Advantages of a Real-Time Emissions Data Management System for NOx Reduction Record Keeping and Reporting

Presented By:

Chris Matthews
Lyondell-Citgo Refining
LP
Houston, TX

Alan Pate
Ellipsys, Inc.
Bellaire, TX

Cecillia Davis
Lyondell-Citgo Refining
LP
Houston, TX
This paper has been reproduced for the author or authors as a courtesy by the National Petrochemical & Refiners Association. Publication of this paper does not signify that the contents necessarily reflect the opinions of the NPRA, its officers, directors, members, or staff. Requests for authorization to quote or use the contents should be addressed directly to the author(s).
Advantages of a Real-Time Emissions Data Management System
For
NOx Reduction Record Keeping and Reporting

By

Chris Matthews
Roel Muñoz
Cecillia Davis

Lyondell-Citgo Refining, LP
Houston, Texas

and

Alan Pate

Ellipsys, Inc.
Houston, Texas

Presented at the

NPRA
2004 Environmental & Safety Conference
September 27 and 28, 2004
San Antonio, Texas
Introduction

Lyondell-Citgo Refining, LP (LCR), a 270,000 bbl/day refinery located in the Houston/Galveston Area, has successfully implemented a real-time process historian based system for meeting the monitoring, record keeping, and reporting requirements under the Texas Commission on Environmental Quality’s (TCEQ’s) NOx Reduction rules. This paper presents the challenges that LCR faced in meeting the NOx reduction rules requirements; the reasons that LCR selected a real-time process historian-based emissions data management solution, and the benefits that LCR has been able to realize. Even though this paper focuses on NOx, LCR selected a system that was fully capable of handling the requirements for any other regulated pollutants (e.g. CO, SO2, VOC, etc.) of which E!CEMS is capable.

LCR’s goal was to implement a fully integrated Continuous Emissions Monitoring System (CEMS) Data Historian and Reporting system for NOx reduction record keeping and reporting. LCR’s ideal solution was one that met the mandated environmental regulations but also offered value and was an off-the-shelf standard software product.

History of Emissions Calculations at LCR

In the past, monthly, quarterly, semi-annual, and annual CEMS and emissions reports required manual input from several groups:

- Environmental Engineers
- Analyzer Technicians and Supervisors
- Process Engineers
- Lab

These reports were manpower intensive, and never real-time. Purchasing or selling NOx allowances required faster access to actual NOx calculated data.

LCR performed some of these calculations on the DCS, but this proved to be expensive to implement and maintain. Most of the calculations were performed in spreadsheets by different departments with little or no standardizations and possible calculation errors.

Record keeping for emissions calculations, analyzer drift checks and cylinder gas audits (CGA) was typically performed using word processing and spreadsheet documents by a variety of people. LCR wished to centralize these records in an enterprise-class system.
Project Justification

LCR’s recent amendment to its TCEQ Flexible Air Permit requires compliance to be demonstrated on an hourly basis. Additionally, real-time emissions calculations allow the plant to be proactive in regards to emissions limits. Real-time emissions versus the heater operations will show how operational changes affect emissions.

The project was justified based on the following criteria:

- Regulatory Requirement
  - LCR’s recent amendment to its TCEQ Flexible Air Permit requires compliance to be demonstrated on an hourly basis
  - Anticipated future environmental mandates (HRVOC, Title V, etc.) will likely require additional, configurable capability in this area.

- Lowers Costs
  - Reduces man-hours to determine compliance
  - Reduces man-hours to generate reports
  - Minimizes out-of-control events
  - Improved NOx trading information
  - Limited resources can focus on problem items

- Improves Reliability
  - Emissions data
  - Field equipment monitoring
  - Shorten response time to potential problems
Project Methodology

The project began with the selection of a cross-functional project team and a project sponsor. The team included members from several departments: HSE, Instrumentation, Electrical, and Analyzer (IEA), Process Control, Operations, Information Services (IS), and Capitol Projects. It was important to clearly define team member roles and tasks so that management and the team members would know how much time would be required.

Each team member was involved in the process of gathering detailed system requirements. The project team was required to review and approve system requirements prior to sending out the bid packages to a list of vendors. HSE, Process Control, IEA, and IS members recommended potential vendors that had either systems or hardware to satisfy these requirements. The team decided to bring all of these vendors in to present their systems and explain their company’s business model and history. From these interviews, the team decided which vendor would receive the bid package for the NOx Reporting System.

Meanwhile, the team reviewed the system requirements and categorized them into Must-Have, Nice-to-Have, and Wish List items. The Must-Have items were prioritized and ranked, and then approved by the project team. The project team performed a technical evaluation only--no financial information was disclosed. The vendor bid responses were compared to the entire requirements list, and then compared to the Must-Have requirements using a simple ranking system.

Purchasing performed the financial evaluation comparing total project cost and shared it with the team after the technical evaluation was complete.
System Requirements

The system requirements included the following items:

- Automated CEMS downtime and exceedance event detection and reporting
  - Predefined reason and corrective action codes for emission events and downtime
- Drift check and CGA record keeping and alarming
  - Drift Check
    - Automatic out-of-control determination
      - 2x limit for 5 consecutive days
      - 4x limit immediate
    - Alarming
      - 2x limit exceeded
      - Missed drift checks (Noon)
      - Missed drift checks (entire day – Title V)
  - Cylinder Gas Audits (CGA)
    - Cylinder Certificate of Analysis storage
    - Assignment of Cylinders to Analyzer Audit Points
    - CGA Run Results and Reporting
- Permit & Action Level Limit Checks and Alarming
  - Permit Limit
    - Can be any permit or federal or state regulatory limit
    - Flow, Concentration, Temperature, Duty, etc.
  - Action Level Limit
    - An LCR internal action level set slightly more stringent than permit or regulatory limit
    - Flow, Concentration, Temperature, Duty, etc.
- Notifications (email and/or page)
  - Daily Drift Check exceedance
  - Missed Drift Check
  - Action Level Limit exceedance
  - Permit Limit exceedance
  - No data, bad data, or flat-line data
- Data validation
  - Data Substitution
    - Automatic
      - Detect ‘bad’ data
        - Bad DCS Scans
        - Drift Checks, CGA, Blowbacks, Analyzer Faults
        - Analyzer Out of Control
      - Use Last Good Value when Bad
      - Ignore bad inputs when unit is down
    - Manual
      - Recalculated only affected values
Status reporting
  - Parameter status detail

Real-time emissions calculations
  - Real-time for LCR = as fast as every 15 seconds
  - Consistently applied plant-wide
    - Formulas
    - Engineering Unit Conversions
    - Calculation Rules

Plant-wide access via web pages
  - Simple deployment and no desktop footprint

An audit trail to document all configuration changes and data entry

Configurable security to prevent non-authorized access
  - Role based
    - Roles also used for notifications
Product Selection

The Ellipsys’ E!CEMS environmental data management product was selected. E!CEMS met all of the LCR requirements. E!CEMS provides very tight integration with the process historian, which, for LCR is AspenTech’s InfoPlus.21. Additionally, Ellipsys personnel have years of experience with real-time process historian applications. Ellipsys’ development and services team is based in the Houston area. Ellipsys is a wholly owned subsidiary of Mustang Engineering, LP, owned by Wood Group PLC of Aberdeen, Scotland.
Implementation

The scope of LCR’s implementation was to configure the following fired-sources:

- 19 CEMS analyzers on sources with multiple pollutants
- 61 non-CEMS sources

The implementation took approximately 9 months. However, we believe this schedule could have been compressed with the following:

- More focused LCR resources
  - Gathering the information required for each fired-source emissions for input into E!CEMS takes time.
- Ensure all required calculations are known early in the project
- Parallel project to upgrade the legacy CEMS analyzers to support data collection should be coordinated with the E!CEMS implementation

LCR’s implementation includes installation in a Staging (Test) and Production environment. LCR’s implementation phase included the following steps for each environment:

**Staging (Test)**

- History Migration of 1 ½ years worth of plant data into the Staging E!CEMS server for testing of the E!CEMS Calculation Engine
- Documentation Review
- Installation in Staging (Testing)
- Training (Power Users & End Users)
- User Acceptance Testing

**Production**

- Setup up automatic update of CIM-IO (DCS data to Historian)
- History Migration of Data from Jan 1, 2004 to present
- Configuration of the source calculations
- Turning on the Calculation Engine starting at Jan 1, 2004
- Final Acceptance Testing
- Go-Live
- Lessons Learned
**Benefits Realized**

The following are some of the benefits realized by this project:

**Improved Maintainability of Emissions Data**
- Eliminate duplicate work between environmental and technical departments
- Standard calculations applied plant-wide
  - Same formulas
  - Same engineering unit conversions
  - Same rules (unit up down, quality)
- Better data validation
- 5 years of on-line emissions data for comparison/review

**Improved NOx Trading Decisions**
- Year-to-date NOx totals updated hourly instead of quarterly
- Makes NOx planning, responding, and trading easier

**Reduced NOx Emissions**
- Better Operations/Maintenance Integration
  - Real-time notification
    - Failed or Missed Drift Checks
    - Permit and Action Level Limit Violations
    - Flat-line Detection from Analyzer Data
    - Real-time historian integration
  - Awareness of the Impact of Operational Changes on Emissions

**Adaptability for future regulations**
- HRVOC, Title V
- Allows addition of future sources
- Allows choice of averaging period (hourly, daily, etc.) in order to show compliance with multiple regulatory requirements
E!CEMS Product Highlights

This section includes sample screenshots from LCR’s E!CEMS implementation:

Drift Check Summary Report

Current Emissions Report
Events Search Capability

E-Mail Task Notification
### Aggregate (Average) Configuration

#### Aggregate Types

<table>
<thead>
<tr>
<th>Aggregate Name</th>
<th>Aggregate Label</th>
<th>Tag Suffix</th>
<th>Aggregate Type</th>
<th>Time Interval</th>
<th>Count Target</th>
<th>Quality Options</th>
<th>Aggregate Option</th>
<th>Aggregate Option Use Good Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td></td>
<td></td>
<td>Last</td>
<td>Time Interval</td>
<td>Count Target</td>
<td>Quality Options</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instantaneous</td>
<td></td>
<td></td>
<td>Instantaneous</td>
<td>Time Interval</td>
<td>Count Target</td>
<td>Quality Options</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Label</td>
<td></td>
<td></td>
<td>Label</td>
<td>Frequency</td>
<td>Count Target</td>
<td>Quality Options</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual Entry</td>
<td></td>
<td></td>
<td>Manual Entry</td>
<td>Time</td>
<td>Count Target</td>
<td>Quality Options</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual Entry</td>
<td></td>
<td></td>
<td>Manual Entry</td>
<td>Time</td>
<td>Count Target</td>
<td>Quality Options</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Formula Configuration

#### Formulas

<table>
<thead>
<tr>
<th>Formula Name</th>
<th>Formula String</th>
<th>Formula Description</th>
<th>Formula Help</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add</td>
<td>AL, A2, A3, A4, A5, A6, A7, A8, A9, A10</td>
<td>Add two values</td>
<td>Sum 10 values</td>
</tr>
<tr>
<td>Add</td>
<td>AL, A2, A3, A4, A5, A6, A7, A8, A9, A10</td>
<td>Add two values</td>
<td>Sum 20 values</td>
</tr>
<tr>
<td>Conc%</td>
<td>Conc% (17.9 / (20.9 – 0.0))</td>
<td>Adjust concentration to 17.9%</td>
<td>Adjust concentration to 17.9%</td>
</tr>
<tr>
<td>Concentration</td>
<td>Conc% (MEASURED*100) / 100</td>
<td>Adjust concentration to 17.9%</td>
<td>Adjust concentration to 17.9%</td>
</tr>
<tr>
<td>Emission Fader</td>
<td>Conc% * F_FACTOR * MM / 365.9 * (20.9 / (20.9 – 0.0))</td>
<td>Emission Fader</td>
<td>Emission Fader</td>
</tr>
<tr>
<td>Emission Fader</td>
<td>Conc% * F_FACTOR * MM / 365.9 * (20.9 / (20.9 – 0.0))</td>
<td>Emission Fader</td>
<td>Emission Fader</td>
</tr>
</tbody>
</table>
Audit Trail

Role-Based Security

ENV-04-177
Page 13
**Conclusion**

LCR was able to select and implement a standard off-the-shelf software product that met the NOx reduction requirements. The solution selected was the best value for LCR and was an excellent fit for LCR’s IT and plant process historian infrastructure. Because of the real-time nature of the solution, it has excellent applicability for other environmental mandates in the Houston-Galveston Area.

Real-time emissions calculations provide significant benefits by integrating environmental data into plant operations.

**Biographies**

Chris Matthews is the Environmental Superintendent at the Lyondell-Citgo Refinery. Chris is a registered professional engineer in the state of Texas. Chris has a B.S. in Petroleum Engineering from Texas Tech University and an M.S. in Environmental Engineering from The University of Texas at Austin.

Roel A. Muñoz is a Principal Engineer in the Environmental Department at the Lyondell-Citgo Refinery. Roel has a B.S. in Chemical Engineering from Texas A&M (formerly Texas A&I) University in Kingsville, Texas and has 15+ years of experience in the refining and petrochemical industries.

Cecillia Davis is the IS Support Analyst Team Lead at the Lyondell-Citgo Refinery. She is the Project Lead for the NOx Reporting Project at Lyondell-Citgo Refinery. Cecillia has a B.S. in Chemical Engineering from Lamar University in Beaumont, Texas.

Alan Pate is a Principal Consultant for Ellipsys, Inc with 20 years of process industry automation experience. Ellipsys is a Houston-based systems integration firm specializing in IT solutions for the process and manufacturing industries. Alan is responsible for Ellipsys’ E!CEMS environmental data historian and reporting software product. Alan has a B.S. in Chemical Engineering from Rice University.