Amine Strength is Now Possible for Capacity Increase
- Waste Volume and Nitrogen Content Has Been Reduced
- Amine Losses Reduced
- Merchant Reclaiming Costs Eliminated

Recommendations

- Reclaimer Design for Future Voyageur Expansion Project Will Be Based on Plant 53/68 Design
- Improvements to Level and Temperature Indication Will Be Implemented
- Condensate Drum Should be Considered for Future Designs
- Vibration Analysis and Inlet Design Are Important in Future Designs
- 2:1 L:D Ratio is Effective in Reducing Liquid Carryover