Profitable Use of Vented Emissions in Oil & Gas Production

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Thanks goes to the **C**limate **C**hange and **E**missions **M**anagement **C**orporation (CCEMC) for financial support

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Profitable Use of Vented Emissions in Oil & Gas Production

Replacement of Natural Gas Engine Fuel with Vented Hydro-Carbon Gases Using SlipStream®

Part 1 – SlipStream® Technology and Field Results

Howard Malm REM Technology Inc.

Part 2 – Experience and Results with SlipStream

Andrea Lamond Encana

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SlipStream® Technology and Field Results

Outline – Part 1

1. Vent Gas Sources

2. Benefits of Combusting Vented Gas in Engines

3. SlipStream Technology

4. Results

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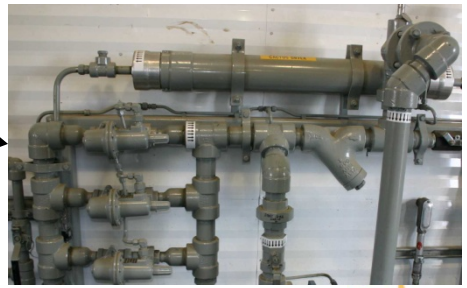
SlipStream® Technology and Field Results

Vent Gas Sources

Instrument gas

- **Actuators – valves, regulators**
  - **Variable**
- **Transducers**
  - **Variable**
- **Pumps**
  - **Pulsed; on/off**
- **Membrane driers**
  - **Steady**



Typical total system (engine-compressor unit) vents **4 to 30 m^3/h (140 to 1000 scf/h)**

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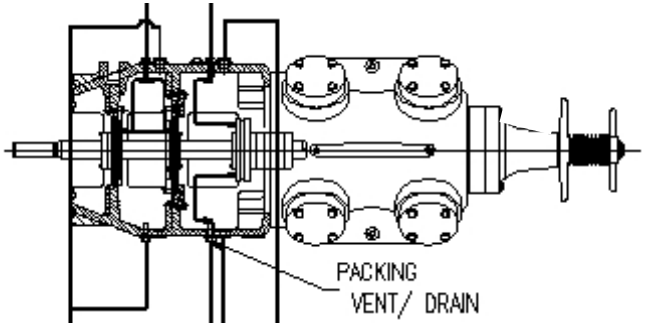
Vent Gas Sources

- **Compressor packing**
  - ReCip packing glands
  - Steady
  - Mixed with lubrication oil



0.8 to 4.2 m^3/h (29 to 147 scf/h) 4 cylinders

- **Liquid storage tanks**
  - Oil storage
  - Scrubber dump collection
  - Separator dump collection
    - Highly Variable (heating/cooling effects)

0 to 20 m^3/h (0 to 700 scf/h)

- **Other**
  - Dehydrators
  - Centrifugal compressor wet seals

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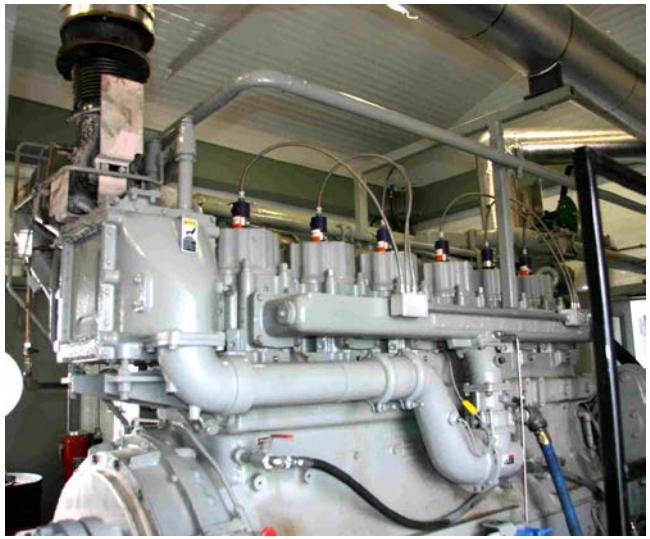
Benefits of combusting vented gas in natural gas engines

- **Fuel replacement**
  - One typical 1000 HP (750 kW) engine uses ≈180 kg/h (260 m^3/h) of NG fuel
  - Vented gas available from 4 to 30 m^3/h
    - At $3.50/GJ the value = $4300 to $32,000 /y



- **Methane destruction; GHG reduction**
  - Typical methane % = 95%
    - At $15/t, the value = $7900 to $52,000 /y
- **VOC destruction**
  - > 99%
- **BTEX destruction**
  - > 99%

Annual Fuel saving + Carbon credits = $12,200 to $84,000

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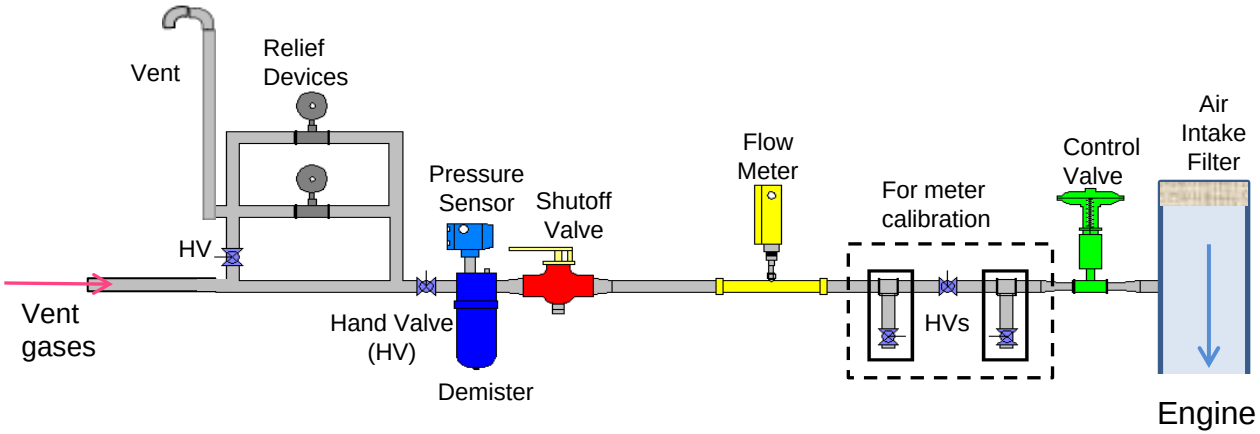
SlipStream® Technology

- Can use multiple vent sources
- Does not require gas compression
- Measures vent gas flows and provides totals
- Can provide up to 50% of engine fuel needs
- Minimal pressure on vent gas source(s)
- No effects on engine up-time



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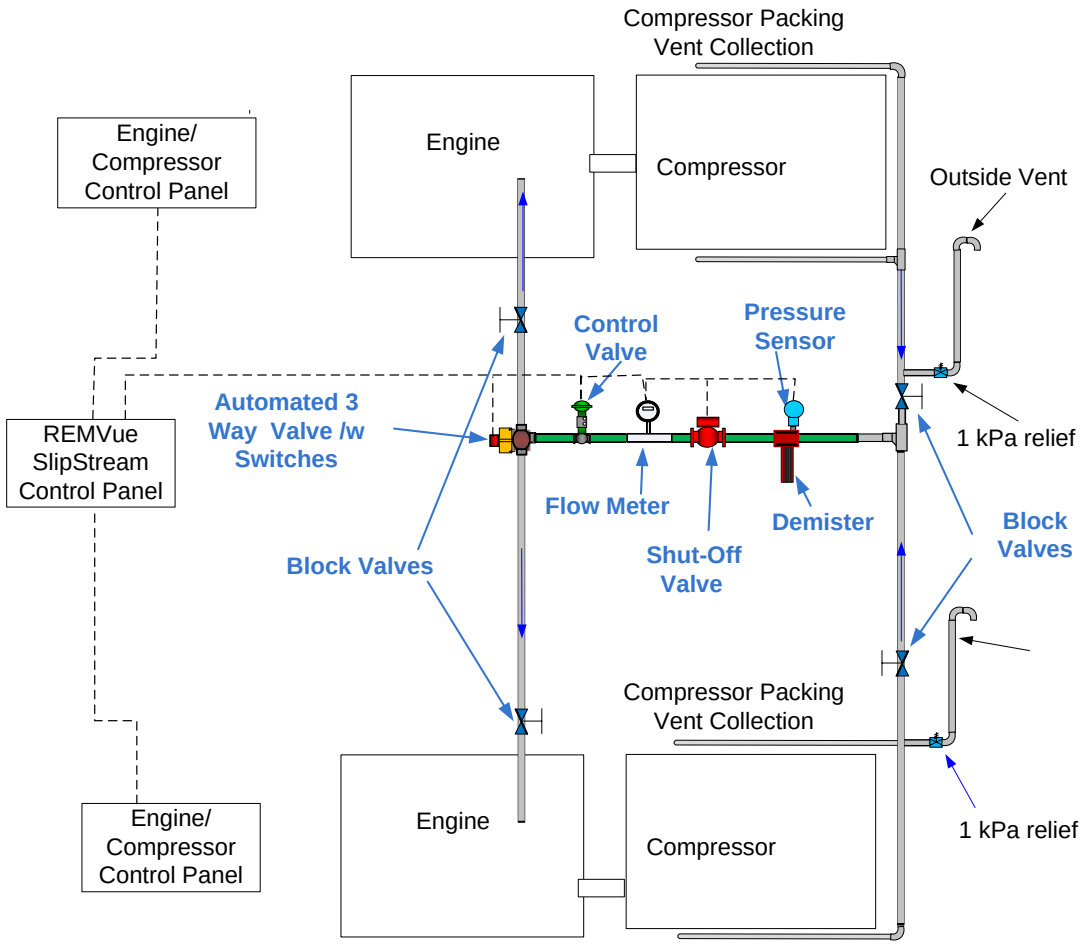
SlipStream® Technology and Field Results

SlipStream® Technology

- **Dual engine arrangement**

  - **Vent gas destruction time increased**

  - **Allows packing vent collection from units pressurized, but not running**



SlipStream® Technology and Field Results

SlipStream® Technology

- **Safe**
  - Has undergone numerous Process Hazards Reviews
- **Reliable**
  - Does not affect engine operation
- **Adaptable**
  - Variable flow
  - Variable gas heat content
- **Needs electronic engine air-fuel control**
  - Stoichiometric – OEM, third party, REMVue
  - Lean – OEM, third party, REMVue
- **Needs minimal engine scavenging**
  - Carbureted engines ideal
  - Not suitable for 2 cycle stroke engines
- **Certain gases are unsuitable**
  - $H_2S < 1\%$

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SlipStream® Technology and Field Results

Results

- **Field results are averages/site for > 60 sites**

Vent Source	Average Flow kg/h	Methane %	CO_2(e)t/h	CO_2(e) t/y	Car-year Equivalent*
Instrument Gas	8.1	95	0.16	1372	275
Compressor Packing	2.7	95	0.05	457	91
Liquids Tank	7.3	30 to 50%	0.06	524	105

*** 1 Car-year ≈ 5 t**

Typically 20 to 40% non-methane, non-ethane volatile organic compounds (VOC)

Totals

Annual Fuel Replacement	CO_2(e) t/y	Car-year Equivalent*
> $500,000	> 55,000	> 11,000

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Results

➢ Value

Vent Source	Average Flow kg/h	Annual fuel replacement	Annual CO_2(e) credits	Total
Instrument Gas	8.1	$12,914	$20,574	**$33,488**
Compressor Packing	2.7	$4,304	$6,857	**$11,161**
Liquids Tank	7.3	$11,715	$7,858	**$19,573**

Fuel Value
= $3.50 / GJ

CO_2(e) credit
= $15 / tonne

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Part 2 – Experience and Results with SlipStream®

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Experience and Results with SlipStream®

Outline – Part 2

1. Introduction to Encana Corporation
2. Regulatory Environment
3. Encana Scope of Operation
4. Expected Benefits of SlipStream®
5. Adopting the Technology
6. Installing and Commissioning
7. Results

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Introduction to Encana Corporation

Leading North American energy producer focused on growing its strong portfolio of resource plays producing natural gas, oil and natural gas liquids

➢ Encana's Environment Policy

- Adopt technically sound, economically practicable measures to mitigate environmental impacts
- Reduce emission intensity and increase energy efficiency of our operations
- Continual improvement of environmental programs

➢ Encana's Environmental Innovation Fund (EIF)

- Internal investments in projects that economically improve environmental performance of our operations
- External venture capital investments in start-up technology companies

To learn more on the EIF go to: http://www.encana.com/environment/innovation-fund/

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Regulatory Environment

- This project was executed in Alberta and partially funded by the Climate Change Emissions Management Corporation (CCEMC) technology fund. The funding helped overcome project hurdle rates and promoted the implementation of this technology.

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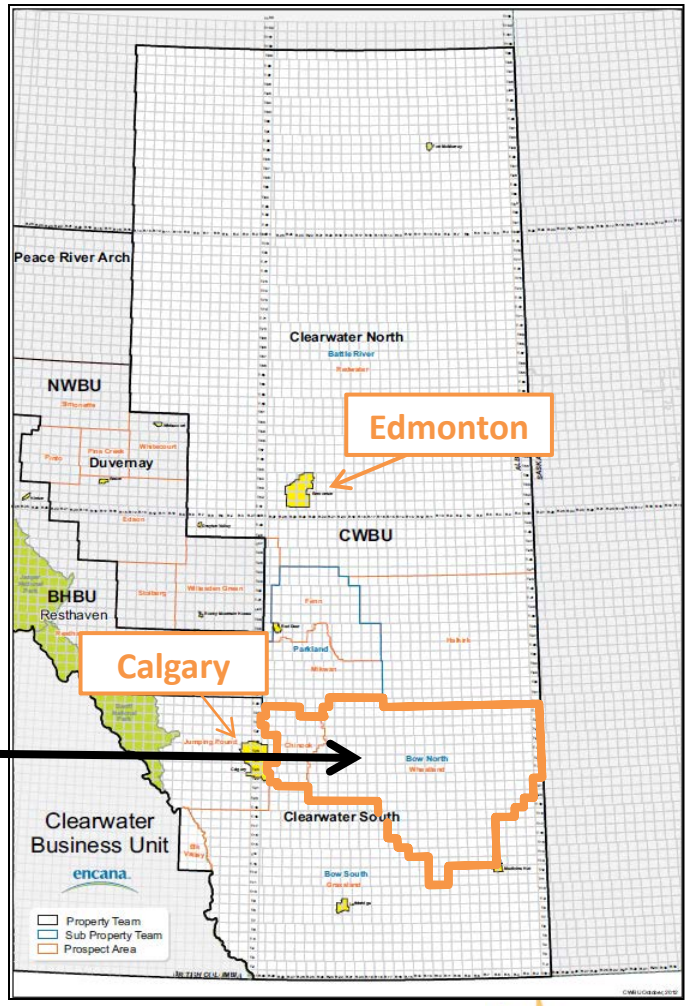
Encana Scope of Operation

- **SlipStream® Vent Gas Capture Project**
  - Climate Change Emissions Management Corporation (CCEMC) grant $2.4 million
    - AB based, not-for-profit organization with mandate to reduce GHG emissions by implementing clean technology
    - CCEMC announces two expressions of interest every year
  - 52 site roll-out across Clearwater Business Unit (Clearwater South)
    - 25 Caterpillar 3512 engines
    - 27 Waukesha H24 engines



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Experience and Results with SlipStream®

Expected Benefits of SlipStream®

Off-grid Sites

- Compressors operated remotely, electricity not available
- Reduce methane (CH_4) venting from pneumatic devices
- Reroute CH_4 to compressor engine to be used as fuel
- Fuel gas savings estimate of $550,000 annually upon full roll-out*

Typical compressor building in the Clearwater Business Unit

*Based on expected AECO 2013 natural gas prices

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Expected Benefits of SlipStream®

Greenhouse Gas (GHG) Objectives

- Capture and combustion achieves direct reduction of GHG emissions

Project eligible to generate GHG credits in Alberta

- Current value ≈ $15/tonne of reduced $CO_2(e)$
- Encana personnel were lead authors for government-approved GHG Quantification Protocol for Vent Gas Capture Projects in 2008-2009

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Experience and Results with SlipStream®

Adopting the Technology

Proof of Economical and Environmental Benefits

- Installed 2 pilots in 2011
- 1 Cat 3512 engine and 1 Waukesha H24 engine

Instrumentation & Programmable Logic Controller (PLC) Modifications

- Embed REMVue logic into existing PLC
- Easier operational maintenance

Hazard and Operability Study (HAZOP) conducted

- Examination of process/operation to identify and evaluate risks
- Proposed outcomes and solutions to mitigate risks

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Experience and Results with SlipStream®

Installing and Commissioning

Valve train had too much pressure drop

- Large amount of back pressure
- Modified valve train piping

SlipStream® valve train redirects previously vented gas into engine's air intake as fuel

Installation process

- First few installs took ≈ 1-2 days
- Later installs, 2 mechanical installations per day

Reliability

- Designed to be reversible
- If SlipStream® fails, back to original venting system
- SCADA system alerts through notification email
- ≈ 48 hours to check issue

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Results

Current projected savings

(based on 17 units commissioned in 2012)

- **1,479 e^3m^3 (52 MMscf) fuel gas annualized**
- **20,378 tonnes (22,476 tons) CO_2(e) emission reductions annualized**

Caterpillar 3512LE - air intake and turbo chargers (rear view)

Estimated savings after full roll-out (2013)

52 units total

- **$550,000 fuel savings per year***
- **67,355 tonnes (74,261 tons) of CO_2(e) reduction per year**
- **$1million in Alberta carbon credits per year / available to offset other Encana Alberta based emissions**

SlipStream® gas injection point to engine

Future plans

- **Install remaining 27 Waukesha H24 units in 2013**

*Based on expected AECO 2013 natural gas prices

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Summary

- The SlipStream® technology is field proven
- Is environmentally beneficial AND is revenue positive ($)
- Meets GHG protocols; destructs VOCs and BTEX
- Is straight-forward to install / commission
- Meets all of the necessary safety and reliability requirements

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