Monitoring Co-firing and Oxycoal Burners using Optical Sensors

Steve Wilcox
Overview

• Monitoring burners co-firing biomass
  – RFCS Project ‘Smartburn’
  – Short project overview, experiments, results & conclusions

• Monitoring oxycoal burners
  – FP7 Project ‘RELCOM’
  – Short project overview, experiments, results & conclusions
Monitoring & Control of Utility Boilers Co-Firing Biomass

- Novel Monitoring, Control and Optimisation for Utility Boilers Co-Firing Biomass

- Gas Natural Fenosa, Indra Systems, Institute of Power Engineering, University of Zaragoza & University of Glamorgan

- 2.4M€ EU Research Fund for Coal and Steel Project – July 2008 to June 2011
## Preliminary Data Gathering

### Experimental Apparatus

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Responsive Wavelength</th>
<th>Peak sensitivity</th>
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<tbody>
<tr>
<td>Ultra Violet</td>
<td>190 to 570nm</td>
<td>440nm</td>
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<tr>
<td>Visible Light</td>
<td>320 to 1000nm</td>
<td>720nm</td>
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<tr>
<td>Infrared</td>
<td>900 to 1700nm</td>
<td>1550nm</td>
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</table>
Full-Scale Burner Monitoring Locations
Self Organising Maps

NOx/CO/Airflow
Normal

NOx/CO/Airflow
too High

NOx/CO/Airflow
too Low

IR, UV, Visible Photodiode
Wigner-Ville Processed Signals
Monitoring & Controlling Two Co-Firing Burners (10% Biomass)
Summary Results

• Demonstrated burner control over wide range of conditions at 500kW
• Successfully controlled two 5MW co-firing burners on the Dolna Oldra Power Station
• Detected burner instabilities
Reliable and Efficient Combustion of Oxygen/Coal/Recycled Flue Gas Mixtures

- RELCOM is undertaking a systematic and focused series of applied research, development and demonstration activities involving both experimental studies and combustion modelling work to enable full-scale early demonstration oxyfuel plant to be designed and specified with greater confidence as well as providing improved assessment of the commercial risks and opportunities.

- 9.76M€ EU FP7 Project – December 2011 to 2015

- University of Glamorgan
  - Zone modelling
  - Burner monitoring
## Consortium

<table>
<thead>
<tr>
<th>University of Glamorgan – Coordinator (UK)</th>
<th>Abo Akademi (Finland)</th>
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</thead>
<tbody>
<tr>
<td>E.On New Build &amp; Technology Ltd. (UK)</td>
<td>Electrique de France S.A. (France)</td>
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<td></td>
<td>Technische Universitaet Muenchen (Germany)</td>
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<tr>
<td>Enel Ingegneria e Innovazione SpA (ITALY)</td>
<td>University of Leeds (UK)</td>
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<tr>
<td>Instytut Energetyki (Poland)</td>
<td>Katholieke Universiteit Leuven (Belgium)</td>
</tr>
<tr>
<td>International Flame Research Foundation (ITALY)</td>
<td>Universitaet Stuttgart (Germany)</td>
</tr>
<tr>
<td>Fundación Ciudad de la Energía (SPAIN)</td>
<td>Doosan Power Systems Ltd. (UK)</td>
</tr>
<tr>
<td>Third Party: Adinex (Belgium)</td>
<td>Third Party: E.On New Build &amp; Technology GmbH (Germany)</td>
</tr>
</tbody>
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Sensor placement

Burner 1
Burner Separation 500mm
Burner 2
Burner Interaction Experiments

- Burner separation distance [50cm, 100cm]
- Air mode experiments for reference
  - $\lambda = 1.05, 1.15, 1.4$
- Oxycoal mode experiments
  - $\lambda = 1.05, 1.15, 1.4$
  - Flue gas recirculation rates; 50%, 60% & 67%
Visible Flame Emissions
Burner Separation 50cm, Recycle Rate 50%

\[ \lambda = 1.4 \]
UV Flame Emissions
Burner Separation 100cm, $\lambda = 1.15$

FGR = 67%
Summary Results

• Trends observed for all sensors, and for both burner separation distances
  – Increase in $\lambda$ – increase in signal strength
  – Increase in the Flue Gas Recirculation rate – decrease in signal strength
• No detectable burner interaction traits seen
Final Summary

• Use of low cost photodiodes, through suitable signal processing, enables;
  – Monitoring of flame condition
    • Coal, Coal/Biomass, Oxy, Gas
  – Control of some characteristics
    • NOx & CO
  – Detection of burner instabilities
  – Could be integrated into boiler control system