



human energy®

Burnaby Refinery Environmental Initiatives

Dave Schick
PGPA Manager

Kel Coulson, P.Eng., M.A.Sc.
Environmental Engineer

November 30, 2016



Overview

- Chevron Burnaby Refinery Overview
- Environmental Framework
- Environmental Improvements
- Project 1: Environment Canada
 - Tier 3 Low Sulphur
- Project 2: Low Carbon Fuel Regulation (LCFR)
 - Co-processing Initiative

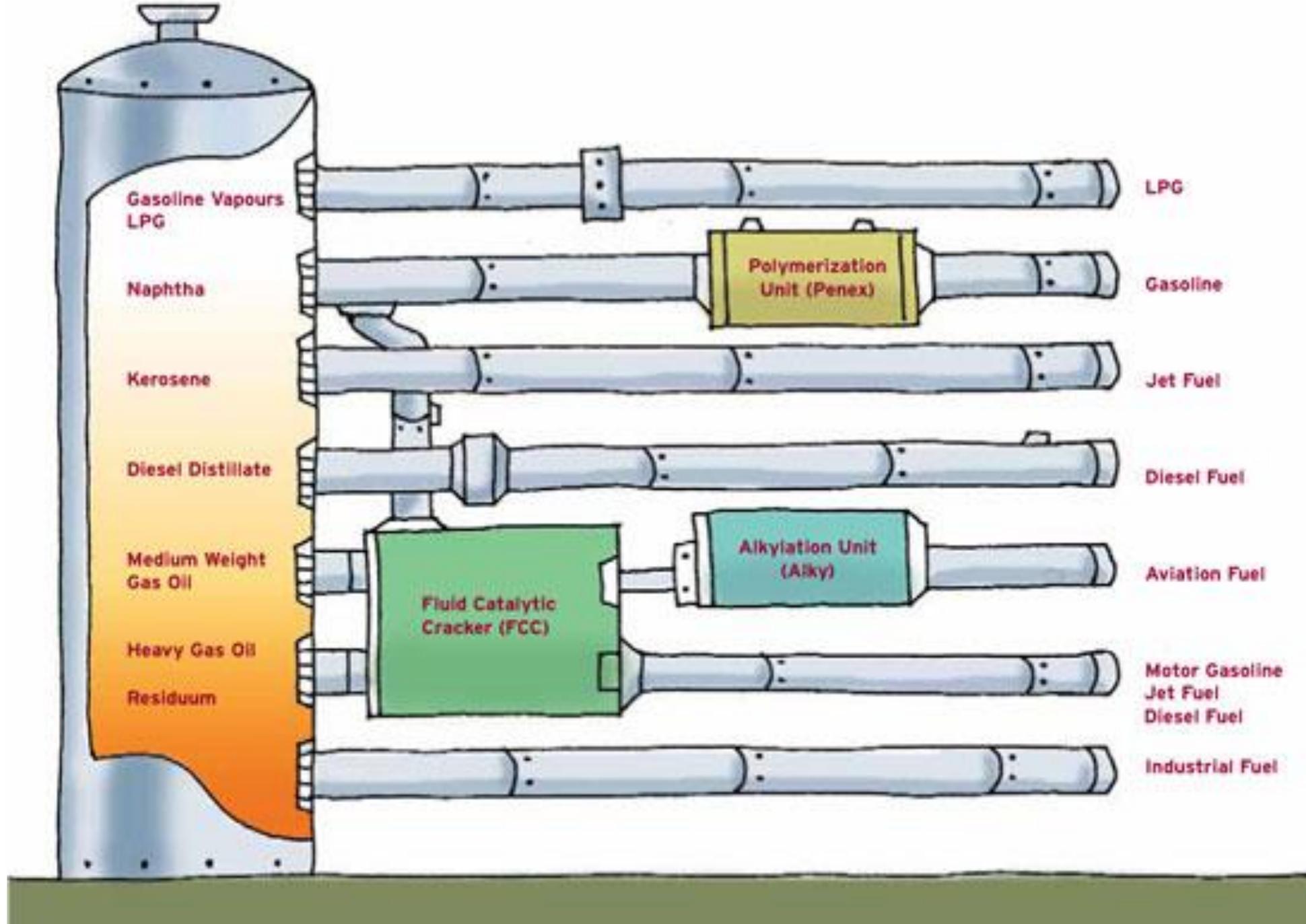


Chevron Burnaby Refinery



- Chevron Burnaby refinery supplies approximately 25 percent of the transportation fuel needs in British Columbia
- Operating since 1936
- Capacity of 55 000 barrels a day
- Receives light-sweet crude from pipeline

Burnaby Refinery Products



Chevron's Environmental Values

Stakeholder Engagement:

- Our environmental policies stress open dialogue with our First Nations and surrounding community and we encourage comments and questions

Protecting People and the Environment:

- We place the highest priority on the health and safety of our workforce and protection of our assets and the environment. We aim to be admired for world-class performance through disciplined application of our Operational Excellence Management System

Operational Excellence Tenets:

- Tenet #1) Always operate within design or environmental limits
- Tenet #7) Always comply with applicable rules and regulations



Sample of the Environmental Regulatory Framework

Water Quality

- Metro Vancouver – wastewater treatment plant permit
- Provincial – stormwater permit
- Federal – water quality guidelines

Air Quality

- Metro Vancouver – air quality permit

Land

- City of Burnaby (zoning bylaws), Provincial (Ministry of Environment) + Federal (Ministry of Transportation, Port of Vancouver)

Fuel Quality – New Initiatives

- Provincial - Renewable & Low Carbon Fuel Requirements Regulation
- Federal – Environment Canada – Tier 3 low sulphur transportation fuels

Environmental Fuel Improvements

Historical Improvements

- 1972 – unleaded gasoline introduced
- 1990 – lead phase out
- 1994 – low-sulphur diesel introduced
- 2005 – gasoline hydrotreater added to meet federal low-sulphur gasoline specifications of 30 ppm
- 2006 – ultra-low-sulphur diesel production begins
- 2010 – blending and shipping mandated renewable fuels begins; ethanol and biofuels sales to customers through Retail and Cardlock facilities
- 2008 - Low Carbon Fuel Regulation (LCFR) introduced

Future Improvements

- 2017 – co-processing commercial trials to lower carbon intensity of fuel (LCFR- Part 3)
- 2020 – Tier 3 Federal Environment Canada mandate for 10 ppm sulphur gasoline specification



Project 1:
Tier 3 – Low Sulphur Fuel

Sulphur Removal – Why is this important?

Where it comes from:

- Transportation is one of the largest sources of air pollution in Canada
- The combustion of transportation fuels to power vehicles and engines has major adverse impacts on the environment and health of Canadians
- Emissions from vehicles impact on air quality, acid rain, smog and climate change

Sulphur Dioxide:

- Sulphur dioxide (SO₂) is a colourless gas that smells like burnt matches that is formed when fuels with a high sulfur content are burned (combustion engine)
- When exposed to high levels of SO₂, people with respiratory conditions like asthma may experience breathing problems
- SO₂ can affect our environment and our economy by acidifying soil and surface water, damaging crops and trees, and damaging or discolouring structures and property
- SO₂ can react with other substances in the air to form fine particulate matter, which also impacts health and contributes to the haze that sometimes obscures scenic views in our region



Low Sulphur Requirements

Government Objective:

- Government, industry and automakers are working together to improve the environmental performance of transportation fuels
- Federal regulations in both Canada and the US are requiring transition to lower the maximum sulphur content of gasoline from 30 ppm to 10 ppm starting now with the full transition complete by January 1, 2020

Results:

- Chevron has contributed to these objectives over the past two decades by removing greater than 95% of the sulphur from gasoline and greater than 99% of the sulphur in the diesel produced from the Burnaby refinery
- Air quality in the region continues to improve over time



Low Sulphur – a (Mass) Balancing Act

The challenge:

- Moving sulphur from non-point source (cars) → point source (refinery)
- Higher level of removal at the refinery means more pollution control devices (that have to work harder)
- Net improvement to the local air shed as well as reduce sulphur emissions province-wide

Non-point source emissions:

- Non-point sources of emissions are often termed ‘diffuse’ emissions and refer to those inputs and impacts which occur over a wide area and are not easily attributed to a single source (example – your car)
- Hard to remove from the environment

Point source emissions:

- A point source is a single, identifiable source of emission, such as a facility
- Industrial wastes point source discharges are often regulated
- Air pollution control measures can be added to point source facilities to remove emissions



Low Sulphur at the Burnaby Refinery

Where we are at:

- The Burnaby refinery is well positioned to meet this challenge as the facility's gasoline pool has been well below 30 ppm since 2012

Where we are going:

- The refinery is retrofitting with a new catalyst process which will integrate into existing units and extract sulphur molecules from the gasoline and adhere them to the catalyst
- The spent catalyst has a base metal content that is attractive to recyclers that can utilize it as a feedstock for their facilities. Without creating an additional waste stream or emissions source - it's a win-win for the environment
- Construction will begin in 2018 with initial work occurring during our 2018 refinery turnaround with the new technology will be commissioned in the second or third quarter of 2019 in order to make sure it is fully functional before 2020



Project 2:
Bio-oil Co-processing Initiative

Low Carbon Fuel Requirements

Government Objective:

The Greenhouse Gas Reduction (Renewable & Low Carbon Fuel Requirements) Act and the Renewable & Low Carbon Fuel Requirements Regulation were introduced by the Provincial Government in 2008 to:

- Reduce British Columbia's reliance on non-renewable fuels
- Help reduce the environmental impact of transportation fuels
- Contribute to a new low-carbon economy

Examples of renewable fuels include:

- Ethanol (corn, wheat)
- Hydrogenation-derived renewable diesel (HDRD) (palm, tallow, canola, soy)

Between 2010 and 2012, the release of over 2.3 million tonnes of greenhouse gas emissions was avoided province-wide under the Regulation — more than the total emissions of all cars in Vancouver over two years. These significant reductions were achieved without limiting the various ways in which British Columbians use their vehicles. - (LCFR website, November 2016)

Low Carbon Fuel Requirements

Part 2 of the Act establishes renewable fuel content requirements for gasoline and diesel sold in British Columbia:

- Fuel suppliers must ensure that they have a minimum renewable fuel content of five percent (5%) for gasoline and four percent (4%) for diesel, on a provincial annual average basis
- Fuel suppliers have the flexibility to vary their blend percentages and can choose where in the province they supply renewable fuel blends, as long as they meet the provincial annual average requirement for renewable fuel content

Part 3 of the Act:

- Fuel suppliers must progressively decrease the average carbon intensity of their fuels to achieve a 10% reduction in 2020 relative to 2010
- Under the Regulation, fuel suppliers choose their own approach for compliance with Part 3 requirements. Fuel suppliers may choose to:
 - Acquire credits through a Part 3 Agreement
 - Trade credits with other suppliers
 - **Supply more low carbon fuels ← co-processing bio-oils**



Burnaby Refinery Strategy for LCFR Compliance

Co-processing Project

- Processing alternative feeds in the refinery allows Burnaby to participate in the manufacturing of biofuels
- Co-processing bio-oils with petroleum feedstock in an existing refinery will produce a portion of transportation fuels having a lower Carbon Intensity (CI)
- Carbon Intensity is determined using the industry standard GHGenius Life Cycle Assessment (LCA) modeling

Risks Identified:

- Bio-oil and petroleum feedstock incompatibility
- Off spec refinery products due to bio-oil processing
- Effect on downstream processing units (hydrotreaters, waste water treatment, etc.) and equipment



Co-processing Feedstock Assessments

- Several different sources of potential feedstock for co-processing have been identified and are being evaluated by our corporate and local teams.

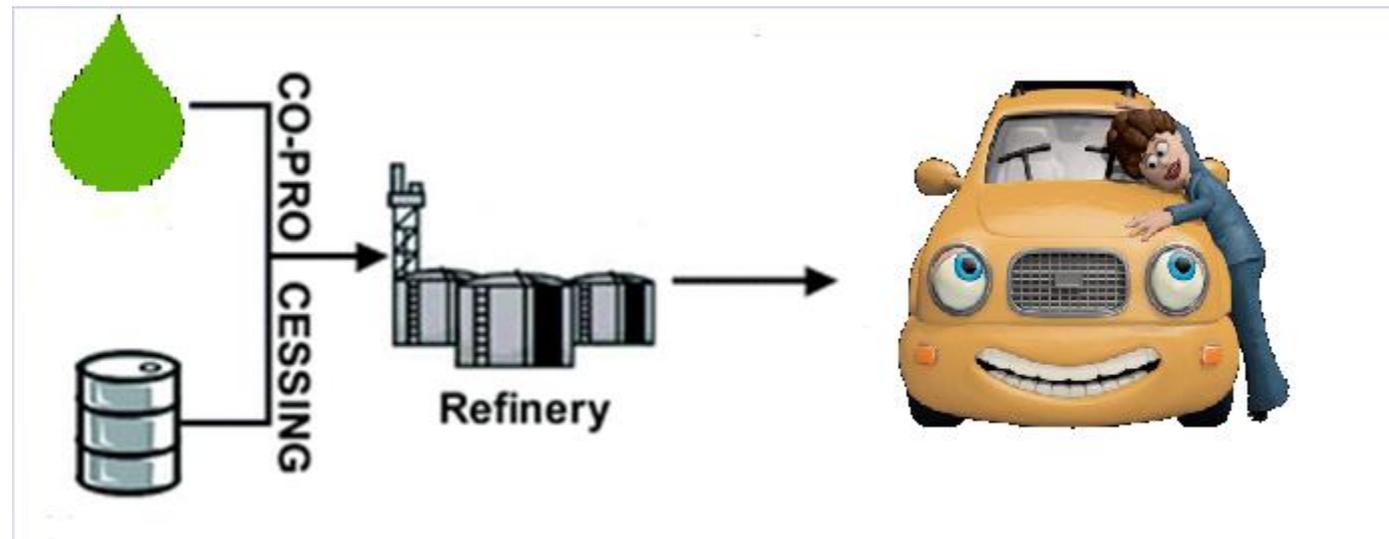
Some current feedstock challenges include:

- Reliable supply chain
- Large enough volumes
- Appropriate chemical and physical characteristics for equipment (eg. Low enough oxygen content to avoid corrosion and hydrogen consumption)
- Low enough carbon intensity (CI) (evaluated with GHGenius LCA)



Looking Forward

- Chevron's Burnaby refinery is the only British Columbia refinery capable of implementing co-processing technology that can have a significant impact on the reduction of transportation fuel CI in British Columbia
- Co-processing at the Burnaby refinery would be a made in BC solution with the potential of bio-oil feedstocks being sourced locally within Canada
- This technology development demonstrates Chevron's commitment to and leadership in the energy industry supporting innovation in local fuel manufacturing and if successful be considered at other Chevron facilities



Questions

