GLENDALE ENERGY

SILOXANE REMOVAL AT A SMALL LANDFILL GAS TO ELECTRICAL ENERGY FACILITY IN THE ARIZONA DESERT
THE FACILITY

- CITY OF GLENDALE LANDFILL
- 2 – GE JENBACHER 420 ENGINES
- RATED AT 2.8 MW TOTAL
- GAS QUALITY AT 40-42 % METHANE
- DESERT CLIMATE; HIGH DUST
- SWAMP COOLERS FOR HIGH TEMPS
LANDFILL GAS ANALYSIS

- GAS SAMPLE ANALYZED BEFORE ENGINE ORDER PLACED
- SAMPLE SHOWED 9 PPMV (12 MG/M3)
- SIMILAR TO ANOTHER FACILITY NOT AN ISSUE
- GE JENBACHER ALSO SAW NO CONCERN
SILOXANE PROBLEMS

- PROJECT COMMERCIAL : JAN 2010
- IMMEDIATE ENGINE PROBLEMS
- GE BLAMED GAS QUALITY THROUGHOUT
- TACKLED PROBLEMS FOR 2 YEARS
- OBVIOUS SILOXANE BUILD UP
- GLENDALE ENERGY ENGAGED CCA FOR TURNKEY SOLUTION
DESIGN CRITERIA

• REGENERATIVE TOO COSTLY
• LITTLE DATA ON SILICA GEL
• USED VESSEL THAT SHOULD WORK WITH ACTIVATED CARBON
• INSTALLED 15 TONS OF SILICA GEL
MEDIA DISPOSAL

- SPENT MEDIA LANDFILLED ON SITE
- REQUIRED A TCLP TEST AND PASSED
- A VAC TRUCK REMOVED AND HAULED THE MEDIA
HOW DID IT PERFORM?
SILOXANE REMOVAL

• INITIAL CHARGE OPERATED FOR 7 MONTHS
• STILL WORKING AT A LESS EFFICIENT LEVEL
• THERE WAS SOME BUILD UP BUT NOT DISRUPTIVE TO ENGINE OPERATIONS
GE JENBACHER CALCULATES THE RATE OF SI BUILD UP IN THE OIL TO DETERMINE IF THERE IS AN ISSUE.
OIL LIFE

• GREATLY INCREASED OIL LIFE

• EVEN GE JENBACHER IS HAPPIER
# GAS QUALITY

<table>
<thead>
<tr>
<th></th>
<th>SITE 1</th>
<th>SITE 2</th>
<th>MFGR. SPECS</th>
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<tbody>
<tr>
<td>SILCONS (PPMV)</td>
<td>9</td>
<td>9</td>
<td>9</td>
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<tr>
<td>METHANE</td>
<td>40%</td>
<td>57%</td>
<td>50%</td>
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<tr>
<td>BTU/SCF</td>
<td>400</td>
<td>570</td>
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<td>HEAT RATE (HHV)</td>
<td>11500</td>
<td>10600</td>
<td>9312</td>
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<tr>
<td>SI LOADING (PER KWH)</td>
<td>259</td>
<td>167</td>
<td>168</td>
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LESSON LEARNED

• NEED TO LOOK AT MORE THAN JUST THE SILICON LEVELS IN THE GAS

• NEED TO SEE THE MASS PER MWH
COSTS

- TOTAL INSTALLED CAPITAL $305,000
- COST OF MEDIA PER EVENT $35,000
- ANNUAL MEDIA COST (7 MONTHS) $60,000
ANNUAL SAVINGS

• DECKING (2 PER YEAR) $75,000
• PLUGS (2000 TO 5000 HR) $40,000
• OIL (1200 TO 5000 HR) $40,000
• PARTS & LABOR (MISC.) $10,000

• TOTAL SAVINGS $165,000
INCREASED REVENUE

- AVOIDED DOWNTIME: 328 ENGINE HOURS
- OPERATING LEVEL: 1.4 MW
- PRODUCTION: 460 MWH
- PRICE (AVE): $80 PER MWH
- TOTAL ANNUAL: $36,800
PAY BACK

- SAVINGS & REVENUE $202,000
- COST OF MEDIA $60,000

NET ANNUAL BENEFIT $142,000

PAYBACK (305,000/142,000) = 2.14 YEARS
CONCLUSION

• CONSIDER SILOXANE REMOVAL RATHER THAN INCREASED MAINTENANCE FOR A SMALL FACILITY

• INTERESTING STUDY TO EVALUATE THE DIFFERENT SPECIES OF SILICON NOT JUST THE TOTAL

• NEED MORE THAN GAS ANALYSIS TO EVALUATE POTENTIAL SILOXANE PROBLEMS