Online Coal Analyzers in the US Utility Industry

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Presentation Outline

- PGNAA principle of operation
- Background
- Common utility applications
- PGNAA Analyzers
  - Two different models
  - Choosing between them
- Getting the most value from the analyzer
  - Software packages
Prompt Gamma Neutron Activation Analysis (PGNAA)

Thermal Neutron → Nucleus → Excited Nucleus → Stable Nucleus → Gamma Ray
Principle of Operation: Thermo Scientific CQM

- **Cf-252 Neutron Source**
- **Fission Gamma Ray Shield**
- **Slider Plates**
- **Neutron Moderator / Reflector**
- **Neutron Shield**
- **NaI Crystal**
- **Photo-multiplier Tube**
Advantages of (PGNAA)
Prompt Gamma Neutron Activation Analysis

- Lowest cost of neutrons
- Lowest radiation while in operation
- Most uniform sensitivity to entire coal cross-section, leading to superior accuracy
- When coal source is known, has best algorithm for calorific value determination
- Best reliability—no chance of failure of ionization source
- Most mature online analysis technology
  - Thermo Fisher alone has sold more than 600 analyzers in the past 25 years
  - Large installed base permits service staff location close to customer
Online elemental coal analyzers have been in use for 25 years
- EPRI was an early sponsor

Analyzers measure
- sulfur
- ash
- moisture
- caloric value
- all major ash constituents

Analyzer use in power plant applications growing
Utilities are becoming a more significant part of the analyzer user population

% of Thermo Scientific Coal Analyzers Sales going to Utilities

- 1998-2000: 0%
- 2001-2003: 43%
- 2004-2006: 43%
- 2007-present: 52%
Most utility analyzers are belt analyzers and are found on bunker feed.

Mix of Thermo Scientific Coal Analyzers sold to Utilities since 2000

- At the mine -- CQM, 14%
- At the mine -- ECA, 8%
- Receipt monitoring -- CQM, 8%
- Receipt monitoring -- ECA, 5%
- Bunker Feed -- CQM, 16%
- Bunker Feed -- ECA, 49%

Full-flow 62%
Sample stream 38%

Bunker feed 65%
Receipt monitoring 13%
At the mine 22%
Accounts for 65% of all Thermo Scientific utility installations since 2000

Process goals include
  • Boiler optimization
  • Emissions compliance
  • Ensuring proper sorting between scrubbed and unscrubbed units

When there are parallel bunker feed conveyors the solution can be
  • Two full-flow analyzers
  • One sample-stream analyzer, fed by two primary samplers
Receipt monitoring application

Constellation Energy’s C. P. Crane plant in Maryland
- Installed full-flow analyzer
  - Monitors all incoming rail shipments as conveyed to yard stockpile
  - Operator Console located in coal yard office

Luoyang Longyu power plant in China
- Use an auger sampler to sample each incoming truck
  - Sample increment sent through sample stream analyzer to determine if truck is on spec
  - Plant saved $375K in six months
Two Types of PGNAA Elemental Analyzers

**Sample stream**
- Typically flow rates of 2-10 tph
- Primary save stream or secondary rejects
- Most accurate analyzer in industry
- Constant analysis geometry

**Full flow**
- Most effective on belt sizes between 30 and 60 inches
- Accuracy best when flow variations are minimal

![Thermo Scientific (formerly Gamma-Metrics) CQM](image1)

![Thermo Scientific ECA](image2)
Choosing between sample stream analyzer (CQM) and full flow analyzer (ECA)

Any one of the following conditions could tip the scales in favor of a sample stream analyzer:

- Stringent accuracy requirements
- Highly variable belt loading
  - Top sizes greater than 4 inches
- Conveyor belt conditions
  - Steel corded belts
  - Belt sizes of 72 inches and greater
- Installation conditions
  - Two parallel belt conveyors, which might be able to share—in a multiplexed manner—a single sample stream analyzer
  - Existing sampling system with which a sample stream analyzer can be easily integrated
Choosing between sample stream analyzer (CQM) and full flow analyzer (ECA)

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If none of these are issues, a full flow analyzer should be sufficient
Full Stream Analyzer Accuracy Compared with Sample Stream Analyzer Accuracy

Sample stream analyzer

Left-to-right sensitivity variance

Varying belt loading

Vertical sensitivity variance

Full flow analyzer

~ 15 -50%
Accuracy comparison: sample stream vs. full flow

Arch Mountain Laurel CQM: Lab vs. Analyzer Ash
Comparison
August 2007

RMSD = 0.46%
Standard Error of the Estimate = 0.35%

Arch Mountain Laurel ECA: Lab vs. Analyzer Comparison
August 2007

RMSD = 0.51%
Standard Error of the Estimate = 0.44%

When flow is consistent and belt is fully loaded, the accuracy difference is slight; in this example

- 20% worse Standard Error of the Estimate
The critical importance of analyzer and reference system accuracy

Seemingly modest differences in accuracy can lead to huge profit differences

- Assume
  - 5 mtpy clean coal burned
  - $10/ton cost differential
    - 0.6% sulfur
    - 1.8% sulfur

- Annual savings associated with 0.03% RMSD rather than 0.04% = $833,000
The analyzer value pyramid

Choose the right analyzer

Install it in the best location, with a sampling system located on the same process stream.

Do a thorough calibration during commissioning.

Regular lab vs. analyzer calibrations to ensure optimal calibration.

Proper selection of set point based upon actual performance.
The analyzer value pyramid

Choose the right location to install

Choose the right analyzer
The analyzer value pyramid

- Calibrate thoroughly during commissioning
- Choose the right location to install
- Choose the right analyzer

Proper selection of set point based upon actual performance.

Regular lab vs. analyzer calibrations to ensure optimal calibration.
The analyzer value pyramid

- Choose the right analyzer
- Choose the right location to install
- Calibrate thoroughly during commissioning
- Check calibration regularly

Proper selection of set point based upon actual performance
The analyzer value pyramid

1. Choose the right analyzer
2. Choose the right location to install
3. Calibrate thoroughly during commissioning
4. Check calibration regularly
5. Use Applications Software for added value
Utility Applications Software

- COBOS Automated Blending from Thermo Scientific
- Coal yard Quality and Silo Tracking from the Engineering Consulting Group
- Boiler optimization and profit maximization from Black & Veatch
COBOS from Thermo Fisher

- Up to six sources
- Up to three control parameters
- Cost minimization algorithm subject to achieving min’s & max’s on control variables
- Batch or continuous, with adjustable recovery rate from deviations
- Feeder constraints
- Adjusts for varying delays from feeders
- Auto adjustment in analyzer assumptions (e.g., MAF Btu) based upon feed proportions
ECG’s AccuTrack Objectives

- Fuel Tracking Objectives:
  - Track incoming coal tons and fuel spec from Mine to Yard to Bunker to Burner
  - Forecast Blending to meet Operational and Economic Objectives
  - Track Chemistry to Avoid Boiler Upsets while Maintaining Consistent Emissions
  - Provide Operators with Early Warning Advisory Information
AccuTrack Operator Advisory Screen

When?

What?
• Holistic view
• Takes market conditions into account
• Overall goal is profit maximization
• Model is dynamic, learning from actual effects of different coal qualities
Questions and Comments