Safely Reducing Greenhouse Gas Emissions from Sulphur Recovery Unit Incinerators in Alberta
WE NEED TO SAY STOP

GLOBAL WARMING ALARM!

The average temperature of Earth's atmosphere and oceans started to rise too fast. The scientists say that deforestation and urbanization are leading to the melting of polar ice caps, which are essential to the world's water supply.

DISASTER!

Economic Growth
Canada is the world's 5th largest producer of natural gas.
Alberta Sour Gas Statistics

≈250
Number of sour gas processing plants

>50
Larger facilities that produce elemental sulphur

20%
Total Fuel Consumption from Upstream Oil & Gas
Total Reduced Sulphur (TRS)

\[
\text{H}_2\text{S} + \text{COS} + \text{CS}_2 \rightarrow \text{SO}_2
\]

400 – 500 °C
Greenhouse Gas Emissions ≈ 25% Total Facility Fuel Consumption

CO₂

500 – 600 °C
Why Does This Matter?

We Can Reduce GHG Emissions and Operating Costs
Simulated Annual Savings From Stack Top Temperature Reduction

Fuel Savings \([60(10)^3 \text{m}^3/\text{day} \ @ \ $1.75/\text{GJ}]\)
Simulated Annual Savings From Stack Top Temperature Reduction

- **Fuel Savings** \([60(10)^3 \text{m}^3/\text{day} @ \$1.75/\text{GJ}]\)
- **GHG Savings** \([\$30/\text{t}]\)
Simulated Annual Savings From Stack Top Temperature Reduction

- **+$ (CAD)$ (Stack Top Temperature Reduction (°C))
- **$\text{Total Estimated Savings}$
- **$\text{Fuel Savings} [60(10)^3 \text{m}^3/\text{day } @ \$1.75/\text{GJ}]$
- **$\text{GHG Savings} [\$30/\text{t}]$
What is the trade-off to reducing stack temperature?

- Loss of thermal energy needed to ensure that the stack plume rises in the atmosphere.
- Loss of thermal conversion efficiency in the stack.
How do we lower stack temperature safely?

- We need an accurate measurement method to ensure TRS emissions do not exceed the compliance limits which were set to safeguard human health and the environment.
Project Objectives

DEVELOP
Measure accurately and continuously the total reduced sulphur compounds being emitted from a high temperature SRU incinerator stack.

FACILITATE
Aid in the AER license amendment process to permit a stack top temperature limit reduction within the SRU incinerator stack.

ACHIEVE
Obtain a minimum greenhouse gas reduction of approximately 4,850 tonnes of CO$_2$e per year by lowering the incineration temperature.
Continuous Measurement Challenges

Flow
Incinerator
Stack
Extraction
Probe
Filtration &
Conditioning
Sample
Transport
Analyzer (s)
TRS Sampling System Challenges

Flow
Incinerator
Stack

TRS => SO₂

SO₂ => SO₂
H₂S => SO₂
COS => SO₂
CS₂ => SO₂

TRS

Controlled

Analyzer (s)
**TRS Analysis Challenges**

**Sample Transport**

**Analyzer (s)**

- **SO₂ Analyzer**
- **SO₂ Scrubber**
- **Oxidizer**
- **SO₂ Analyzer (Modified)**
- **SO₂ Analyzer**

**Total TRS**  -  **CS₂**  -  **H₂S**  = **COS**
Real World Application: The 3 Phase Approach

- Modelling
- Field Study
- Certification of TRS CEMS Technology
Technology Pilot Project
SemCAMS Kaybob South 3

- 2nd Largest Gas Plant in Alberta
- Max Sulphur Inlet: 1999 t/d
- Minimum Stack Top Temperature Limit: 400ºC
## SemCAMS K3 Field Study Results

<table>
<thead>
<tr>
<th></th>
<th>Average Normal Operating Conditions (prior to testing)</th>
<th>Optimization Results</th>
<th>Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stack Exit Temperature (°C)</td>
<td>420</td>
<td>335</td>
<td>(85)</td>
</tr>
<tr>
<td>%Oxygen</td>
<td>8.0</td>
<td>4.7</td>
<td>(3.3)</td>
</tr>
<tr>
<td>Fuel Gas Consumption (1000m³/d)</td>
<td>60</td>
<td>20</td>
<td>(40)</td>
</tr>
<tr>
<td>TRS (ppmV)</td>
<td>35 (±20)</td>
<td>45</td>
<td>10</td>
</tr>
</tbody>
</table>
$1,522,000  
estimated annual savings from fuel & GHG reduction

12,250,000  
m³/year reduction in sales gas fuel used

24,256  
tonnes of CO₂e reduction per year
5273
Passenger vehicles off the road
Certification of TRS CEMS

There are many factors that affect the ability to draw a Relative Accuracy comparison [manual method vs CEMS]

- Differences in the sample extraction techniques
- Time-to-analysis
- Time of travel in the stack
- Stratification of gas within the stack
- Sample integration times
Certification of TRS CEMS

- Most challenging part of project
- Took several attempts and investigations to successfully pass current provincial standards
- Sample degradation in reference method problematic
Conclusion

◉ Reducing stack temperatures in order to conserve fuel and lower greenhouse gas emissions is a viable way to reduce emissions within Alberta.

◉ An accurate method to measure TRS has been developed and proven within the regulatory framework in Alberta.

◉ Accurate methods, such as the TRS CEMS, are needed to ensure the TRS compounds do not exceed the compliance limits which were set to safeguard human health and the environment.

Next Steps

◉ Further testing using a mobile platform that will be used as a tool to quantify emissions, validate incinerator performance, and optimize Sulphur Recovery Unit performance.
Thanks!

Any questions?

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