Setting the Standard for Automation™

The Role of On-line, Real-time Coal Analysis in Advanced Process Control & Optimization

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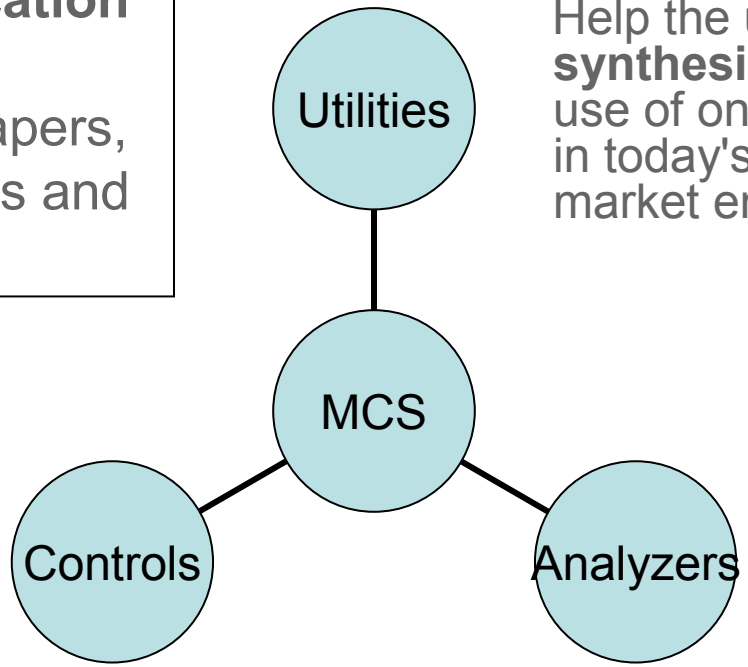
On-line Analyzers and Process Control

- Conservation of resources, for highest efficiency and proper control, are necessary for the continued and future success of power plant operations.
- Modern tools can help the plant operators maintain balance and optimize the return on investment.
- Today, almost all utility boiler operators are “flying blind” due to the absence of coal chemistry data in real time
- The incorporation of online coal analysis into computerized optimization systems has lagged behind.

GOALS of our Multi-client study of OnLine Analysis:

Facilitate communication among industry segments through papers, meetings, conferences and panel discussions



Help the utility industry **synthesize a vision** of the use of online coal analysis in today's competitive utility market environment.

Promote the integration of online coal analysis into boiler controls and optimization systems

Help on-line analyzer manufacturers **understand utility motivations and problems**

The Problem with Chemical Coal Analysis

- Plants worldwide have problems with low quality coal
  - ***Unanticipated, unknown, and unmonitored*** changes in coal quality
  - Coal quality varies ***dramatically*** from lot to lot
  - Large Lot sizes (over 1500 tons) can ***hide variations in quality***
  - the operator must change boiler conditions, leading to ***loss of efficiency***
  - If ***boiler changes are based on guesswork***, the outcome can not be guaranteed and sometimes can make conditions worse.

Barriers to Entry

- Experience based on research units
- Poor reliability of sampling systems feeding OLA
- Upgrades to control software needed to get real time data to control system
- Coal quality impacts must be correlated (fed forward)
- Financial controls not generally available
- Status quo slows improvement processes

Barriers and Aids to Acceptance

Barriers

- Installation downtime
- Calibration
- Bunker mixing
- DCS integration
- Institutional
  - perceptions
  - objectives
  - coal variability
  - reactive analysis
  - proof before purchase

Aids

- Through-belt design
- Multiple sensors, software
- Silo flow modeling
- Common data pipeline
- Innovation
  - new information
  - financial not technical
  - dual use (pre- and post)
  - continuous coal quality data
  - prompt resolution of problems

Ways Coal Quality Impacts Controls

ASH	Pulverizer power	Boiler Performance	Aux Power, EFOR
SULFUR	Scrubber reagent	Scrubber Performance, CEMs compliance validation	Sorbent feed rate, Aux Power, SO2 Trading
HEATING VALUE	Stoichiometry	Heat Rate MW output	Cost per MW, Opportunity cost marginal price
Ash Chemistry	ESP control Soot blowing frequency	Aux Power SO3 injection	Regulatory Costs
Short-term variability	Plant impacts	Close loop with Fuel Procurement	Contract price adjustments
Off-spec fuels	Pre-combustion blending	Plant spec performance Opportunity fuels during low load ops	Reduced fuel costs

Uses for Real Time Coal Quality

	ASH/MINERAL CONTENT	SULFUR	HEATING VALUE	MOISTURE
COAL HANDLEABILITY	•			•
BOILER SLAGGING	•		•	
SCRUBBER PEFORMANCE		•		
CEMS		•		
HEAT RATE			•	•
SOOTBLOWERS	•			
CYCLING COSTS	•	1/2 •	•	
NEURAL NETWORKS	•	•	•	•
FERC REPORTING	•	•	•	•
PI SOFTWARE	•	•	•	•
CMMS	• •			•
FLAME SCANNERS				•
ESP	•	•		•

Why doesn't *every* plant use online analysis?

Potential benefits…

- Tracking coal quality impacts
  - Faster Troubleshooting
  - More accurate heat rate reporting
  - Real-time market timing
  - Safer usage of opportunity fuels
- Feedback for realistic quality adjustments
  - Requires continuous analysis at receiving point
  - Trend is toward vendor analysis at shipping point
- Close the loop - fuel cost, production cost, and market price
  - Improved maintenance predictions, plant diagnostics
  - Plants are "flying blind"
  - Possible real-time market cost (locational marginal price)

Multi-client Study of On-line Analysis

Methodology

- Survey plant operators
- Assess status
- Identify information gaps
- Review projects in progress
- Evaluate automation
- Quantify the value
- Develop generic specification

Analyzer Survey Results

6. **If you have evaluated analyzers and decided not to purchase, what were some possible reasons? (check all that may apply)**

(Question type: Multiple-choice, select many)

Answer	Amount	Percentage
Cost too much	4	40 %
Too much time to install and commission	0	0 %
Accuracy was too poor to be useful	2	20 %
Output was not relevant to the problem	1	10 %
Analyzer capabilities were not clearly defined or specified	1	10 %
Analyzer delivery time too long	0	0 %
Other reasons	6	60 %

- Cost overruns for developmental technologies
- Projects whose principal objective was to prove accuracy
- Negative reports from early second-generation units
- Lack of knowledge of the current state of the art

Analyzer Survey Results

8. How useful to your business is the data you receive, or could receive, from online analyzers?

(Question type: Multiple-choice, select one)

Answer	Amount	Percentage
Extremely Useful	4	40 %
Very Useful	0	0 %
Sometimes Useful	0	0 %
Occasionally Useful	0	0 %
Hardly useful	1	10 %
Other	5	50 %
Number of respondents	**10**	

- 40% see the usefulness of knowing coal quality in real time
- Half the respondents were not sure of usefulness of the data
- Only 10% say the data is not useful

Analyzer Survey Results

9. **Assuming you have used analyzers before, how satisfied are you with the performance of online analyzers, either your own installation, or the overall perception of performance.**

(Question type: Multiple-choice, select one)

Answer	Amount	Percentage
Very Satisfied	5	55.56 %
Somewhat satisfied	2	22.22 %
Somewhat less than satisfied	1	11.11 %
Slightly satisfied	0	0 %
Not satisfied	1	11.11 %
Number of respondents	**9**	

10. **Do you currently recommend the use of online analysis to your peers or superiors?**

(Question type: Multiple-choice, select one)

Answer	Amount	Percentage
Yes	7	77.78 %
No	1	11.11 %
Don't Know	0	0 %
Other	1	11.1111 %
Number of respondents	**9**	

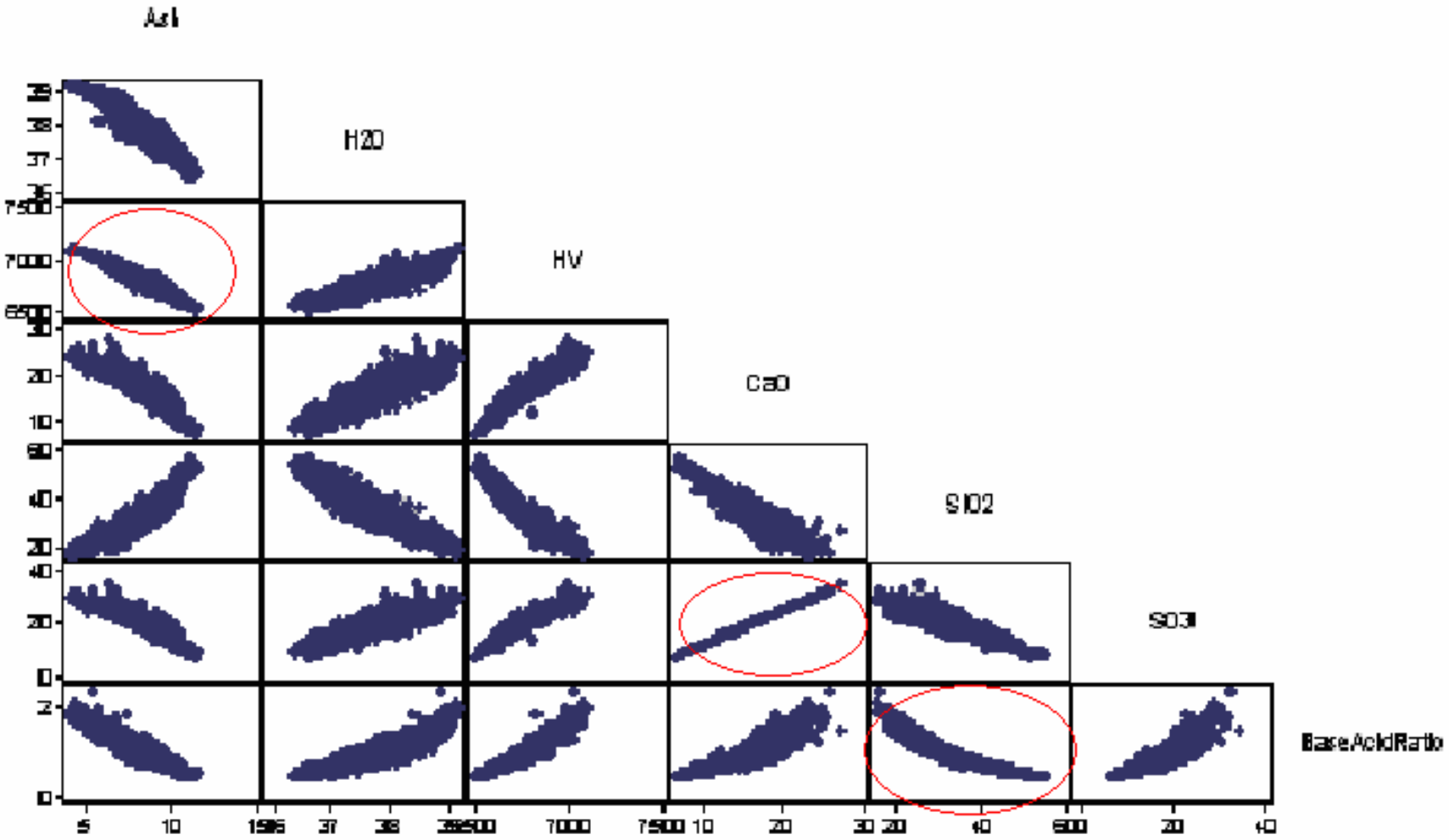
Survey Findings

- Perceptions biased on early failures
- Objectives unclear
- Coal variability not understood
- Reactive coal analysis post-event leads to lack of trust
- Proof before purchase

Current methods of sampling and analysis do not adequately measure variations in coal quality

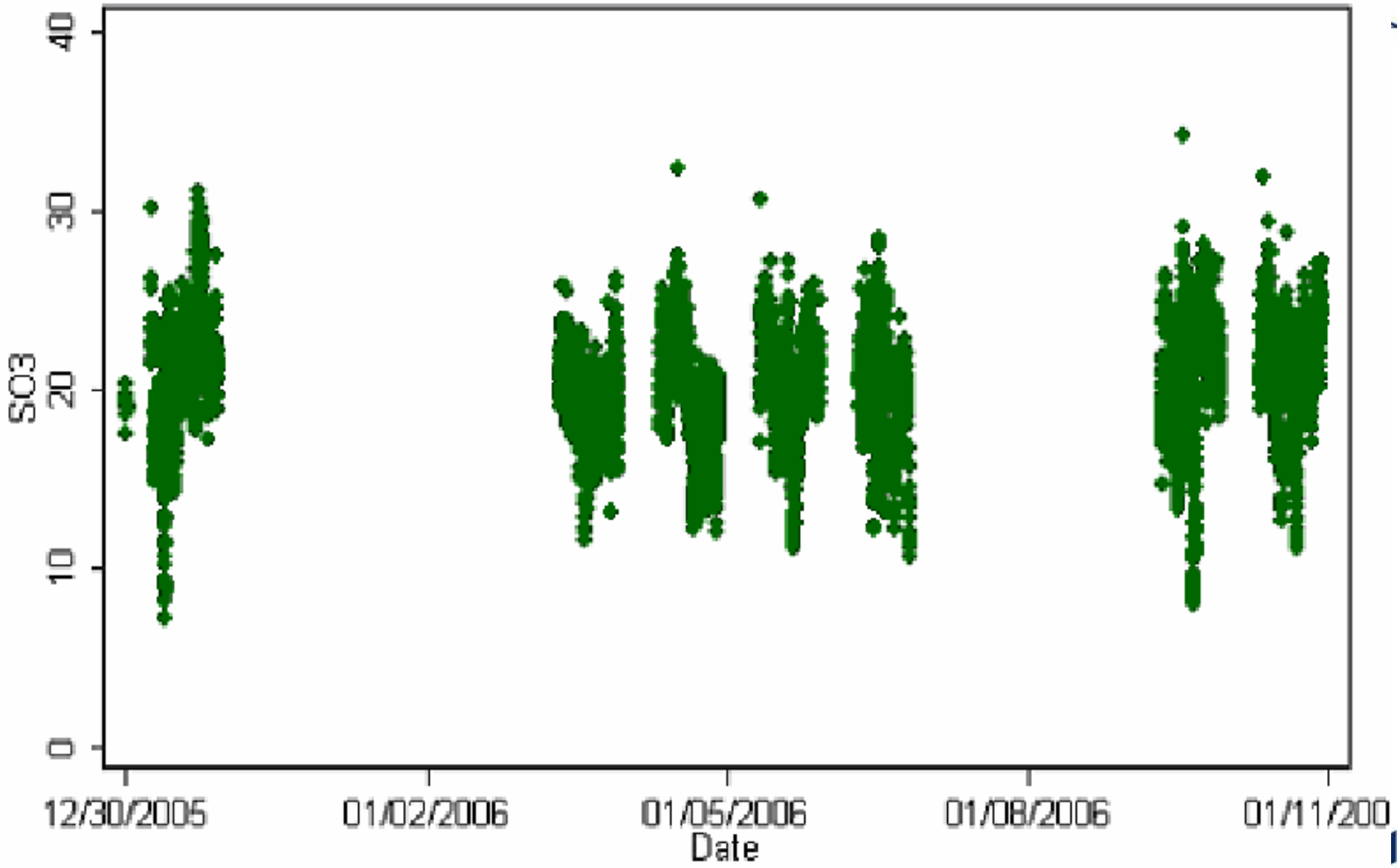
- ASTM sampling methods "average out" variations
- Correlations of coal quality with boiler impacts are impossible
- Lack of knowledge of variability leads to lack of trust in coal quality data.
- Data not trusted won't be used

Typical On-line Analyzer data. Coal constituents with strong correlations SiO2-B/A ratio CaO-SO3 Ash-HV

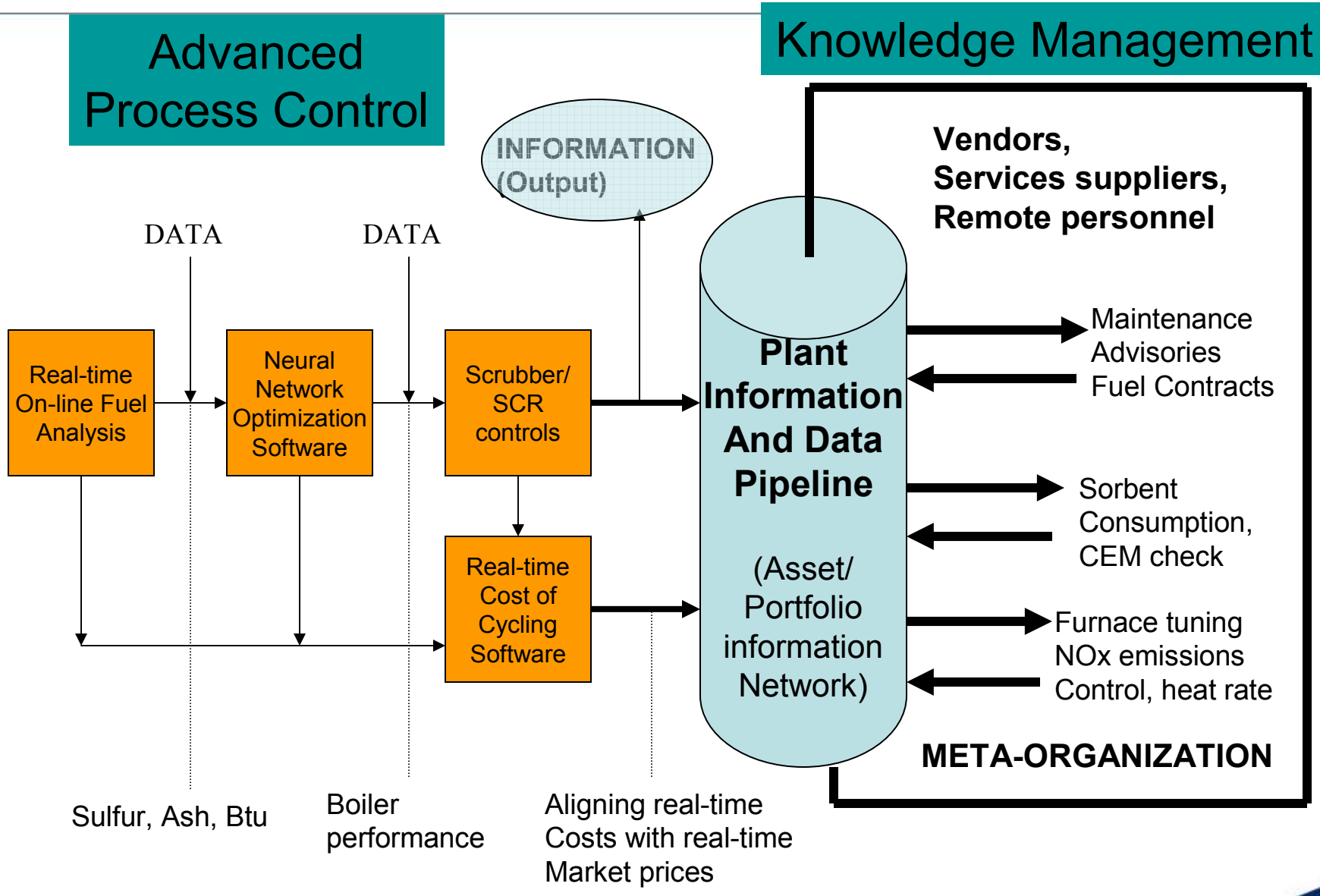


Typical Online Analyzer Data - note sporatic times of readings

SO3 vs Date



Optimization Building Blocks



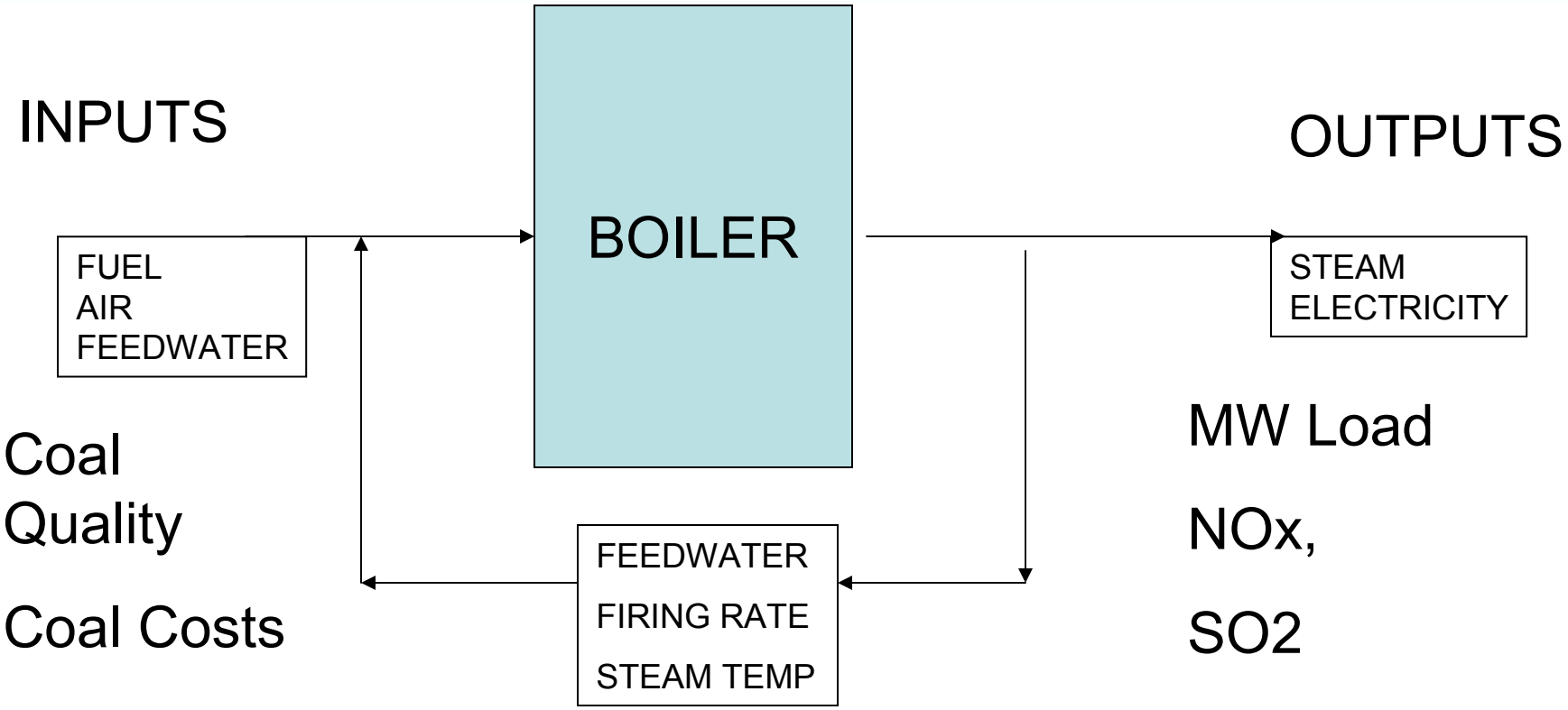
The Promise of Online Analysis

- Convert receiving silos, **control feeders** based on signals from the analyzer
- Maintain constant coal quality, **insure ash constituents do not exceed pre-set parameters.**
- Issues of **analyzer availability** have plagued OLA installations in the past. New designs are **robust, both mechanically and electronically,** and provide coal parameters on an hourly basis.
- The **elimination of coal sampling** by utilizing a through-belt design has improved analyzer availability to near 100%
- Eliminate the sampling system once needed to **feed coal to the analyzer**. These systems have historically been major source of analyzer down-time.
- **Semi-annual servicing** and robust software systems allow operators to see coal variability and be proactive
- Avoid burning blends controlled by **gross samples** of coal, based on laboratory analysis of large lots.
- **Blend** various coals to a single plant specification, or multiple plant specifications, using new analyzer technology.

Combustion Optimization

- Fuel – Lignite, Bituminous, PRB, Blends
- Controls – OSI PI, PLC, Honeywelll, Emerson, ABB, Siemens, Fisher, Analog
- Firing Systems – Wall, Cyclone, Tangential
- Desired optimizations – MW, Steam Temp, Heat Rate
- Holistic Approach – Market timing, ISO, opportunity fuels

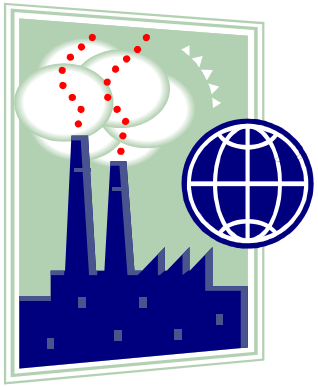
Integrating Online Coal Analysis with Boiler Controls



Unit Operations Using Online Analysis

- Coal blending
- Combustion
- Performance
- Sootblowers
- ESP
- FGD

Needs at the Plant to Meet Higher Level Dynamic Optimization



- **Advanced Knowledge Management**
  - Better coal quality information
  - Feed forward control
  - Reliable emissions monitors
    - Feedback control
    - Balancing compliance with profit
  - Real-time cycling costs information
    - Match dynamic electricity market prices with dynamic plant costs
  - Better direct measurements and sensors
  - Integrating subsystem optimization into plant-wide capabilities
- **Adapting process optimization techniques to portfolio optimization**
  - Strive for cultural change
  - Focus on global, not local optimization

Conclusion

- **Utilities are a growing market for coal analyzers**
  - Improved **efficiency** from existing assets
  - More **consistent output** from aging units
  - Increased **net fuel sales** and mw output
  - Predictable **performance** for real time markets
- **Information and economics needed**
  - Provide a multi-client study to assist **justifications**
  - Provide **estimates** of analyzer installation and maintenance costs
  - Develop a generic OLA/controls interface **specification**
- **Multi-client study is continuing**
  - Two magazine **articles** completed
  - Interim **report** available now
  - **Final report** expected Fall 2006

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