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Ionikylation – Safe and Sustainable Alkylation Process

Emerging Pathways in Alkylation Technology

Well Resources Inc.

American Fuel & Petrochemical Manufacturers

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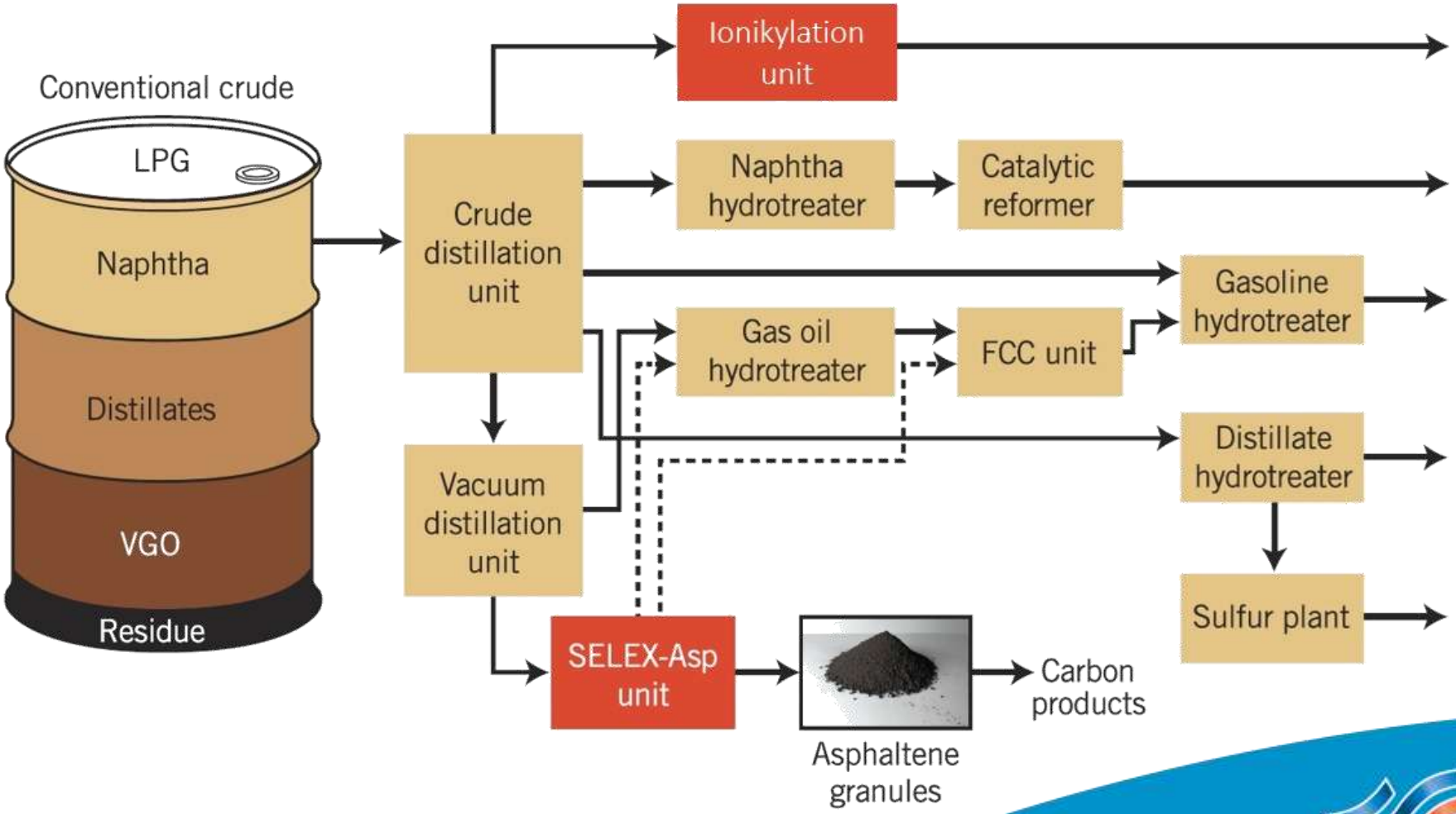
About Well Resources

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- Canadian process licensor
- Incorporated in Alberta, Canada; 100% Canadian owned since 2006
- Boutique technology company: focused on developing green and safe technologies for the petroleum sector
- Effective Resource Utilization: maximize value from traditional refinery waste streams
- Network of international partnerships for advanced R&D activities
- Well's technologies are utilized in roughly one dozen commercial installations across Asia

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Commercial Technology Offerings



What is Ionikylation?

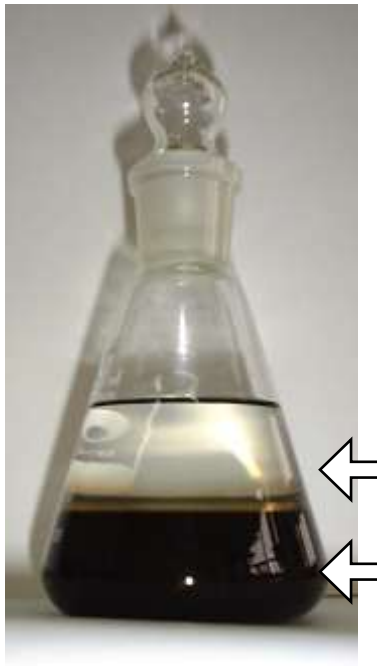
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Composite Ionic Liquid (CIL) based alkylation process

What is an Ionic Liquid?

About Ionic Liquids
- Liquid salt
- Highly manipulatable
- Most are corrosive ✘

Composite Ionic Liquid (CIL)
- Non-corrosive ✓
- Vapor pressure: ~0
- Density: 1.35-1.5 g/cm^3 (84-94 lb/ft^3)
- Viscosity: 50-60 mm^2/s (@ 20°C)
  0.08-0.09 in^2/s (@68 °F)
- Decomposition temperature: 200°C / 392°F
- Freezing point: 3.8°C / 39°F,
  -20°C / -4°F in presence of hydrocarbon

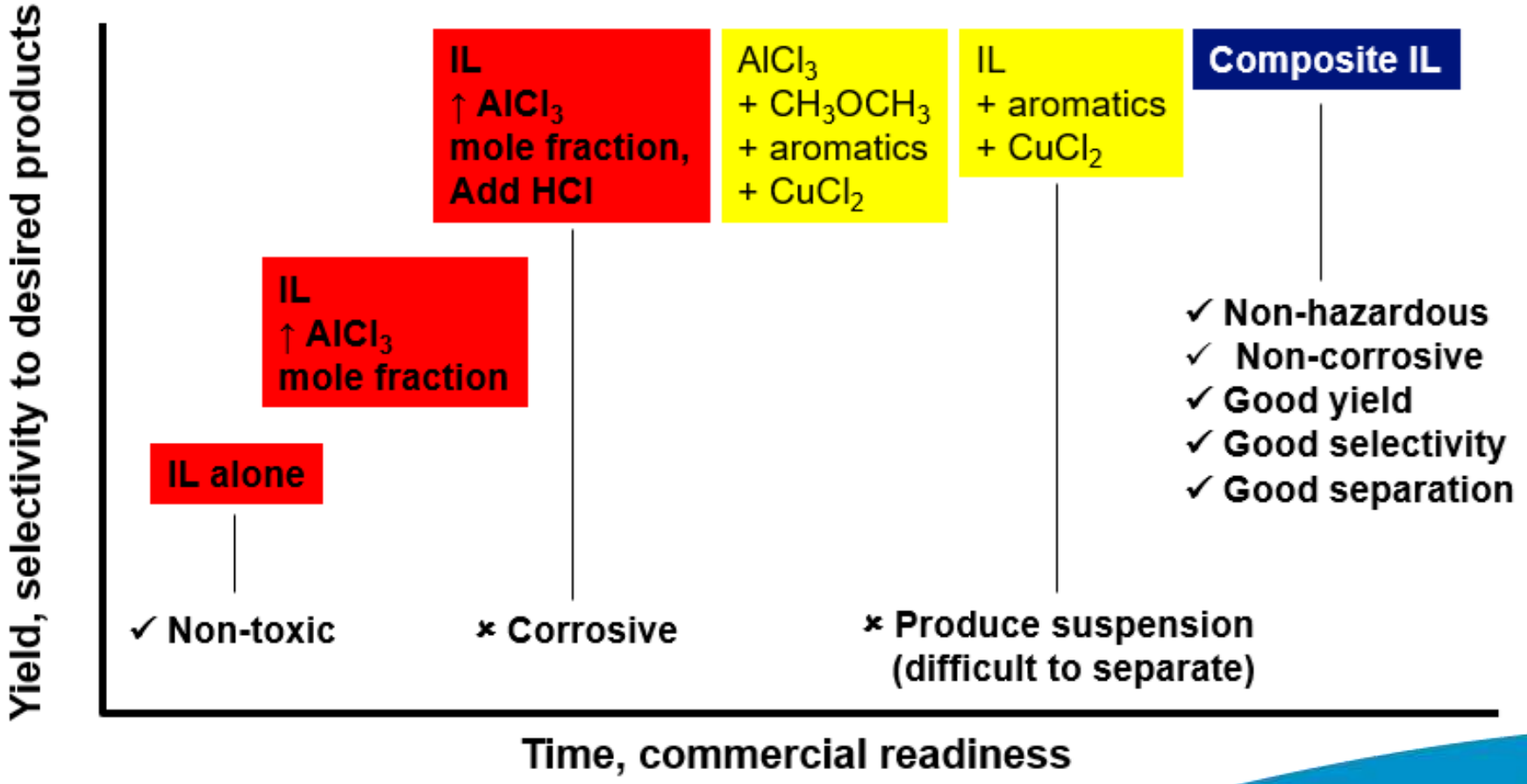


Alkylate

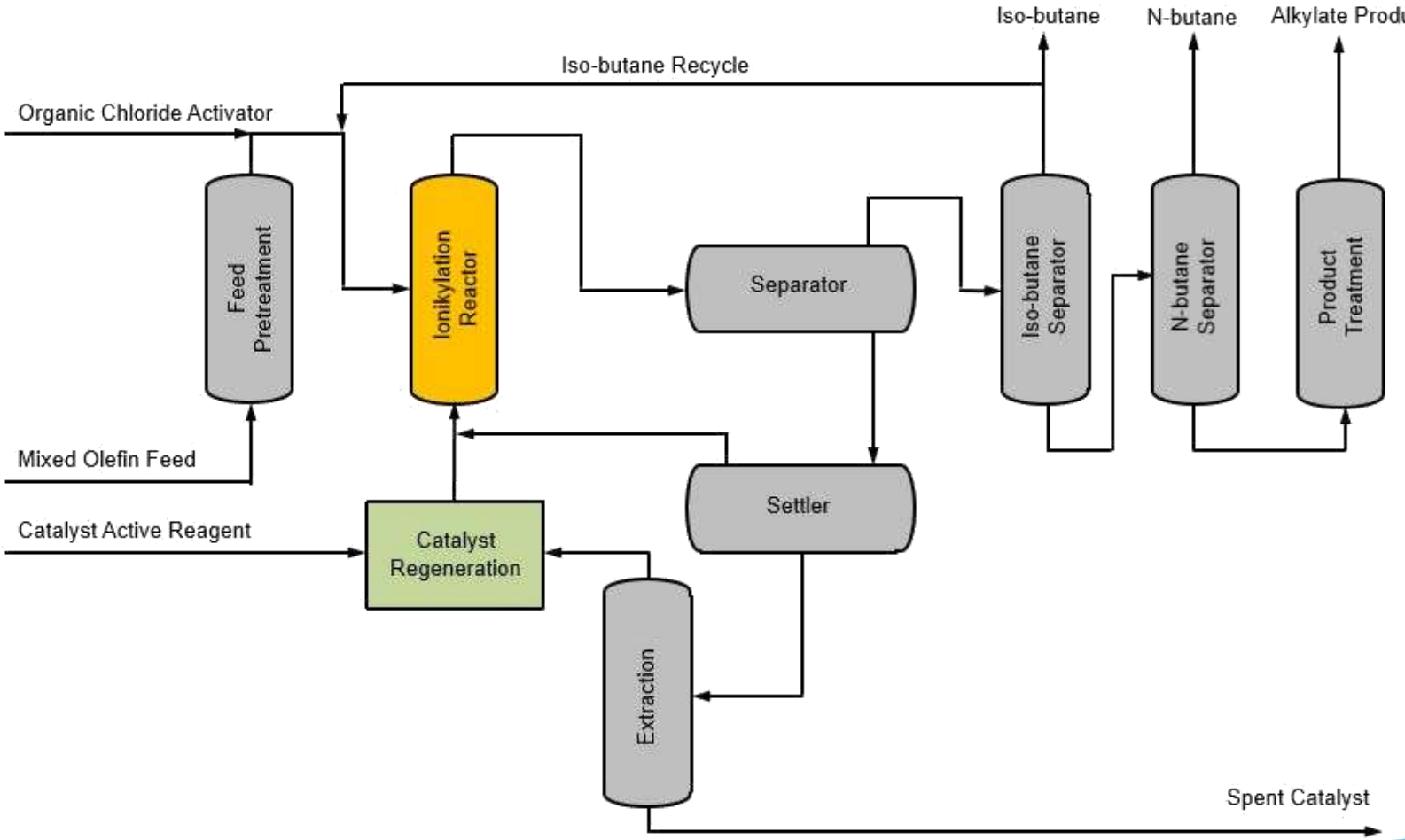
CIL Catalyst

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Catalyst Development



Ionikylation Process Flow Diagram



Ionikylation Advantages

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Safety: Ionikylation allows a refiner to change its reliance on toxic and corrosive acid catalysts such as HF and H_2SO_4.

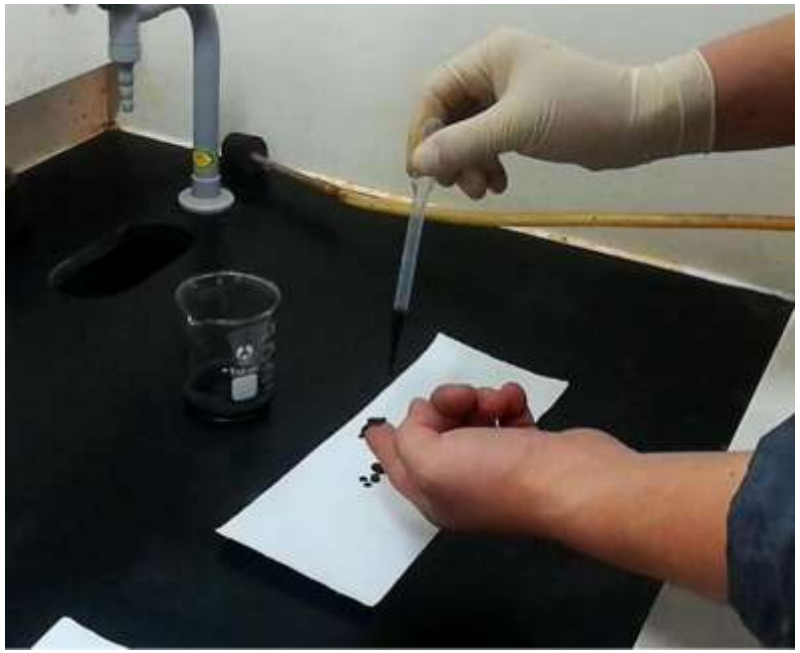
High quality alkylate product: Ionikylation has a high selectivity towards producing valuable high-octane gasoline constituents, such as trimethylpentanes, and limits the production of undesirable by-products, such as ASO.

Lower capital costs: the non-corrosive nature of the Ionikylation catalyst allows for all process equipment to be manufactured using carbon steel, as opposed to expensive and exotic metallurgies required for acid-based systems.

Integrated catalyst regeneration: the Ionikylation catalyst is generated/regenerated on-site under moderate operating conditions, which provides added benefits of emissions reductions and cost savings compared to alternative technologies.

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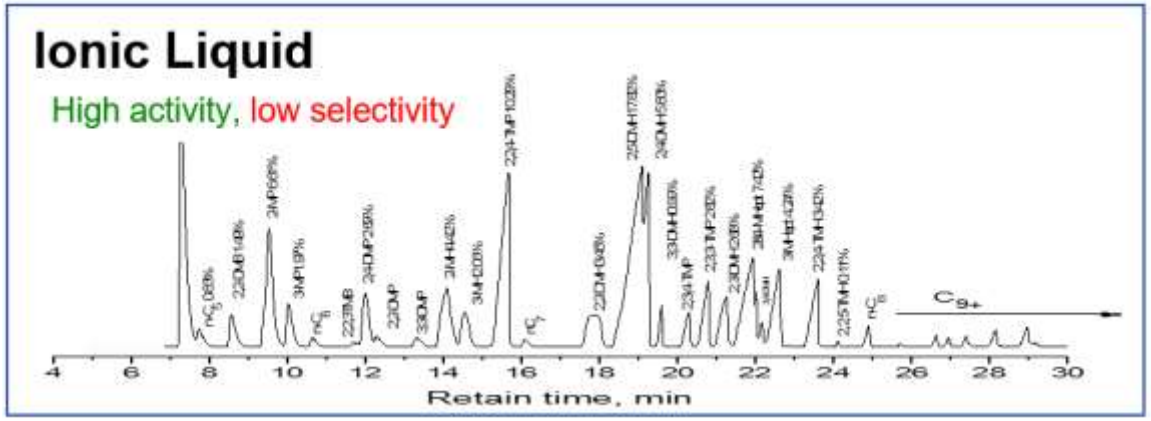
CIL Catalyst Safety

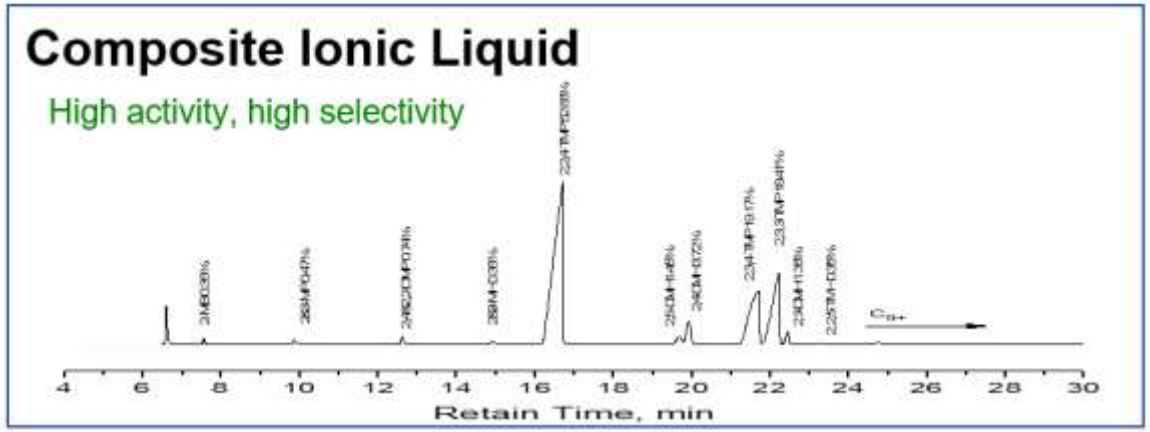


No adverse reaction when contacted with dry skin

- Provide options for safety systems – no need for water curtains, rapid secondary containment, airborne acid detection systems
- Spill incident
  - stays as liquid: safe, easy containment
  - skin exposure: wipe with dry cloth or paper, rinse thoroughly
- Standard PPE
  - ✓ gloves
  - ✓ coveralls
  - ✓ safety glasses
  - ✗ respirators/SCBAs not needed
  - hydrocarbon presents the major risk to personnel around the unit

High Activity and Selectivity





Product Yields (wt%)

	C_5-C_7	C_8	C_8+
Ionic Liquid	35.7	46.5	17.8
CIL	3.2	95.8	1.0

Highlights

- Facilitates stoichiometric reactions of isobutane and mixed olefins
- High alkylate RON (typically 96-98, feed dependent)
- Minimal side reactions, minimal ASO production, shorter alkylate distillation tails

Equipment Safety



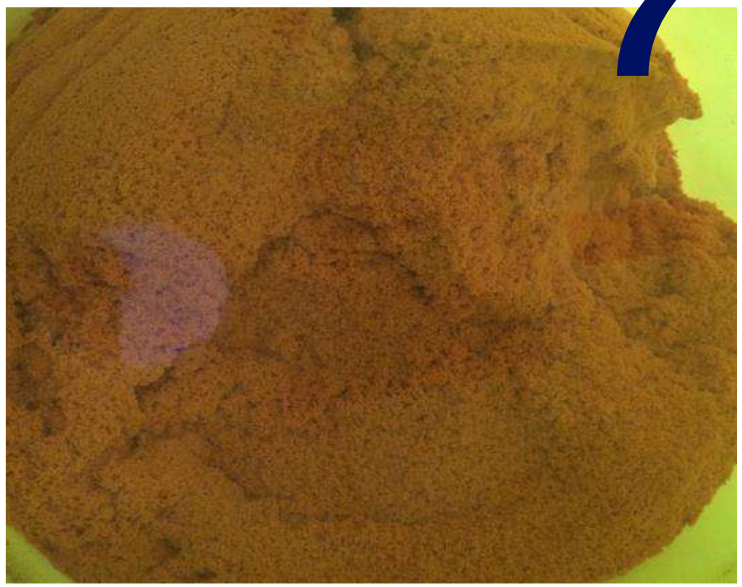





First commercial standalone unit (China, 2013) operated continuously for 3 years before government mandated safety inspection

All equipment manufactured with carbon steel, no corrosion issues noted, smooth shut-down and restart, no safety incidents, no mechanical or maintenance issues noted.

By-Products



Benign paste from extractor



Solidify



Dry

By-products are chemically benign and can be safely handled and disposed

Ionikylation Global Footprint

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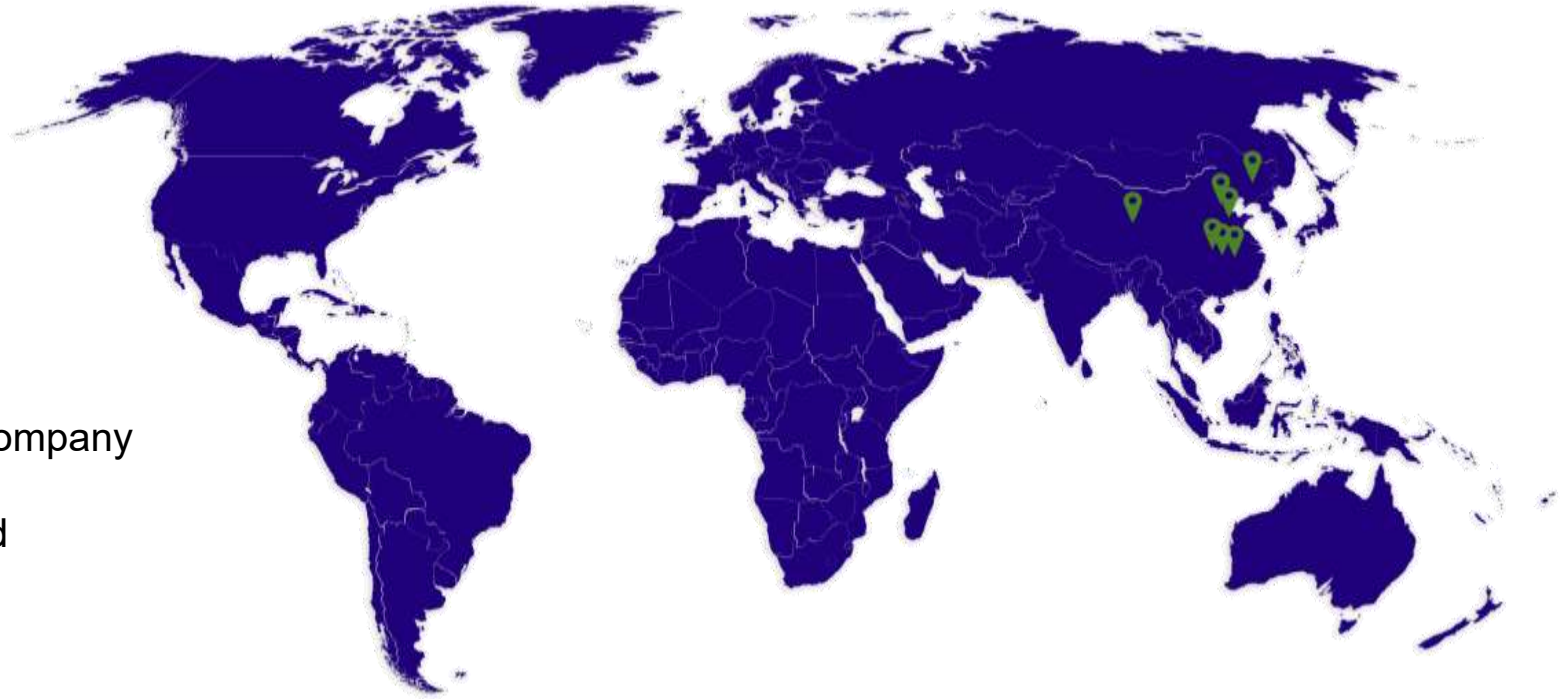
A Technology Decades in the Making

Basic laboratory research and catalyst development began in 1998

- 2003 – lab-scale pilot unit
- 2006 – commercial retrofit test (decommissioned)

Commissioned Units

1. 2013 – 2,450 bpd – Deyan Chemical Company
2. 2018 – 3,700 bpd – PetroChina Harbin
3. 2019 – 1,225 bpd – PetroChina Golmud
4. 2019 – 7,400 bpd – Sinopec Jiujiang
5. 2020 – 7,400 bpd – Sinopec Wuhan (HF alkylation revamp)
6. 2022 – 7,400 bpd – Sinopec Anqing
7. 2022 – 3,700 bpd – PetroChina Dagang



Ionikylation has become the preferred alkylation technology in China over the last decade

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Ionikylation Units



Pilot Unit
2003



Deyan Chemical Co., Ltd.
100,000 tpy, 2013



PetroChina Harbin
150,000 tpy, 2018



PetroChina Golmud
50,000 tpy, 2019



Sinopec Jiujiang
300,000 tpy, 2019



Sinopec Wuhan
300,000 tpy, 2020



Sinopec Anqing
300,000 tpy, 2022



PetroChina Dagang
150,000 tpy, 2022

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