Western Canadian Residue Hydrocracking

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Western Canadian Residue Hydrocracking

- **Why** Western Canada?
- What are the project drivers?
- **Where** are these residue hydrocracking projects?
- **How** are projects being executed?
- **Who** is making these projects a regional success?

Oilsands Overview

- Western Canadian Sedimentary Basin – Alberta & Saskatchwan
- World-scale oil reserves
 - 3rd Largest proven reserves
 - 2nd Largest heavy oil
- Production & Refining Centers
 - Fort McMurray
 - Edmonton
 - Lloydminster
 - Regina



Regional Connectivity

- Bitumen requires upgrading or dilution for transport
- Upgraders convert bitumen into synthetic crude oil (SCO)
 - Coking
 - Residue Hydrocracking
- Facilities include secondary upgrading and refining



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Project Drivers

Pros

- Politically friendly
- Investment friendly
- Infrastructure
- Mature industry
- Technical expertise
- Available workforce
- Cons
 - Land-locked
 - Pipeline Constrained
 - Capital Cost (winterization, labor)
 - Investment Competition
 - 'Dirty oil' image



Overview of Western Canadian Upgraders

UPGRADER:	MILDRED LAKE	UG 1&2	SCOTFORD	HORIZON	LONG LAKE	NW REFINERY	LLOYDMINSTER
OPERATOR:	SYNCRUDE	SUNCOR	SHELL	CNRL	CNOOC	NWR	HUSKY
BITUMEN FEEDSTOCK:	Mildred Lake & Aurora North	Base Plant, MacKay River & Firebag	Muskeg River & Jackpine	Horizon Mine	Long Lake SAGD	CNRL Cold Lake & BRIK	Cold Lake
CAPACITY SCO (bbl/day):	350,000	357,000	255,000	240,000	58,500	50,000	75,000
DDIMADV	Fluid Coking	Delayed		Doloved OrCrude +			H-Oil
UPGRADING:	+ LC-Fining	Coking	LC-Fining	Coking	Solvent Deasphalting	LC-Fining	+ Delayed Coking
GASIFIER:	No	No	No	No	Yes	Yes	No
CARBON CAPTURE:	No	No	Yes	No	No	Yes	No
PRODUCT:	light/sweet SCO	light/sweet + heavy/sour	light/sweet + heavy/sour	light/sweet	light/sweet	Diesel	light/sweet
YIELD:	85%	81%	100+%	85%	83%	100+%	90%

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Statistics compiled by www.oilsandsmagazine.com from referenced sources.

Western Canadian Statistics Overview

- 1.4 MBPD of VDU Capacity
- 490 kBPD of Coking Capacity
- > 240 kBPD of RHC Capacity



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Western Canadian Residue Hydrocrackers

OPERATOR/ OWNER	LOCATION	START- UP	LICENSOR	CAPACITY, KBD	TRAINS	CONVERSION
Syncrude	Fort McMurray	1988	CLG	40	2	56%
Husky	Lloydminster	1992	Axens	32	2	60%
Shell / CNRL	Scotford Base Plant	2003	CLG	92	2	75-80%
Shell / CNRL	Scotford Expansion	2011	CLG	46	1	75-80%
North West	Redwater	2018	CLG	30	1	78%

Scotford Upgrader Operator: Shell Owner: CNRL

Location: Scotford, Alberta Start-up: 2003 Train 1 & 2 2011 Train 3 (Expansion) RHC Features:

- 138k BPD vac residue feed
- Feed optimized with mining extraction
- ► LC Finer with integrated hydrotreater
- Common heavy oil stripper and product stabilizer sections
- Quest Project Add-on:
 - CO₂ Capture and Sequestration



Quest Project: Carbon Capture & Sequestration



Shell Quest Carbon Capture Storage



CO₂ Compressor

CO₂ Stripper & Amine Coolers

SHELL QUEST CARBON CAPTURE AND STORAGE

Northwest Sturgeon Refinery Operator: NWR Owner: CNRL/NWR

Location:	Sturgeon County, Alberta
	(North of Edmonton)
Start-up:	2018
RHC Feature	es:

► 30k BPD of vac residue feed

- Distilled products sent to HCU
- Unconverted oil sent to Gasifier
- Implemented CLG reliability improvement program



Innovations and Expertise

- Land-locked reactor logistics
- Ebullated-bed pump installation & removal system
- Catalyst system receiving and loading systems
- Design Optimizations
 - Improved high pressure letdown station design and layout
 - Purge system design and distribution (tubing system)
 - Flushing Oil manifold and slops collection systems

Reactor Shipping Options

- Shipping Envelope: 14.7' W x 16.9' H
- Weight:
 - 500 tonnes QTTX railcar or
 - 800 tonnes Schnable car
- Heavier reactors (>1200 tonnes) shipped in 3 pieces and field welded



Schnabel Car Picture by Westinghouse

Reactor Logistics





Reactor Loading in Duluth, Minnesota

Reactor Field Welding





Reactor Segments Shipped by Rail and Welded in a Mobile Shop at Site

Ebullated-Pump Installation & Removal System



Catalyst System Receiving and Loading Systems

- Fresh catalyst supply and spent catalyst disposal logistics
- Bulk transport
 - Rail or Truck
- Pneumatic Conveying
- Bin transport with cranes
- Local Logistics (Hoover Ferguson)
- Reclamation in Edmonton being explored

Design Optimization and Experience

- Proving ground of many firsts and lessons learned
 - Integrated fixed-bed reactor
 - Bulk catalyst handling
- Maintenance Improvements
 - Flushing oil manifolds and slop oil system design
 - Hub management program
- Reliability Improvements
 - Purge systems
 - High-pressure letdown valves
 - Instrument installations

Western Canadian Residue Hydrocracking Expertise

Network of Experience

- Engineering & Design
- Modularization
- Logistics
- Operations

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- Maintenance
- Safety Systems Design and Implementation
- High pressure components and materials

