Air Products POx Technology for Low Carbon Hydrogen Production

Presentation by

Sean Yan, Ph.D.

Product Manager

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Agenda

Introduction
- Who is Air Products

Air Products' POx Technology Features
- Global Experience
- Process Overview & Features

Concluding Remarks

Air Products is a leading global industrial gas company, built on deep experience, strong performance and high ambitions

$8.9 billion in FY20 sales	**19,000+** employees	**50+** countries
$60B+ market cap	**80** years in business	**170,000+** customers
1,800 miles of industrial gas pipeline	**750+** production facilities	**30+** industries served

Creating Long-term Value

Through sustainability

Our products enable customers to avoid

72 M MT CO_2e

equivalent to emissions from 15 M cars, and 3 times our direct and indirect CO_2 emissions

Our products improve the environment, make our customers' processes better and fulfill societal needs

We are focused on improving our operations to manage environmental, social and governance risks

Member of Dow Jones Sustainability Indices Powered by the S&P Global CSA

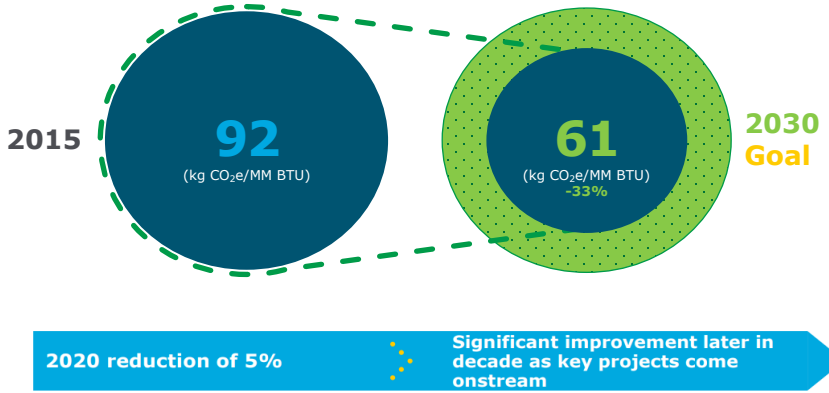
Corporate Responsibility Prime rated by ISS-oekom

GOLD 2020 ecovadis Sustainability Rating

BEST PLACES TO WORK 2021 for LGBTQ Equality 100% CORPORATE EQUALITY INDEX

TOP 100 BARRON'S Most Sustainable Companies 2021

"Third by '30" Carbon Intensity Goal



AIR PRODUCTS

Air Products has the technology and capabilities to drive sustainable growth

Hydrogen Global Leadership

Large Projects capabilities

World scale green H2

Hydrogen for mobility

CCUS expertise

Strong Balance sheet

Supported by ***Air Products Technology***

Build-Own-Operate

AIR PRODUCTS

Air Products: world hydrogen leader

The world's largest hydrogen producer with proven reliability

1100+ kilometers of pipeline

> 32 billion Nm3/year

H_2 The world's longest H_2 pipeline system and world-class liquid hydrogen supplier

15+ years safe fueling

250+ Hydrogen fueling projects worldwide

30+ H_2 Electrolyzer projects

20+ countries

Unique product offering for H_2 fueling

1,500,000 fueling per year

10 million Total fueling

~50 patents for hydrogen fueling

Production	SMR, Gasification, Off-gas, Electrolyzer, Liquefier
Distribution	Pipelines, Liquid trucks, Gaseous trucks, Mobile fuelers

Air Products develops, owns & operates hydrogen and syngas projects using a portfolio of technologies

- The choice of technology is optimized for the project requirements

SMR,
NO CCS

NG / Oil Fed
POx, NO CCS

Solids gasification, NO CCS

NG Fed SMR + CCS (Syngas only)

Blue POx, Gas/Liquid/Mixed Feed
Blue Gasification, Solids Fed
Blue ATR, Gas Fed
Blue SMR , Gas Fed

H2 as decarbonized Fuel

H2fM

H2 for Fuel Upgrade

H2 for Industry

Liquid H2

Blue NH3

Blue Methanol

+ other Blue Processes

Application

Level of Blue H2

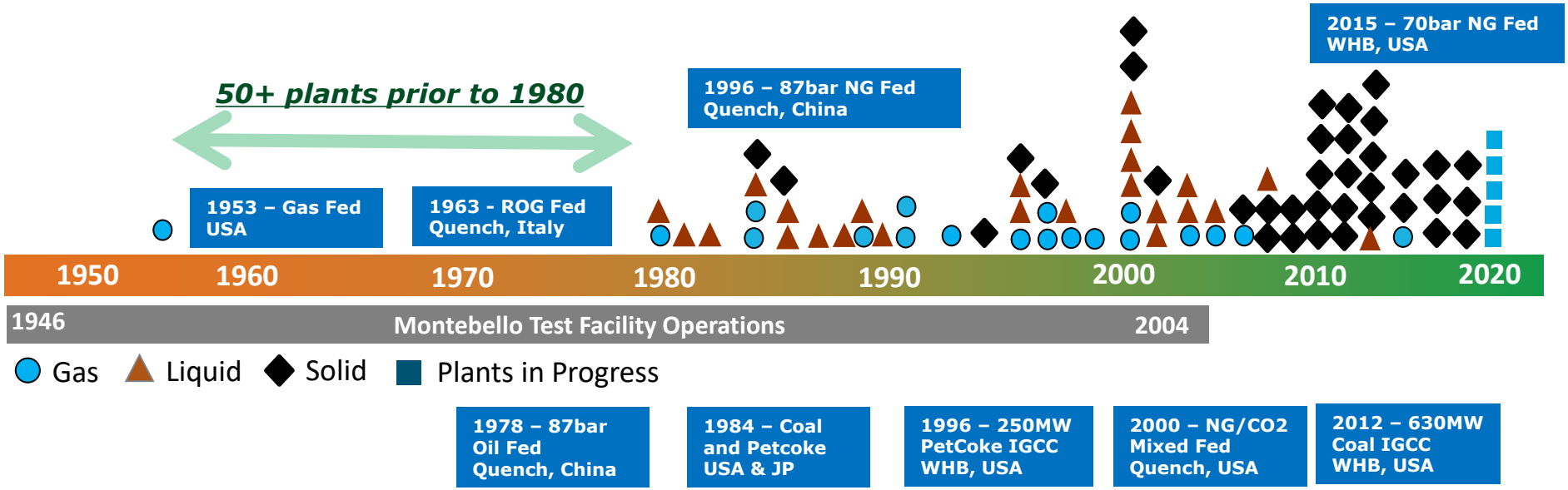
Air Products' POx technology has a long operating history

- Partial oxidation is a non-catalytic process that produces a CO-rich syngas
- Among the common syngas production processes, POx is uniquely suited for monetizing heavy feedstocks
- Decades of experience
  - 1946, Texaco started POx research
  - 1953, first commercial plant - natural gas POx to Ammonia
  - 1961, first licensed Oil POx unit in Japan
- Today's applications for gas-fed POx are focused on carbon monoxide and syngas for chemicals:
  - Methanol, Oxo-chemicals, Acetic Acid, Isocyanates, Phosgene, Formic Acid, etc.

Montebello R&D Center, circa 1990

Sarlux Oil POx for IGCC, circa 2000

Air Products' POx Technology – Reliable & Proven Worldwide



Technology with 60+ years expertise globally

Air Products LaPorte POx Facility
Commercial syngas operation since 1996

Air Products' POx Flexibility – Feeds Variety

Gas Fuel Feeds

- Natural gas (NG)
- LPG/ Refinery off-gases (ROG)
- Pyrolysis gases

Biogenic Feed

- Renewable Gas
- Renewable diesel byproducts
- Pyrolysis oils

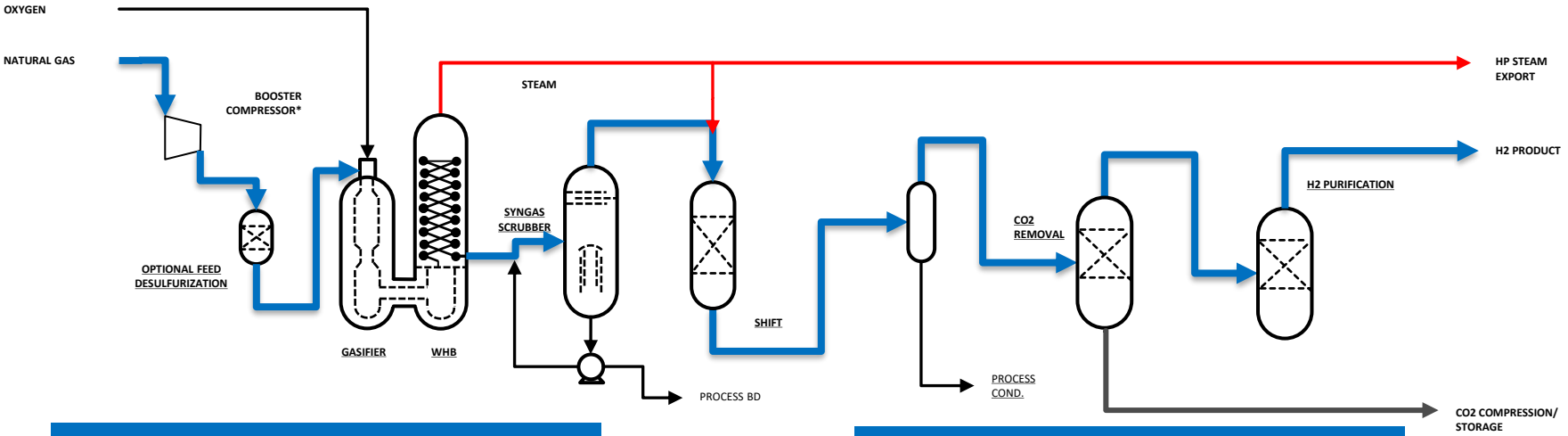
Mixed Feeds

- NG, hydrocarbon liquid, and/or moderators
- NG, wastewater, heavier hydrocarbon and/or byproduct waste
- ROG, hydrocarbon residues

Moderators

- Carbon dioxide (w/ feed gas)
- Steam (w/ feed gas or O2)
- Water (separate from steam)

Air Products POx Based Blue H2 Solution – the next generation



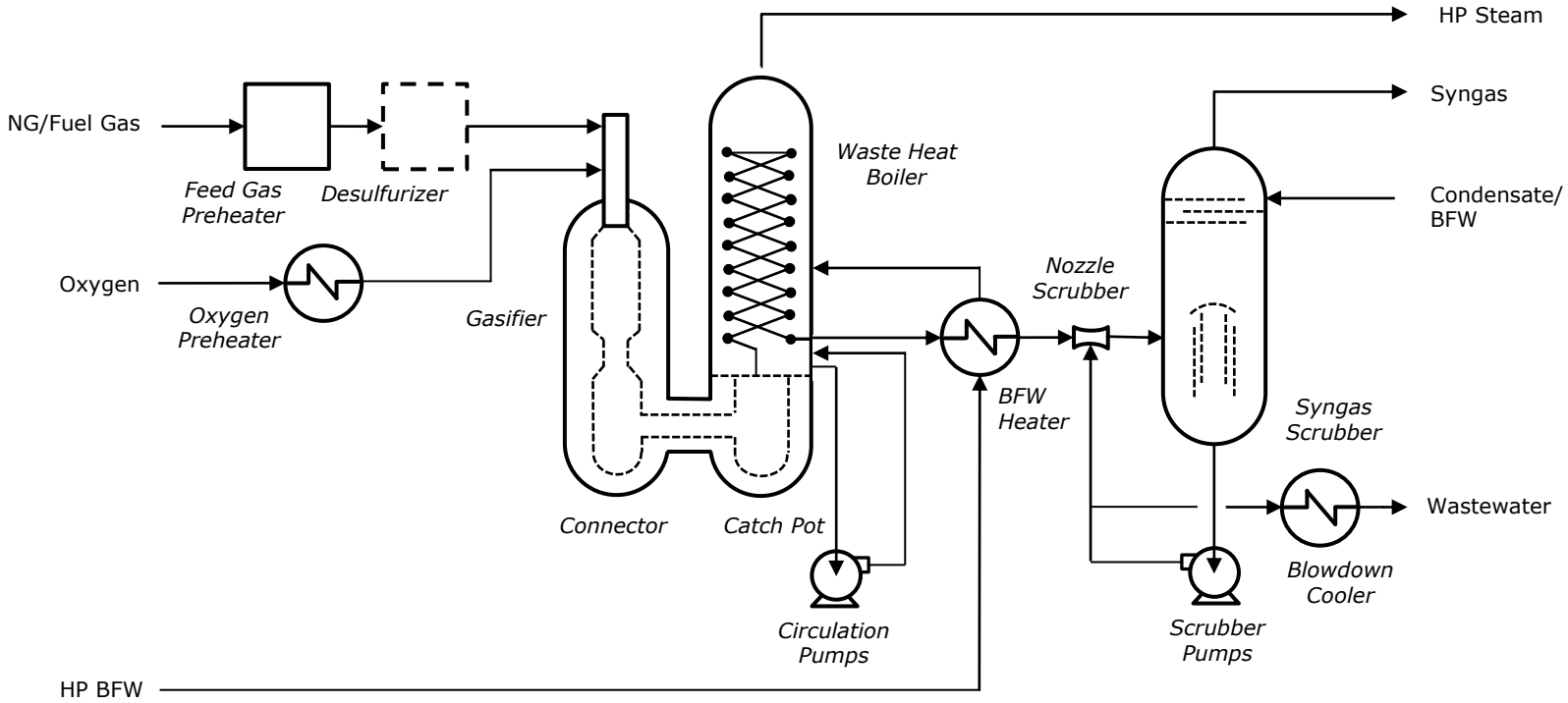
Owner's Take:

- **Non-catalytic process in Refractory lined vessel**
- **No or minimal feed pretreatment**
- **Zero direct CO2 emission from Process when needed**
- **High pressure POx → HP H2 product delivery**
- **Flexible in steam generation**

Voice of Customer:

- **High availability & reliability** (99+%)
- **No Catalyst** for Syngas generation
- **High Syngas Pressure**, feasible & proven
- **Low CH4 slip** (0.5% or lower)
- **Near zero low S/C ratio**

Air Products' POx Flexibility – Heat Recovery



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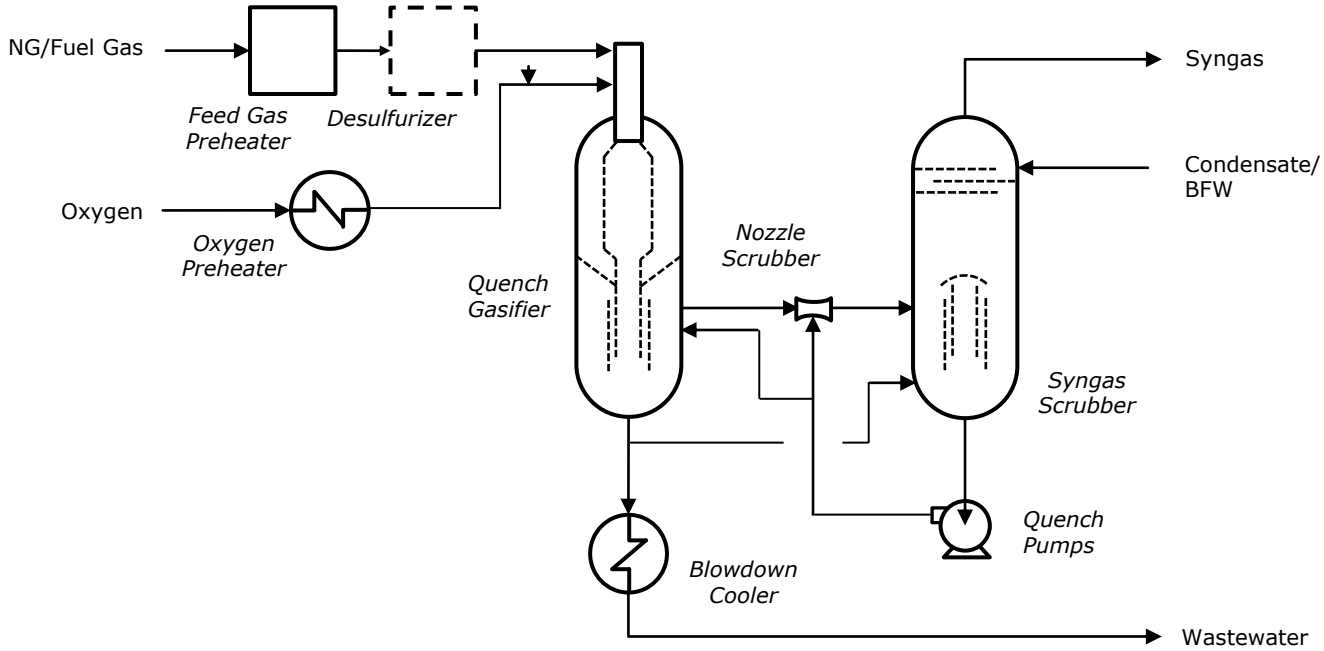

Benefits of Air Products' POx Blue Hydrogen Plant

Plant Capex

- Up to 87bar operating pressure
  - No or smaller H2 compressor
  - Smaller syngas generator
  - Smaller shift & CCS plant
- Less equipment → smaller footprint
  - Fired Furnace/Heater not required
- High single train capacity
- Less total installed cost with high CO2 capture in equation

Plant OPEX

- No regular proprietary catalyst replacement in Syngas generator & Pre-reformer
- Reduced compression duties
  - NG vs. H2 compression
- Flexibility in steam generation
- Flexibility in sulfur handling
- Increased revenue from CO2 product stream
- Simple maintenance & fast turnaround

Key Take-aways

- Partial Oxidation is a proven commercial process with a wide range of feedstock flexibility allowing optimization of feedstock for lowest carbon intensity
- Air Products' proprietary POx Process for syngas generation and its integration capability offers next Gen Blue H2 Plant with
  - Ultra high CO2 capture, up to 99+%
  - Flexibility to handle various gaseous and liquid feeds
  - Utmost heat recovery flexibility for specific project
- Low carbon feedstock in combination with high capture rates offers the ability to target very low carbon intensity hydrogen

Thank you
tell me more