Waste Gas Incineration

Technology serving Industry and Community

Successful partnerships
ALBERTA

Directive 60.
Low heat content gases
- If flared then heat content needs to be at 20 MJ/m³
- If incinerated the stack top temperature must be at least 600°C. No minimum fuel requirements.

Directive 39
Benzene emissions from Dehydrators limited to one tonne/yr effective January 1, 2007.

BC.
- Post operation review to determine if actual performance met the criteria submitted in application. Clean air act
“We used Questor because of the quality of the units. They’re the most effective with almost 100 per cent efficiency in burning all the gas off. It’s a proven unit,” said Seredynski.

In late October 2004, Nexen Canada Ltd. moved a service rig on to its sour gas wellsite facility, located on the east side of 84 Street NE just north of 16 Avenue NE, to complete maintenance on the well.

Nexen had suspended and isolated the wellsite in October 2003 following a routine inspection that identified a maintenance requirement. The workover entailed inspecting the casing, running new production tubing and sub-surface safety landing nipple and valve to ensure the continued safe operation of
CORPORATE PROFILE

- Environmental technology company specializing in the custom design, manufacturing and installation of high efficiency waste gas incineration systems
- Calgary based public company
- Listed since 1998 on the TSX venture exchange (QST)
- Technology applicable to the oil and gas industry, landfills, agriculture, waste water treatment, tire recycling plant
- US and Canadian patent
OUR CLIENTS

- Altagas
- Anadarko
- Atco Pipelines
- BP Amoco
- Bonavista
- Calpine
- Canadian Forest
- Canadian Natural
- Compton
- Cougar/Starpoint
- CrossAlta
- Cypress/Progress
- Crest/Ketch
- Devon
- Duke
- Duvernay
- Dominion
- Edge
- EnCana
- Enerchem
- Enermark
- ENI
- Exxon/Mobil
- Hunt Oil
- Husky
- Lockwood
- Mustang
- Navigo
- Nexen
- Nuvista
- Paramount
- PetroCanada
- PetroReef
- Purcell Energy
- Pogo
- Quintana
- Rider
- Samson
- Schlumberger
- Sherritt Int.
- Talisman
- TransCanada Pipelines
- Ultima/Trioco
- Vaquero
- Velvet
QUESTOR PRODUCTS

- Permanent Incinerators (design, manufacture, service)
- Portable, self-contained Incinerators
- Field Burner Service
- Fuel Trains & Customized Burner Control Systems
- Produced Water Evaporation Systems
- Heat Recovery Systems (process glycol, steam, electricity)
<table>
<thead>
<tr>
<th>Unit No.</th>
<th>Company</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>3020-0352</td>
<td>Cypress Energy Inc.</td>
<td>Atlanta, GA 30303</td>
</tr>
<tr>
<td>3020-0353</td>
<td>Cenovus Energy Inc.</td>
<td>Calgary, AB T2E 7X1</td>
</tr>
<tr>
<td>3020-0354</td>
<td>Apache Canada Resources Corp.</td>
<td>Calgary, AB T2E 7X1</td>
</tr>
<tr>
<td>3020-0355</td>
<td>Enbridge Energy Ltd.</td>
<td>Calgary, AB T2E 7X1</td>
</tr>
<tr>
<td>3020-0356</td>
<td>TransCanada Energy Ltd.</td>
<td>Calgary, AB T2E 7X1</td>
</tr>
<tr>
<td>3020-0357</td>
<td>Enbridge Energy Inc.</td>
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</tr>
<tr>
<td>3020-0358</td>
<td>Cenovus Energy Inc.</td>
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</tr>
<tr>
<td>3020-0359</td>
<td>Apache Canada Resources Corp.</td>
<td>Calgary, AB T2E 7X1</td>
</tr>
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</table>

**PERMANENT FACILITIES**
# WELL TESTS - Since Fall 2004

<table>
<thead>
<tr>
<th>WELL TESTS - Since Fall 2004</th>
<th>Location</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tests 1, 2, 3, 4, 5, 6, 7, 8, 9</td>
<td>Test Well</td>
<td>Year</td>
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<td>Year</td>
</tr>
</tbody>
</table>

**Source:**

**Notes:**
- WELL TESTS - Since Fall 2004 includes data from various tests conducted since Fall 2004.
- The data is presented in a tabular format with columns for the test number, location, and year.
- The tests are numbered from 1 to 9.
- The location is general and does not specify a specific geographic location.
- The year column indicates the year the tests were conducted.
WHAT IS INCINERATION?

• Controlled combustion of waste gases in an enclosed combustion chamber with:

✓ control temperature and air intake
✓ pre-mixed air and fuel,
✓ specific retention time, and
✓ an ignition source,
✓ Measured combustion efficiency of 99.99%
✓ Effective dispersion of the combustion products

*Temperature, velocity and stack height*
FLARING

- Difficult to measure efficiency and varies from site to site
- Heavily influenced by crosswinds allowing gases to escape unburned
- Difficulty burning rich gases often producing soot deposits and black smoke (BTEX, VOC, PAH)
- Entrained liquid droplets decrease combustion efficiency
- Visible flame

**Based on ARC and U of A Findings:**

INCINERATION

- Measured independently at 99.99% consistently
- Combustion occurs in a closed chamber unaffected by winds
- High temperatures efficiently burn rich gas. Air pre-mixed with the waste gas prior to combustion
- Not affected by liquid droplet size
- No visible flame
COMBUSTION OF HYDROCARBONS

99.99% combustion requires the right mix of air and fuel

\[ \text{CH}_4 + 2 \text{O}_2 = \text{heat} + \text{CO}_2 + 2 \text{H}_2\text{O} \]

Methane + Oxygen = heat + Carbon Dioxide + Water

Poor combustion results in the creation of:

- Unburned hydrocarbons
- Carbon monoxide
- Volatile organic hydrocarbons or VOC’s (benzene, styrene, toluene, xylenes etc.)
- Sulphur compounds besides SO\(_2\) (H\(_2\)S, carbonyl sulfide, carbon disulfides, mercaptans)
- + over 250 other compounds identified in the research
The Global Warming Potential (GWP) of methane is 21 times higher than that of CO₂ and therefore inefficient combustion increases the greenhouse gases emitted.

For example: 19 mscf/d of waste methane gas generates these daily CO₂ emissions:

<table>
<thead>
<tr>
<th></th>
<th>T/d</th>
<th>T/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vented</td>
<td>7.6</td>
<td>2,775</td>
</tr>
<tr>
<td>65% combustion efficiency</td>
<td>3.3</td>
<td>1,205</td>
</tr>
<tr>
<td>80% combustion efficiency</td>
<td>2.3</td>
<td>840</td>
</tr>
<tr>
<td>Incineration (99.99%)</td>
<td>1.0</td>
<td>365</td>
</tr>
</tbody>
</table>

*Incineration converts 99.99% of the methane to CO₂ and H₂O*
In both pilot tests Questor technology’s portable incinerator was used. In each case approximately 75 per cent of the remaining gas was incinerated. Questor incinerators use a vortex combustion system to achieve 99 per cent combustion efficiency.

<table>
<thead>
<tr>
<th>Each Incineration:</th>
<th>Methane Incineration for both tests was equivalent to:</th>
<th>GHG Emission Comparison with and without Incineration after Transfer Compression</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Reduced emissions by approximately 1100 tonnes of carbon dioxide equivalent</td>
<td>• Taking 209 cars off the highway</td>
<td></td>
</tr>
<tr>
<td>• Produced approximately 212 tonnes of carbon dioxide emissions from combustion</td>
<td>• Heating 10 homes for one year</td>
<td></td>
</tr>
<tr>
<td>• Incinerated approximately 2.93 million cubic feet of gas</td>
<td>• Planting 1,337 lodge pine trees</td>
<td></td>
</tr>
<tr>
<td>• Approximately 3.11 million cubic feet of gas remained in the lines after transfer compression</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
How it Works

• Proprietary gas burner control creates a high velocity vortex

• Air is naturally drawn in

• Air and fuel premixed

• Refractory lined chamber
  – 1200°C stack top temperature

• Optimal SO² dispersion with velocity, temperature, and “effective height”
Technology Assessment

Shell Canada / EUB and CAPP test in January 2000

- Tested at 2 rates - 2.5 and 4.8 MMscf/d
- Sour gas (11% H₂S)
- Questor 5MMscf/d incinerator - 40 ft stack

Results:

- 99.99% combustion efficiency - at both rates
- Plume rise of over 250 meters
  - comparable to a 110 ft flare stack
  - assuming flare stack efficiency 98%
- Naturally aspirated with up to 100% excess air
- No ground level violations of SO₂ or H₂S

This test was the basis for the new EUB template

Also independently tested and verified by Exxon/Mobil, Vaquero, Dominion Exploration and TransCanada Pipelines
Each System is Custom-Engineered
FEATURES

• Dependable and simple to operate
• Live pilots with constant spark igniters
• Stack top temperature monitoring
• Continuous Stack Emission Monitoring (CSEM)
• Reliable burner control system with backup
• Customize to fit site operating practices
• Fuel train CSA B149.3 compliant
• Fiber refractory – Light and thermal shock resistant
• Air intake flash arrested for closer spacing – enclosed burner
Why Consider Incineration as a Solution

- Incineration technology is an improvement over existing flaring:
  1. Uses 80% less fuel than a flare to achieve efficient combustion of low heat content gases
  2. Single incinerator processes variable pressure waste gas streams concurrently
  3. More efficient combustion – 99.99% - improves air quality and reduces negative health impacts currently observed with flares
  4. Visual impact minimized and smaller lease sizes
  5. Community well-being potentially avoiding costly hearings
ACID GAS DESTRUCTION

- 20% H₂S / 60% CO₂
- 80% less fuel than a flare.
- Reduced fuel usage from 1410 m³/d to 290 m³/d (50 to 10 mcf/d)
- Payout in 4 months
- Reduced greenhouse gas emissions
- Thank you from the land owner
I live one kilometer downwind of a natural gas plant owned by Compton Petroleum. When this company wanted to expand their operations and applied for a permit to incinerate sour gas I was concerned about air quality and bad smells that may result. Now after several months of operations, I can say that I have never detected any smells from the plant from where I live.

To Whom It May Concern:

I live one kilometer downwind of a natural gas plant owned by Compton Petroleum. When this company wanted to expand their operations and applied for a permit to incinerate sour gas I was concerned about air quality and bad smells that may result. Now after several months of operations, I can say that I have never detected any smells from the plant from where I live.

The noise level coming from the plant is such that I can hear it while outside at night if I listen for it, but it is not at a level that would bother anything. I am unable to hear the plant while in the house. The noise might be comparable to that of a large farm tractor working the same distance away—e.g., one kilometer.

Compton is monitoring air quality.

Thank you,

Nelson Ferris
Hines Creek, Alberta
Incineration contributes to clean air strategy

As Compton Petroleum Corporation learned in the Peace River country, incineration can also be an excellent alternative solution to landowner concerns.

When rancher Nelson Ferris learned of Compton's plans to burn sour gas, he objected strongly. But air monitoring showed him that the few emissions from the Questor incinerator were well below provincial guidelines. There was also little noise and no light.

Now Ferris says, “If I had it to do over again, I wouldn’t object to Compton’s application at all.”
ACID GAS PLANT
80 ft incinerator combusting 65% H2S

Questor Technologies Inc.
Canadian Permanent Facility
Incinerator - Q50
Customer: Grimes Energy
Phone: +1 403 539-4370
www.questortech.com
QTI AT GAS PLANT

- QTI Q5000 Incinerator (225 MMBtu / hr)
- 12' OD x 60' tall
- Tail Gas Destruction
- SO₂ ground level concentration of 383 micrograms per cubic meter
- Fuel gas consumption of 0.5 MMscf/d vs. current 1.3 MMscf/d ($2 MM savings)
- Corresponding reduction of 73,000 CO₂ eq. tonnes per year ($0.5 MM to $1.1 MM) - $7 - $15 per CO₂ eq. tonne basis
- 99.9% destruction efficiency
CASE STUDY: Cabre Kessler Battery

- Incineration of sour produced gas and vapours from production tanks

  ✓ Sour rich solution gas - 60 MJ/m³

  ✓ Smoky flare and odour at site

  ✓ Flow rates between 50 - 950 mscf/d. **20 to 1 turndown**

  ✓ Single incinerator processing multiple variable rates at low and high pressure gas

Cabre/Enermark site
Q500 Incinerator Unit
TANK VAPOUR RECOVERY

- Passive continuous vapour recovery with incineration
- Low capital cost ~ 50% of traditional VRU
- Low operating cost
- Reliable simple system; no moving parts
- Ability to incorporate other waste streams
  - Treater gas, dehydrator or amine vapours
Dominion Exploration Canada
Acid Gas Pipeline Blowdown

- 2.1 km, 3” pipeline with 75% H₂S gas and 25% CO₂
- Transporting 1.5 MMscf/d at 1200 psig
- Blowdown to a Q5000 incinerator in < 15 minutes
- Meets dispersion and company safety requirements
- Monitored air emissions up to 8 km away with no detection of H₂S or SO₂
- Short stack 40ft, so it minimized the lease size
West Stoddart -75% H2S and 25% CO2
Dominion Exploration - West Stoddart

- Multi-stakeholder project - Dominion, OGC, QTI, Forestry, Public, Williams, Environment.

- Public and major highway were within emergency planning zone.

- The continued safe processing of the acid gas and environmental compliance were the top priorities.

- Project solution customized to fit operating requirements.

- Small footprint, minimized clearing of trees.
Trailer Mounted Q3000 Rental Unit
CUSTOMER BENEFITS

- Can meet tougher Environmental Regulations
  - measured combustion efficiency in excess of 99.9%

- Air quality improvement and Greenhouse gas reduction

- No odor, soot, smoke or visible flame

- Builds strong community relationships

- Low Capital & Installed Cost

- Significant reduction in fuel and operating costs

- Reliable and Easy to Operate

- Reduced footprint