Hydrogen for the NWR Upgrader by Lurgi MPG® Technology
A challenging Project

General Outline

- Hydrogen Sourcing for Refineries
- Lurgi MPG® Heavy Residue POX
- Case Study: North West Redwater Upgrader
- NWR Module Fabrication
- Conclusions
The Air Liquide Group

50,000 Employees

Present in 80 Countries

Air Liquide Global E&C Solutions Germany GmbH

Revenue 2013
€15,2 billion
Hydrogen Sourcing for Refineries

Produced by the owner:

- Steam Reforming of Natural Gas
- Partial Oxidation of Heavy Residues
- Gasification of Pet Coke
- Recovered from Refinery Off-Gases

Or

- Delivered Over-The-Fence (OTF)
Lurgi Gasification Technologies History

- **Shell Gasification Process - SGP**
  - Lurgi was exclusive licensor until 1997
  - Last plant w/i this agreement: *Shell’s PER+* hydrogen plant

- **Lurgi Multi Purpose Gasification – MPG®**
  - Originating from SVZ, operated for > 30 years
  - Active in the market since 1998
  - Latest plant: *NorthWest Redwater Upgrader*
Lurgi MPG® - Technology Advantages

- Lurgi MPG® technology quench and boiler configuration available
- Feedstock Flexibility
  - No limitations on flash point of feedstock
  - Viscosity up to 300 cSt
  - Particles up to 1 mm
- Long burner life time result in higher reliability and availability of plant
- Inherent safety by pressurized cooling water system
- Simultaneous feeding of immiscible feedstock

Picture:
Operating since 2002 @ Brazil
MPG application: North West Redwater Upgrader (NWR)

- Site: 45 km NE of Edmonton, Alberta Province, Canada

- Joint Venture between North West Upgrader (NWU) and Canadian Natural Resources Ltd (CNRL)

- ENHANCE as the CO₂ off-taker providing the CO₂ grid
NWR Upgrader General Setup

- One out of three phases

Bitumen Blend Feedstock 77,080 bpd
- Dilbit 51,760 bpd
- Synbit 25,320 bpd

Crude and Vacuum Unit

Hydrocracker & Hydrotreater

Resid Hydrocracker

Multi Purpose Gasification

Diluent and Naphta 32,501 bpd
- ULS Diesel 36,178 bpd
- LS Vacuum Gas Oil 8,276 bpd
- Butane 771 bpd

Hydrogen

High Quality CO₂
NWR Hydrogen Plant Licensor Selection Criteria

- All Required Technologies from One Licensor
  - Gasification, Acid Gas Removal, CO-Shift, H2-Purification
  - Single Line Responsibility for the Hydrogen Unit

- Multi Purpose Gasification
  - Experience and Commercial References of MPG/ POX
  - Large Feedstock Flexibility
  - Robust Burner
  - Quick Restart Option

- Acid Gas Removal (AGR)
  - Know-How to select most suitable processes
  - Rectisol® removing all trace contaminants, too.

High Availability and Reliability
NWR Hydrogen Plant Flow Scheme

Feedstock
~ 52 t/h

Steam
~ 26 t/h

O₂
~ 37,000 Nm³/h

Air
~ 3 x 50 %

MPG® Quench → Raw Gas Shift → Gas Cooling

LP-Steam

CO₂ Compression

Pure, dry CO₂ to EOR
148 t/h

Hydrogen
97% pure

~ 129,000 Nm³/h

H₂S + CO₂

Claus

Sulfur

Claus Off-Gas

Air + O₂

Waste Water Treatment

Process Water

Filter cake

Filter

ASU

Methanation

Rectisol®

Filter cake

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Filter cake

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ASU

Filter

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Methanation

Rectisol®
NWR Hydrogen Plant Project Status

- NWU awarded to Lurgi EPC order in 2007/ paused in 2008
- NWU & CNRL joined to NWR in 2011
- NWR project sanctioned in November 2012
- Air Liquide Global E&C Solutions engineering RFC ongoing
- NWR final investment decision made in January 2013
- Air Liquide EPC contract effective December 2013
NWR Hydrogen Plant Module Fabrication Strategy

- **Client’s requirements:**
  Minimize overall construction activities as much as possible:
  - Where potential to positively influence safety, schedule or cost, perform modularization
  - Even if no positive influence on safety, schedule or cost is obvious, still consider modularization as an option

- **Main Motivations:**
  - Site location and environment
    - Climate conditions
    - Huge shortage of craftsmen expected for Alberta during construction period
  - Costs and schedule certainty
  - Improvement of quality and productivity due to working environment
    - Manufacturing approach
    - Stable, experienced work force in workshops compared to Alberta site
  - Enhancement of HSE

**NWR Project** has reached a level of modularization of **approx. 75 %**
(considering Equipment, Piping and Structural Steel)
Severe Climatic Conditions Hampering Transport and Erection

- Average rainfall & temperature for Edmonton

![Graph showing average rainfall and temperature for Edmonton with a possible erection period of 5 months and strong transport restrictions. Source: XXXXX]
Basic Principles of Module Execution Strategy

- Global procurement of equipment and bulks
  - cost efficient execution
  - increased project execution flexibility

- Global fabrication of modules
  - increased project execution flexibility

- Increased engineering design requirements
  - increased efforts during plant engineering
    >> leading to reduced overall project costs
Trial-fit of a Hydrogen Plant SuperModule
Module Transportation
Module Erection into a SuperModule
Lurgi Rectisol® Technology - Highlights

- Acid Gas Removal (AGR): Physical Absorption
- Solvent: Methanol @ low temperatures
- The standard for high-pure synthesis gas
- Achieving pure, dry CO₂ for sequestration
- First commercial plant on CCS in gasification:
  - Dakota Gasification Co. (DGC)
  - Weyburn > Sequestration by EOR
Lurgi Rectisol® Technology - Shenhua Ningxia 2009
Conclusion: A Comprehensive Bottom of the Barrel Solution …

- Typical Refinery Set-up

Different Oil Fractions from refinery → Hydrocracker → LPG
Vacuum Residue from refinery → Solvent De-Asphalting → Diesel

Sweet Heavy Oil → Hydrocracker

Off-Gases → Hydrogen
Acid Gases → Hydrogen

Air Liquide plants: Integrated Power, Oxygen, Gasification, Hydrogen, Chemicals, Steam & Sulphur

Common Off-Site Facilities

Air Liquide Global E&C Solutions is capable to solve the “bottom of the barrel” problems in refineries.
... and a Low Carbon Footprint Refinery

- Lurgi MPG® Technology for heavy residues gasification is a reliable source for hydrogen with
  - No consumption of Natural Gas
  - No disposal of coke and asphaltenes necessary
  - Can take all refinery wastes

- Lurgi Rectisol® Technology secures high quality products and pure, dry CO$_2$, ready for sequestration

- Both together providing the flexible basis for poly-generation and full integration w/i a refinery
- Good design allows for construction under severe conditions
Thank you for your kind attention!

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