REMVue® Energy Optimization with SlipStream™

Todd Gilbertson
EngineWorx LLC

Gas STAR Program May 6, 2008

REMVue™ Energy Optimization with SlipStream™

Relevant Star Partner Topics

- Efficiency
- Diagnostics
- SlipStream™
  - Using fugitive emissions as fuel
- Challenges

EngineWorx Overview

- EngineWorx — a services company and wholly-owned subsidiary of John H. Carter
  - North American Representative: REM Technology
  - EngineWorx has installed 100+ REMVue® systems in Texas, Louisiana, Florida, Colorado, Alabama, Mississippi and the Gulf of Mexico
  - 7/24 Customer Service
- John H. Carter Co., Inc. established in 1933
  - Emerson Representative for US Gulf Coast
    - DCS systems
    - Asset Optimization and Management
  - 250 Employee Owners
  - Support Offices: New Orleans, Baton Rouge, Lafayette, Lake Charles, Monroe and Mobile

REMVue™ Energy Optimization with SlipStream™

REM Technology

- REM Technology Inc. provides technology solutions for engines and compressors
- Parent Company is Spartan Controls of Calgary, AB. Forty-five years in business and 600 employee owners.
- Focused on technology development applied to recips for better efficiency, reliability and emissions (regulated and GHG)
- **REMVue®** solutions reside in an integrated Engine/Compressor Control Platform with:
  - **Combustion Management**
    - Rich to Lean Conversions
    - Lean Burn
    - Stoichiometric with Catalyst
    - Low Horsepower - LHP
  - Safety Shutdown
  - Process/Unit Control
  - Diagnostics
    - Key Asset Performance and Health Indicators
  - **Advanced Applications – SlipStream™**

Let's begin with the end in mind.

REMVue™ Energy Optimization with SlipStream™

Fuel Savings and Emission Reductions

- **REMVue® R-L conversion** **260mcfd – 20% =** **52 mcfd**
- **Slipstream (Up to 50% of Fuel)** **50 mcfd**
  - Vented Gases from Instrumentation: 5-10 mcfd 5 mcfd
  - Compressor Packing Leaks: 5-15 mcfd 10 mcfd
  - Flares and LP, Blanketed Vessels: 10-104 mcfd 35 mcfd
    - Pipeline Pump Surge Tanks, Dehydration Units, Wemco's, Chem-Electrics, Etc.
- **Total Fuel Savings** **= *102 mcfd***
- **Total GHG Reductions** **= *12,000 tonnes/yr CO2(e)***

RESULTS

- **Fuel Savings**
  - **102 mcfd at 97% runtime**
  - **36 mmbtu/year at $8/mbtu**
  - **$289,000 revenue/year (much more if used for Gas Lift)**
- **Green House Gas Reduction**
  - **12,000 t/yr CO2(e) for offset or trade**
  - **Potential trading values of $5 - $15 per tonne**
  - **$120,000 year at $5/t**

REMVue™ Energy Optimization with SlipStream™

Ideal Installations

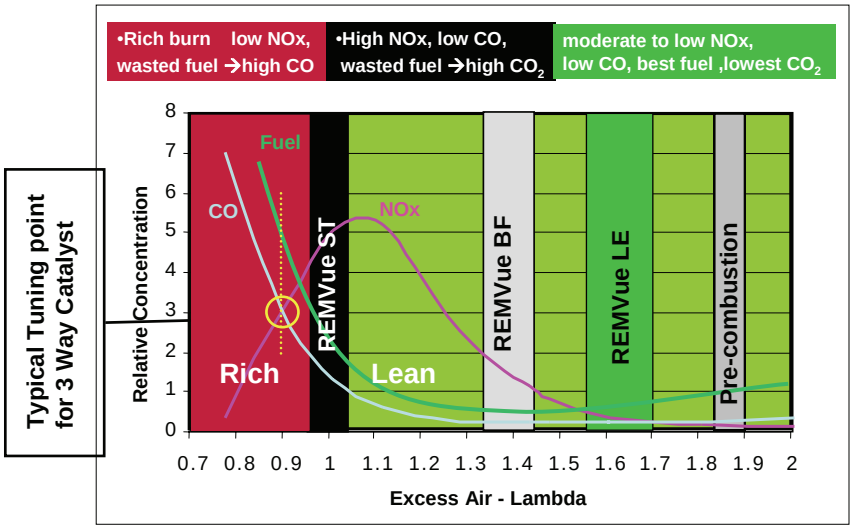
- Highspeed, Turbocharged Engine such as a Waukesha 7042GSI
- Running at Stoichiometric – i.e. Rich Burning
- Located on a structure with pipeline pumps, oil and/or gas dehydration, water treatment, a flare or with other sources of vented gases and fugitive emissions

Relevant Star Partner Topics

- Efficiency
  - Combustion Management
    - Rich to Lean Engine Conversion
    - Improving thermal efficiency
  - Compressor Capacity Control
  - Unit Cooling Control
- Diagnostics
  - Key Asset Performance and Health Indicators
  - Unit Efficiency “Gas Mileage”
  - Compressor Leaks
- SlipStream™
  - Using fugitive emissions as fuel
- Challenges

REMVue™ Energy Optimization with SlipStream™

AFR - Operating Zones



Adaptive Control

Operation in these zones is enabled by robust, adaptive control of the engine.

- Integrated AFR, Governor and Emissions Control
- Automatic Real-Time Compensation for:
  - Ambient Air Temperature
  - Load changes
  - Fuel BTU changes
  - Intercooler and Turbo performance degradation
- Multiple Adjustable Curves for Dynamic Adaptive Control
- Ignition Control and Integration
  - Advance or Retard ignition as conditions allow to maximize efficiency and minimize risk of detonation

REMVue™ Energy Optimization with SlipStream™

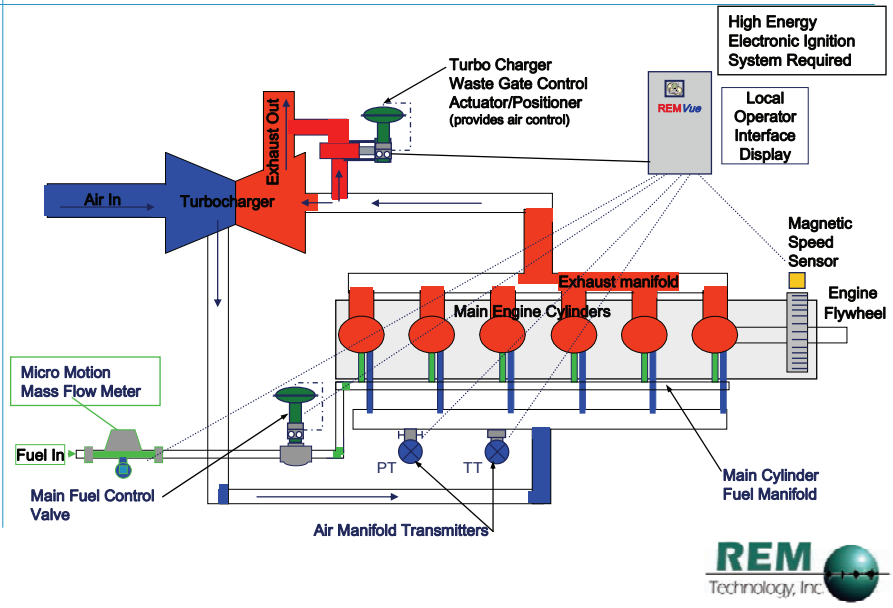
REMVue - Rich to Lean Conversion*

- Provides improved thermal efficiency
  - Less unburned fuel, less CO emissions
  - Less heat loss from burned gases
  - No 3-way exhaust catalyst requiring energy
- Reduces fuel consumption
- Reduces greenhouse gases
  - Less fuel used
  - Less methane in exhaust gases
- Meets regulated offshore emission requirements
- Reliability improvement
  - Lower temperature operation i.e. lower peak burn temperatures and pressures
  - Tighter, more stable engine control
  - Lower occurrence of detonation
  - Significant reduction in head failures
- Improves engines "range" of operation (available horsepower)
- Verified by third party study – Accurata/PTAC
  - http://www.ptac.org/eet/dl/eetf0501p06.pdf

•A high fraction of existing NG engines in the oil and gas industry are "rich burn".

PTAC – Petroleum Technology Alliance Canada

Typical REM*Vue* Modifications



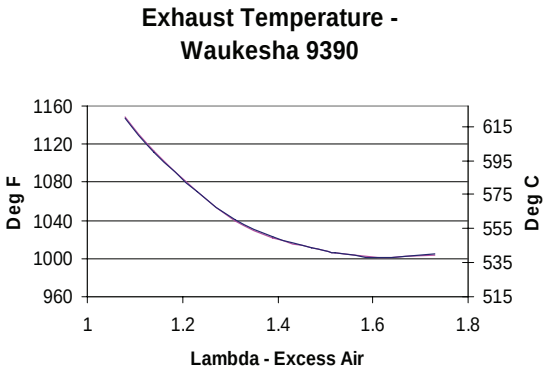
EngineWorx

REM*Vue*™ Energy Optimization with SlipStream™

REM Technology Inc

Reduced Exhaust Temperatures

- Reduced valve failure
- Reduced head damage
- Reduced oil wear metals

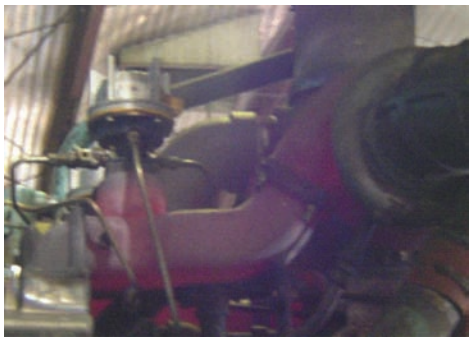


REMVue™ Energy Optimization with SlipStream™

Turbo Temperature

Delta 210 °F

BEFORE



AFTER

REMVue™ Energy Optimization with SlipStream™

- Chevron's compressor optimization fleet plan
  - *100 REMVue® AFR installations*
- Realized annual fuel savings in excess of $15 million!

"…..The increase in production from reliability and efficiencies will far exceed the fuel savings."

Robert E. Ingraham Jr.
Hatters Pond & Chunchula Plants
Senior Process Engineer

Initial installation of the 100 systems cost Chevron around $13 Million. The $15 million in fuel savings is annual, year after year, after year …. These systems have been installed since 2002, making the total ROI to date well in excess of $75 million.

REMVue™ Energy Optimization with SlipStream™

Compression Optimization

- Control asset to minimize energy waste
  - Minimize recycling
  - Minimize suction throttling
  - Minimize blow downs
  - Cooling fan speed/pitch control
    - Minimizes horsepower losses to parasitic load
    - Minimize liquid/flash gas recycling
- Engine loading
  - High % load (100% vs. 50%) gives up to **18% more efficiency**
- Recip Compressor RPM
  - Lower RPM (750 vs. 1200 RPM) can give **19% more efficiency** (less valve loss)

REMVue™ Energy Optimization with SlipStream™

REMVue Diagnostics

- Provides a well/unhealthy indicator
- On-line 24/7 monitoring
- If well, no action is required;
- If unhealthy, provides an indicator of the problem type;
- If serious, provides alarms or shutdowns;
- Can provide an operating (Opportunity) cost of the problem.

Prompt correction of a problem
Can save fuel and avoid lost production

REMVue Diagnostics BSFC

Real-time Graph on engine HMI

The line shows expected performance;

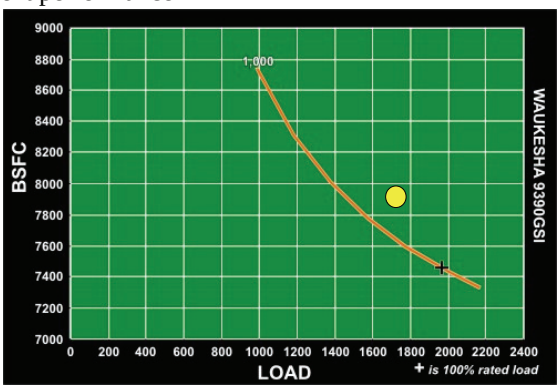
The yellow dot shows current performance

BSFC "Gas Mileage"

On the line = OK

Off the line = problem

Engine or compressor not healthy



Brake Specific Fuel Consumption (BSFC) is the fuel heat per hour to generate 1 HP of mechanical power; a low BSFC means high fuel efficiency

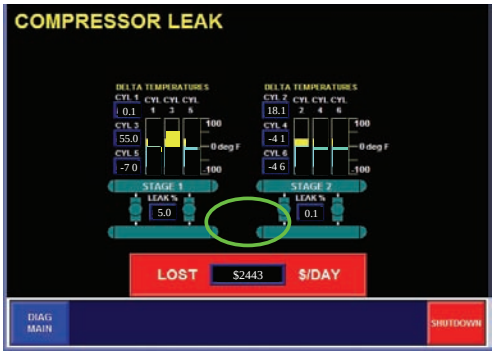
REMVue™ Energy Optimization with SlipStream™

REMVue Leak Diagnostics

Real-time Graph on engine HMI

A compressor leak causes lower compressor through-put and wasted engine fuel

- Compressor leak detection
  - Valve leak
  - Packing leak
  - Ring leak
  - Unloader leak
- Lost production estimate is $2,443



REMVue™ Energy Optimization with SlipStream™

REMVue®
SlipStream™

Getting a free boost!

*** Patents Pending***

REMVue™ Energy Optimization with SlipStream™

SlipStream™

- SlipStream™ is the REM Technology product designed for utilizing *vented hydrocarbons* as a supplementary fuel source for natural gas engines
  - Vented HC gas into engine intake
  - Can be diluted with air or undiluted
  - Suitable for carbureted engines
  - Does not require vented gas compression - VRU
  - Vented fuel that is recovered can be considered “free”
  - Using SlipStream™, up to 50% of engine fuel can come from the vented sources
  - Substantial GHG(e) reduction
  - Advanced control allows for variability of Fugitives
  - Can burn BTEX^{+} (> 99.5% reduction)

Design Requirements for SlipStream™

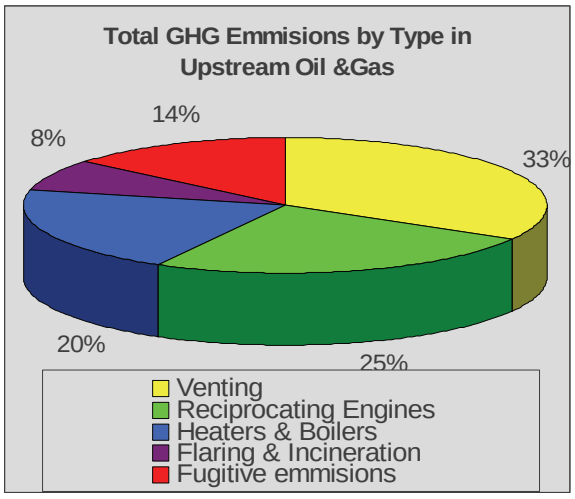
- Develop a technology that would allow vented hydrocarbons to be used as supplementary fuel for natural gas engines
- Must be safe — *Safety First*
- Must not reduce performance or reliability of engine
- Must be scaleable from low volumes of supplementary fuel to high volumes
- Must be able to compensate (*Air-Fuel Ratio and Governor*) for variable flow and BTU value of the supplementary fuel through the REMVue Combustion Management System

REMVue™ Energy Optimization with SlipStream™

The Opportunity!

Potential Savings!!

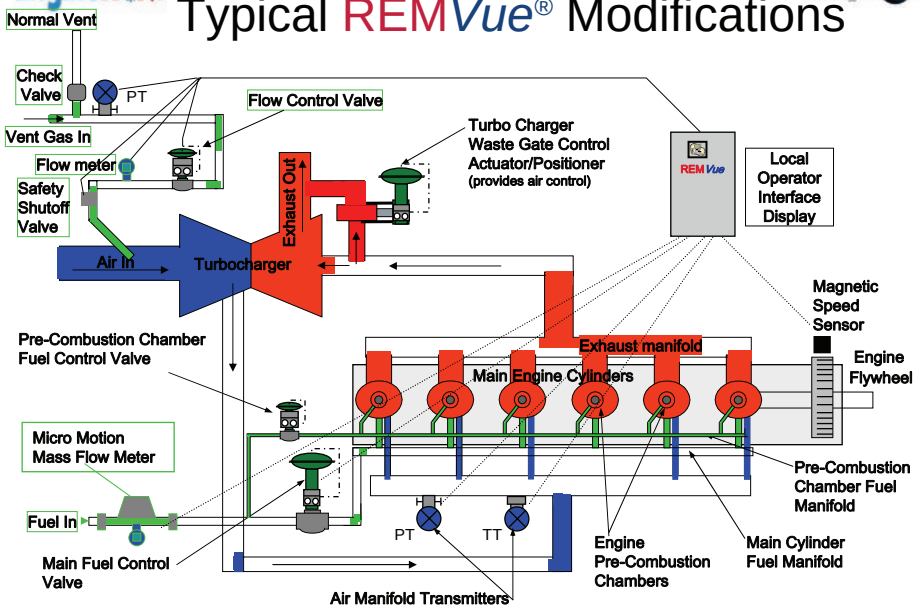
- Venting ($ 40 Million)
- Reciprocating Engines ($ 220 Million)
- Heaters & Boilers ($180 Million)
- Flaring & Incineration ($ 60 Million)
- Fugitive Emissions Leaks ($20 Million)
- Value of gas recovered based on 12% improvement



(from BP presentation Feb 05)

REMVue™ Energy Optimization with SlipStream™

Typical REMVue® Modifications



REMVue™ Energy Optimization with SlipStream™

Offshore Fugitive Sources

- Major Sources – Blanketed Vessels
  - Surge Tanks
  - Chem-Electrics
  - Reboilers
  - Water treatment units
- Minor Sources
  - Instrument gas vents
  - Compressor packing leaks
  - I/Ps and pneumatic devices
  - Engine starting, purging, blow-downs
  - Crankcases

Offshore Specific Implementation Issues

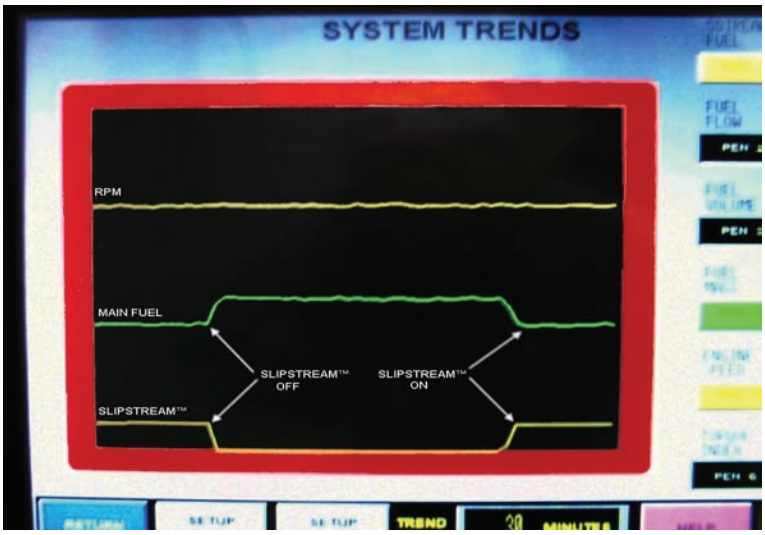
- Air Intake configurations varied
- Vent pipe routing/expense
- Panel vent devices typically not run to a common manifold exiting the panel
- Field Instruments vent locally

REMVue™ Energy Optimization with SlipStream™

Control

- SlipStream™ uses advanced feed forward control algorithms proven with hundreds of R-L conversions to anticipate changes in SlipStream™ fuel flow and adjust the governor and air control accordingly
- The result — no impact to engine reliability or speed from:
  - Load changes
  - SlipStream™ Flow
  - Fuel gas or SlipStream™ gas BTU swings
  - Ambient temperature

SlipStream™ Results

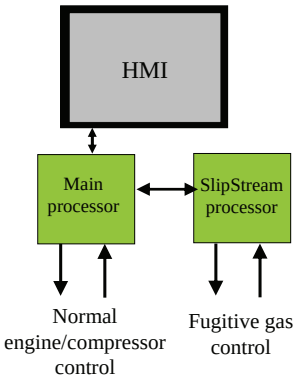


REMVue™ Energy Optimization with SlipStream™

Real-time Graph on REMVue® HMI

SlipStream Technology*

- Level 1 < 10% of engine fuel
- Level 2 < 30% of engine fuel
- Level 3 < 50% of engine fuel



Level 3 SlipStream

* Patents Pending

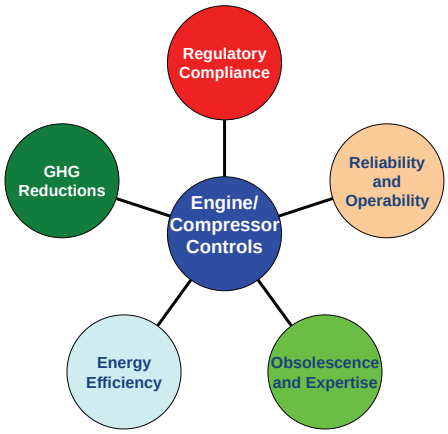
REMVue™ Energy Optimization with SlipStream™

Challenges

- Fuel cost accounting
  - Important but not urgent
  - Perceived as small cost relative to production
  - “The fuel doesn’t appear on my books.”
- Industry adoption of fuel efficiency is sporadic
  - Where are gas prices going?

REMVue™ Energy Optimization with SlipStream™

Moving from an island solution to integrated solutions



REMVue™ Energy Optimization with SlipStream™

Fuel Savings and Emission Reductions

- **REMVue® R-L conversion** **260mcfd – 20% =** **52 mcfd**
- **Slipstream (Up to 50% of Fuel)** **50 mcfd**
  - Vented Gases from Instrumentation: 5-10 mcfd 5 mcfd
  - Compressor Packing Leaks: 5-15 mcfd 10 mcfd
  - Flares and LP, Blanketed Vessels: 10-104 mcfd 35 mcfd
    - Pipeline Pump Surge Tanks, Dehydration Units, Wemco's, Chem-Electrics, Etc.
- **Total Fuel Savings** **= *102 mcfd***
- **Total GHG Reductions** **= *12,000 tonnes/yr CO2(e)***

REMVue™ Energy Optimization with SlipStream™

RESULTS

- **Fuel Savings**
  - **102 mcfd at 97% runtime**
  - **36 mmbtu/year at $8/mbtu**
  - **$289,000 /year (much more if used for Gas Lift)**
- **Green House Gas Reduction**
  - **12,000 t/yr CO2(e) for offset or trade**
  - **Potential trading values of $5 - $15 per tonne**
  - **$120,000 year at $5/t**

REMVue™ Energy Optimization with SlipStream™

Ideal Installations

- Highspeed, Turbocharged Engine such as a Waukesha 7042GSI
- Running at Stoichiometric – i.e. Rich Burning
- Located on a structure with pipeline pumps, oil and/or gas dehydration, water treatment, a flare or with other sources of vented gases and fugitive emissions

Thank You!