REAL TIME ONLINE ENERGY MANAGEMENT SYSTEM FOR SAUDI KAYAN PETROCHEMICALS

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REAL TIME ONLINE ENERGY MANAGEMENT SYSTEM FOR SAUDI KAYAN PETROCHEMICALS

OUTLINE
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Introduction
• What is Energy optimization
• Real Time Energy Management System Project Executed at Saudi Kayan

Technical Circumstantial
• Real Time, Online Systems
• Description of the Real Time Energy Management System
• Manual, Open Loop versus Closed Loop Operation
• Optimization Variables and Constraints Configuration
• Project Activities
• Calculation foundation for Energy Key Performance Indicators (EnKPIs)
• Economic Benefits

Conclusions
REAL TIME ONLINE ENERGY MANAGEMENT SYSTEM FOR SAUDI KAYAN PETROCHEMICALS

INTRODUCTION
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- **Process engineering team** realized the importance of monitoring the complex energy consumption and sustain it at optimum level during normal operating time. Integrating Energy optimization and Emissions monitoring.

- **Online energy monitoring system** selected and implemented to give complete, real-time and historical remote monitoring and energy management data through a simple web interface.

- **SAUDI KAYAN** is the first company that implemented an Energy Management System (EMS) software in Kingdom of Saudi Arabia & 2nd in Middle East.

- **It provides Operations** a Real Time Target for operating the utilities at the minimum Site-Wide overall Utilities cost.

- **A Utilities Real Time Optimizer** ensures that Operations is doing the best it can with the utilities assets available at that moment and within the current operating conditions.
INTRODUCTION

Whatever utilities the process needs, the process gets. But the fulfillment of the process utilities needs should be done at the lower cost,
–within emissions constraints,
–within current operating constraints, and within contractual constraints

SAUDI KAYAN online Energy monitoring makes it easy for senior management, employees or the sustainability team to see energy management and carbon reduction practices at work. Energy information monitoring data can also be used for

- Sustainability reporting
- Carbon management reporting
- Annual and quarterly reports to shareholders
- Compliance reporting and ENERGY reporting
- Reduce heat exchangers fouling incidents
EMS PROJECT PHASES IN SAUDI KAYAN

Saudi Kayan Project Phases:

• **First phase:**
  ✓ U&O plant detailed model and the main optimization handles available in the Olefins Unit was commissioned in **March 2013**.

• **Second phase:**
  ✓ **August 2014**, the RTEMS model was expanded to include all the units of the site, *covering all the energy sub-systems and allowing its energy performance monitoring and tracking*.

• **Third phase:**
  ✓ Installation of an ad-hoc Energy Dashboard which was commissioned in **January 2015**.
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TECHNICAL BACKGROUND
DESCRIPTION OF THE REAL TIME ENERGY MANAGEMENT SYSTEM

A detailed first principles model of the energy system (fuels, steam, electricity, boiler feed water, condensates network) was built with Visual MESA software and continuously fed with real-time data coming from the OSI PI real time database.

It includes all the actual constraints of the site energy system and the decision variables for their operation.

The real time, online, energy management system allows identifying the different economic trade-offs that challenges the production and internal distribution of the energy at minimum cost.

Greenhouse emissions are calculated and reported. They could be taken into account either as constraints or its emission cost included in the objective function to be optimized, as required.

Performance monitoring is also done on a continuous and automated basis, since the model writes back its calculated results to the PI Plant Information system.
EMSS ADVISORY ACTIONS

Plant Implementation

ON-LINE DATA

EMS

RESULTS

REPORTS/ ADVISORY ACTIONS

Sustainability Team

Improvement Action

Actions

Current Cost
11,650 $/Hr

Captured Savings

Potential Savings

Opportunity Savings

280 $/Hr

309 $/Hr

215 $/Hr

110 $/Hr

130 $/Hr

Optimum Cost
11,500 $/Hr

150 $/Hr (7 recommendations)
EMS to be the driver of complex optimization activities/actions, and to ensure SK achieving Sustainability targets by proactive measures and control.
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REAL TIME, ONLINE SYSTEMS
RTEMS Visual MESA open loop based projects have proven to save substantial amounts of money with very fast pay-back and many results published*.

There are several and important additional advantages of using RTEMS’s for online, real time, closed loop optimization because it increases the benefits already obtained in open loop because of the high frequency implementation of the optimum solutions.

- Saudi Kayan is evaluating the feasibility of proceeding to a fourth phase, closed loop real time optimization, over a selected number of continuous variables.

* Published references are provided at the end of the paper
ONLINE CAPABILITIES
WEB BROWSER ACCESS TO THE RTEMS MODEL

Figure shows how the information is contained in the model, which can be drilled down from the main view until the place where the data of interest is found. In this example,

- starting from the top view, the Specialties area is open by clicking on the icon,
- then going into Phenolics,
- later to Phenol Unit and
- finally opening the detailed electric system showing the Phenol electric system detail.
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OPTIMIZATION VARIABLES AND CONSTRAINTS
OPTIMIZATION VARIABLES AND CONSTRAINTS

Building a model that realistically represents the utilities and energy system topology needs to include all the optimization variables and constraints and, at the same time, properly take into account all the relevant economic details, especially the fuels and electricity real time prices and contractual complexity.

- **Optimization variables** are those where some freedom exists regarding what value they might take.

- **Constrained variables** are those variables that cannot be freely chosen by the optimizer but must be limited for practical operation.
CRUDE OIL BOILER AND EMISSIONS PAGE

BO-71401A PLANT

Sabic Kayan Dev v04j

EMISSIONS
Sabic Kayan Dev v04j

Total Emissions

CO₂ 193587 kg/h
SO₂ 117 kg/h
NOx 56 kg/h

Total Emission PBs

CO₂ 118035 kg/h
SO₂ 18 kg/h
NOx 51 kg/h

Total Emission COBs

CO₂ 42438 kg/h
SO₂ 99 kg/h
NOx 5 kg/h

Total Emission VHP Boiler

CO₂ 33114 kg/h
SO₂ 0 kg/h
NOx 0 kg/h

Graphs and tables showing emission data for different components.
SYSTEM BENEFITS, CAPTURING OPPORTUNITY

Opportunity savings

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<td></td>
<td>USD</td>
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<td></td>
<td>(MSAR)</td>
<td>(9.2 MSAR)</td>
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Captured savings

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<th>2015</th>
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<td></td>
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<td></td>
<td>(MSAR)</td>
<td>(8.9 MSAR)</td>
<td>(4.6 MSAR)</td>
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2017
Captured saving
948,480 USD
(3.6 MSAR)
EMS PERFORMANCE REPORT

- Emission Summary.
  Environment enhancement and sustainability improvement
- EN KPI:
  1. Key energy performance
  2. Energy consumption
  3. Reboiler steam feed ratio
- Boilers details
  Boilers overall performance & Emissions
- Switchable Drivers:
  Turbine / Motor Swaping recommendation
- DSHW:
  De superheater water supply to process units.
- CW and SW:
  1. Cooling water distribution to all units
  2. Cooling tower Range
  3. Approach and Effectiveness
- Condensate System: Cond Recovery from all units
- Electric System: Current and optimized Power consumption
- Fuel System: Current and optimized fuel consumption
- Steam Details & Systems
- Advisory action items (SK overall Optimization)
ENERGY MANAGEMENT SYSTEM

Increasing the HP steam extraction on KT-13001 turbine at Olefins plant

Olefins steam let-downs reduction

HPS import from U&O reduced By 7 T/hr

Fuel Gas reduction

HP Extraction from KT-13001

VHP to HP letdown

HP Import from U&O
ENERGY MANAGEMENT SYSTEM

Increasing the HP steam extraction on KT-13001 turbine at Olefins plant

Olefins steam let-downs reduction

HPS import from U&O reduced By 7 T/hr

Boilers emissions will be also reduce as a consequence of the reduction in fuel gas.

Fuel Gas reduction

OPPORTUNITY SAVINGS

Reduction Fuel Gas Consumption
The next figure illustrates the savings that were obtained from real time optimization between February 28th and March 7th, 2013.

Before implementing recommendations:
Average potential savings: 390 $/h
Captured Savings: 120$/h (1.05 MM$/year)

After implementing recommendations:
Average potential savings: 270 $/h

Around 3:00 AM on March 2nd, Operators applied one of the optimization actions calculated by the RTEMS and 1.05 MM$/year of savings were immediately captured (i.e., the predicted savings trend drops).

At that time, before SK operators took the actions Visual MESA was suggesting: two turbine and motors swaps and increasing the extraction in all three extraction-condensing turbines at Olefins plant.

Visual MESA Recommendations Report is available to everyone through the Web Browser.
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KEY PERFORMANCE INDICATORS (ENKPIIS) AND DASHBOARD
All the EnKPIs that are being calculated, historized in PI and reported can be tracked and evaluated by many stakeholders using both, the Visual MESA model and the Energy Dashboard software:

- Plant Total Energy
- Plant Energy per feed rate (i.e., energy intensity)
- Boilers Efficiencies
- Heaters Efficiencies
- Turbines Efficiencies
- Cooling tower indicators
- Condensate recovery
- Letdown flows
- Vent flows
- Steam/feed reboiling ratios
- Emissions (Unit and site wise)
- Current and Optimum value for the optimization variables
- Energy cost gap (i.e., difference between the optimum and current energy cost, calculated by the Visual MESA RTEMS optimizer)
SABIC SAUDI KAYAN RTEMS MODEL / DASHBOARD LINKS
THIRD PHASE
CONCLUSIONS
CONCLUSIONS

- Energy Management System’s First phase was successfully commissioned at Saudi Kayan Petrochemical Complex in 2013.

- Over the years, the system expanded to all the Units of the site, calculating and monitoring their energy related KPIs & presenting them in Dashboard.

- Sustainability services from Vendor helped the internal Saudi Kayan Team to maintain the software tool with a very high availability.

- RTEMS is executed online, in open loop advisory mode, with Operations implementing the recommendations through manual actions.
REFERENCES
REFERENCES


6. M. Lorenz, 2009, Energy Real-Time Optimizer Baytown Refining/Chemical Complex, Industrial Energy Technology Conference (IETC), New Orleans, USA

7. M. Reid, T. Reitmeier, 2011, Closing The Loop With Visual MESA. The Transition of Air Liquide’s Real-Time Utility Optimizer to Closed Loop at the Bayport, Texas Facility, , Industrial Energy Technology Conference (IETC), New Orleans, USA