A Case Study in Refinery Energy Improvement
Chevron El Segundo Refinery

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KBC
DRIVING EXCELLENCE
El Segundo Energy Goals & Objectives

- Current Solomon EII high 70’s, plan required to move to low 70’s
  - What can be achieved without investment?
  - What can be achieved with investment?
- Circuit-wide focus to develop energy metrics for process units
  - Joint energy team to lead process energy metric definition with support from Chevron Best Practice teams
  - Utility metrics already defined & monitored
  - Integrate metrics into existing INDX system
Methodology Review

Phase 1
- Site-Wide Energy Balances
  - Detailed steam, fuel & power balances
- Process Flow Diagram (PFD) reviews
  - Identifies operational improvement items
- Best Technology Benchmarking & Gap Analysis
  - Identifies additional, practical areas of opportunity

Phase 2
- Pinch Analysis
  - Detailed Study on the Process Units with most potential
  - Total Site Application – Optimize Process/Utility Interfaces
- Road Map
  - Compare all ideas on same basis, develop a plan of how they fit together

Phase 3
- Develop Process Unit Energy Metrics
  - Targets
  - Lost Opportunity ($) calculations
Best Technology Gap Analysis

• Full BT Gap generally defined by four categories:
  – Steam Usage vs Best Practice
  – Fired Heater Efficiency
  – Shaft Work Efficiency
  – Heat Integration Effectiveness

• Performed for refinery overall, and unit by unit
FCCU BT Gap

- Significant gap identified on FCCU
- Main fractionator not heat integrated with FCC light ends plant (GRU)
  - Pumparounds produce steam and BFW preheat
  - Light ends reboiled with steam
- Recommended revamp to KBC best practice design
Steam Balance

- ProSteam tool used to model refinery utility system
- Model used to confirm value of recommended projects
Fuel Gas Containment

• Energy improvement potential limited by fuel gas surpluses
• Examined FCC LEP, ISOMAX and Coker
FCC Light Ends Plant – Improved C3/C4 Recovery

- Improved cooling of the fractionator overhead and deethanizer feed separator
- Increased lean oil rate
- Elimination of naphtha bypass through C-270
- Increase absorber pressure
Detailed Heat Integration Analysis

- SuperTarget software is leading edge
  - Determines minimum and practical energy targets
  - Examines capital/energy trade off
  - Automatically designs heat exchanger networks

- Typical network changes might include:
  - Exchanger upgrades
  - Additional surface area
  - Re-piping
  - Online cleaning facilities
Total Site Approach

Power, Steam & Fuel + Utility Infrastructure = Scope for Savings
Sampling of Identified Opportunities

• 19 Non-Investment Ideas, e.g.:
  – Reduce 2CU quench rate
  – Eliminate HVGO Quench on Overflash 4CU
  – Minimise Desulfurization Pressure on NHT-1
  – Review Turbine/Motor economics
  – Review boiler BD conductivity specs
  – Review O2 control on fired heaters

• 16 Investment Ideas, e.g.:
  – Modify 4H2S Regen O/H Condenser
  – FCC/GRU Revamp
  – Reboil Penex deC3 with 15# steam (instead of 150#)
  – Add feed/btms heat exchanger on NHT2 stabilizer
  – Use 850# steam as heat source for NHT1 desulfurizer reboiling (eliminate fired heater)
  – PRT on FCC Regen Overhead
  – New Gas Turbine on refinery fuel gas
The Metrics Pyramid

Energy Influencing Variables (EIVs)

Site-Wide KPIs

Unit/Area KPIs

Management Level
EII, BT, BTU/bbl, etc

Engineering Level
CIT, Turbine Eff, Boiler Heat Rate, etc

Console Level
Excess O2, Stripping Steam, PA rates, etc

Sum of EIV gaps define Site Lost Opportunity $’s
Process Unit Energy Metrics

- PFD reviews of major units identified 2-5 process metrics per unit
  - Operator metrics
  - Process engineer metrics
  - Energy coordinator metrics
- Lost Opportunity calculations defined for each metric
- Each metric documented
  - Rationale
  - Operation philosophy
  - KBC best practice
Typical Energy Metrics – Process Units

• Stripping steam rates
• Column product set points
  – Reboiler rates/reflux rates/tower pressure
• Pumparound duties
• Feed preheat temps
• Fractionation gaps/overlaps between cut points
• % overflash
• Furnace inlet temperatures
• Treat gas rates
• Separator pressure
Target Setting – Techniques & Philosophies

- Optimize energy without sacrificing yields
  - Understand the downstream products specs & target
    - Winter to summer, gasoline versus distillate etc
- Set targets based on either
  - Historical data (12 month average)
  - Process Simulation
  - Experience using Best Practice
- Tiered targets requiring maintenance/capital expense to achieve
  - E.g. maintenance required to fix stack damper:
    - O2 level target set at 3.5% until fixed, then lowered to 2%
Benefit Calculation

- Determine calculation step to demonstrate deviation from targets as $
  - Take back to fuel basis
  - Use up to date fuel price (natural gas import)
  - Ensure steam is properly valued
    - Not enthalpy basis
    - Take into account any power credit
Lost Opportunity Calculation – Coker Recycle Ratio

$$CFR = \left(1 + \frac{(T_{ff} - Thc)}{55}\right) \times 100 = wt\% \text{ of ff}$$

Assumptions:
Heater COT = 915 °F
Heater CIT = 550 °F
Feed Specific Heat = 0.67 Btu/lb-°F
Feed Latent Heat = 85 Btu/lb

Savings = \((CFR_1 - CFRT)\times FR/24 \times SG \times 0.0048 \times FGC/Eff = \$/hr\)

Where:
CFR = Combined Feed Ratio = Heater Charge/Fresh Feed
CFR_1 = Actual Combined Feed Ratio
CFRT = Target Actual Combined Feed Ratio
T_{ff} = Fresh Feed Temperature, °F
Thc = Heater Feed Temperature, °F
FR = Fresh Feed Rate, BSD
SG = Feed Specific Gravity
FGC = Fuel Gas Cost, \$/MMBtu
Eff = Heater Efficiency, %
Conclusions

• Chevron very pleased with the results of the Strategic Energy Review
• A good mix of no/low cost opportunities along with capital investment ideas
• Chevron currently evaluating new expansion projects against Best Technology standards