DuPont Clean Technologies

STRATCO® Sulfuric Acid Alkylation Technology
ConvEx℠ HF Alkylation Conversion Technology

SCAQMD Working Group Meeting #5
August 23, 2017

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Technical Service & Development Manager
DuPont Clean Technologies

Agenda

- Introduction to DuPont Clean Technologies
- STRATCO® Sulfuric Acid Alkylation Technology
- ConvEx℠ HF Alkylation Conversion Technology
- Summary

Introduction to DuPont Clean Technologies

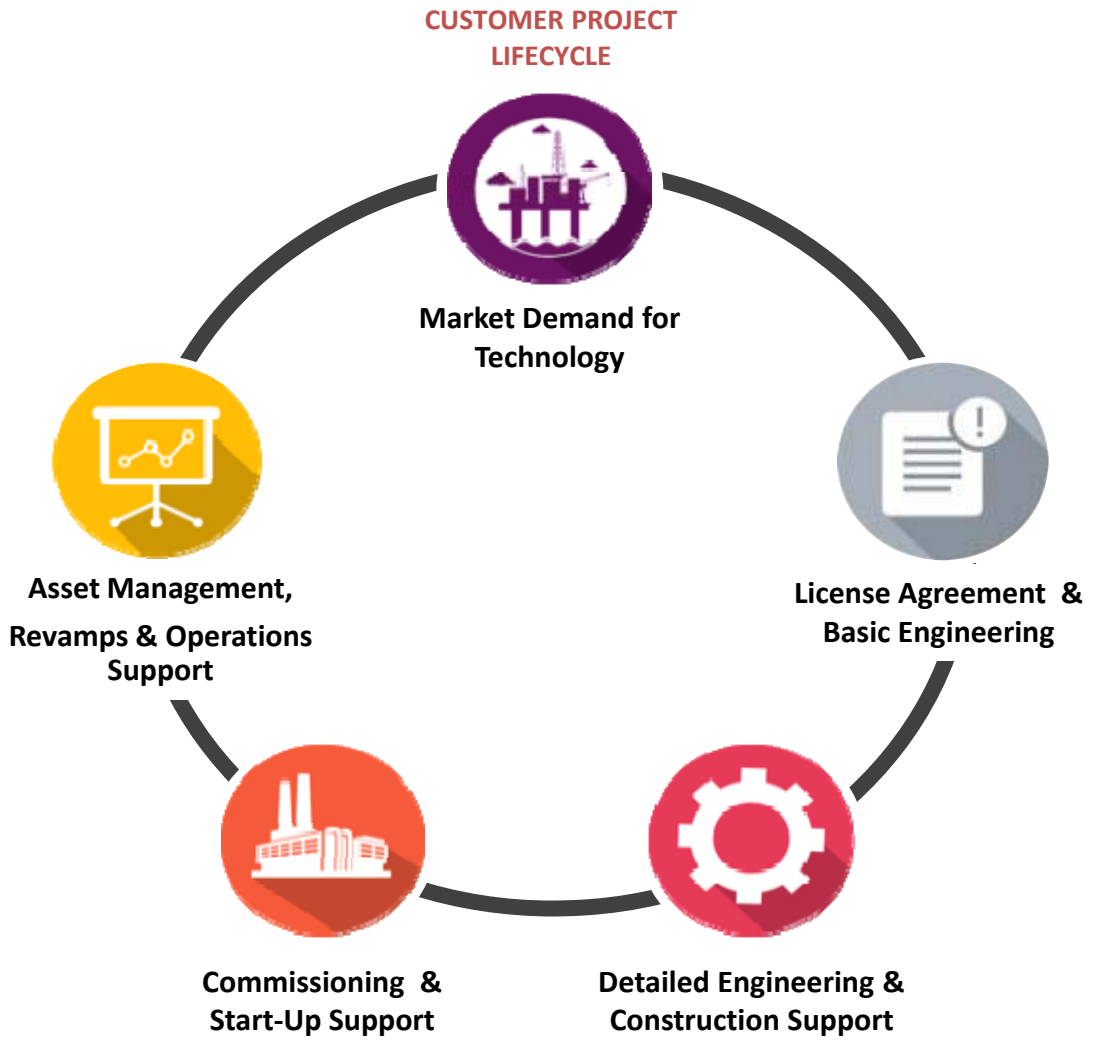
Clean Technologies Businesses

MECS® Sulfuric Acid & Environmental Technologies	BELCO® Clean Air Technologies	STRATCO® Alkylation Technology	IsoTherming® Hydroprocessing Technology
Technology leader for the production of sulfuric acid and related high performance products.	Emissions reduction technology leader for SOx, NOx, and particulates for refinery FCCs and the marine market.	Technology leader for the production of low-sulfur, high octane gasoline blend stock.	Unique hydroprocessing technology for removal of sulfur to ultra-low levels from diesel & intermediate petroleum products.
> 1000 client references worldwide	> 300 installed units worldwide	> 90 licensed units worldwide	> 20 licensed units worldwide




Global Leader in Sustainable Process Technologies

- Global Technology Leaders
- Sustained Performance
- Reliability
- Energy Efficiency
- Environ-mental Integrity



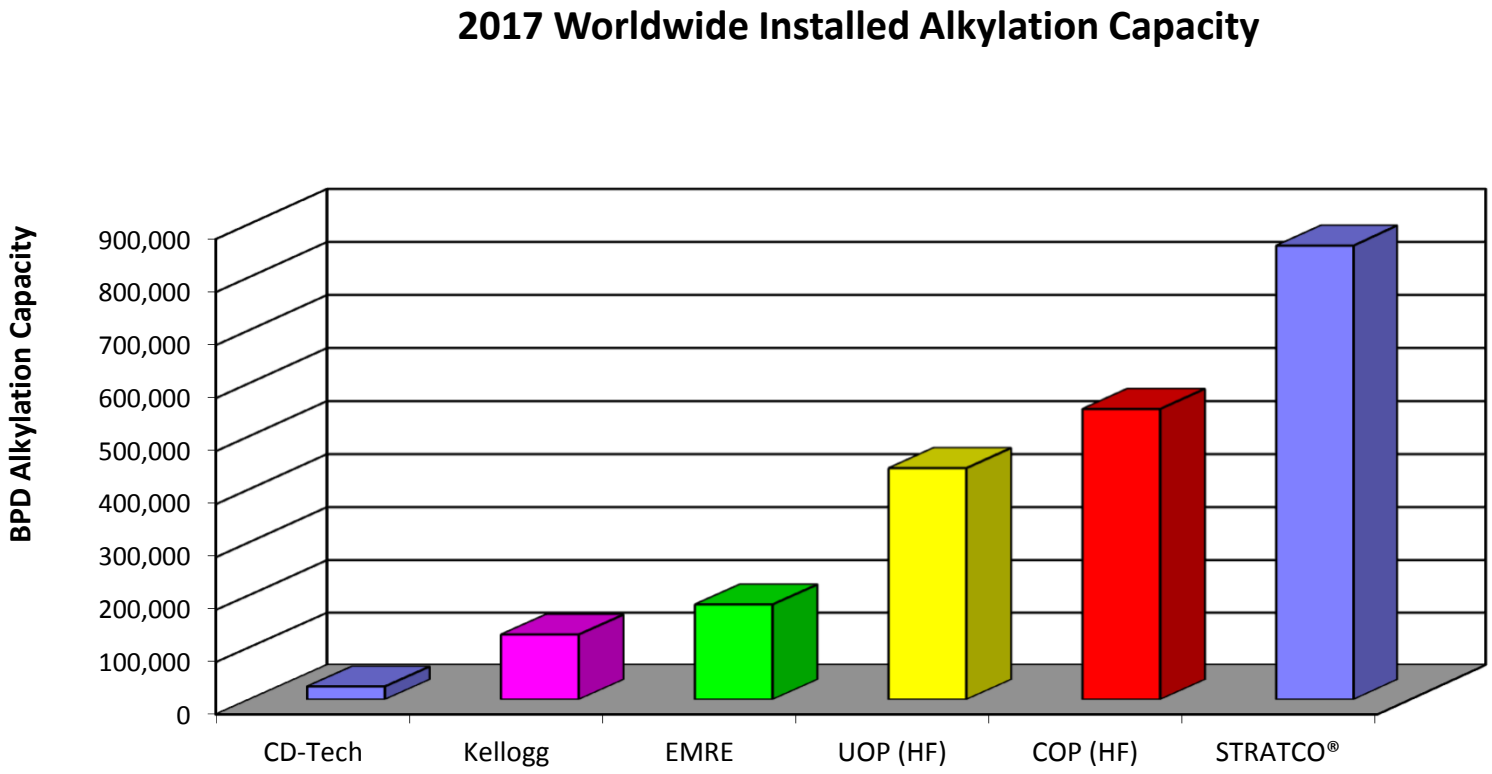
- MECS® Sulfuric Acid & Environmental Technologies
- BELCO® Clean Air Technologies
- STRATCO® Sulfuric Acid Alkylation Technology
- IsoTherming® Hydro-processing Technology

STRATCO® Sulfuric Acid Alkylation Technology

STRATCO® Alkylation Technology at a Glance

Years in Alkylation	**85+**
People Dedicated to Technology	**50 + Regional**
Licensed Units	**90+**
Repeat Customers	**50+**
Barrels of Installed Capacity	**850,000+**
Barrels of Licensed Capacity	**1,000,000+**
Performance Guarantee Success Rate	**100%**
On-Going Alkylation R&D	**Yes**
In-House Engineering Expertise	**Yes**
In-House Technical Service Expertise	**Yes**

Market Leader in Alkylation Technology



Licensee	Location	Startup	Capacity (kmta)	Capacity (bpsd)
TBA	China	2018	300	7,700
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TBA	China	2018	400	10,200
TBA	China	2018	300	7,700
TBA	USA	2019	1,410	36,000
TBA	China	2018	300	7,700
TBA	Nigeria	2018	1,150	29,500
CNPC Jinxi	China	2016	250	6,300
TBA	North America	2018	470	12,000
TBA	South America	2018	250	6,500
TBA	China	2018	370	9,500
Turkmenbashi	Turkmenistan	2016	280	7,000
TBA	Russia	2018	200	5,000
TBA	China	2016	240	6,000
TBA	China	2019	450	11,500
TBA	Middle East	2019	700	17,500
TBA	Middle East	2019	560	14,200
TBA	Middle East	2019	470	12,000
Rosneft Angarsk	Russia	2017	140	3,500
Takreer	UAE	2015	1,500	38,000
TBA	Russia	2020	240	6,000
CPC	Taiwan	2013	700	18,000
TBA	Middle East	Delayed	860	22,000
Bashneft Ufa	Russia	2012	400	10,000
TBA	India	Delayed	1,300	33,000
SATOPR	Middle East	2013	470	12,000
ENAP	Chile	2012	270	7,000
Petrotrin	Trinidad	2012	400	10,000
Hyundai	South Korea	2011	550	14,000
SK	South Korea	2010	630	16,000

STRATCO® Alkylation Activity

Licensed/ Installed

Licensee	Location	Startup	Capacity (kmta)	Capacity (bpsd)
CNOOC	China	2009	160	4,000
S-Oil	South Korea	2009	360	9,200
PetroRabigh	Saudi Arabia	2009	900	23,000
Lukoil	Bulgaria	2009	240	6,000
SK	South Korea	2008	700	18,000
GS Caltex	South Korea	2005	470	12,000
Valero	St. Charles, LA	2005	310	8,000
Valero	Benicia, CA	1967, 2004	710	18,000
CPC	Taiwan	2003	310	8,000
Omsk	Russia	2002	310	8,000
Ecopetrol	Colombia	2002	270	7,000
Shell	Wilmington, CA	1973, 1996, 2002	80	2,000
Irving Oil	Canada	2001	310	8,000
Slovnaft	Slovakia	1999	310	8,000
BP	Carson, CA	1941, 1990, 1999	710	18,000
KNPC	Kuwait	1998	220	5,500
Total	Germany	1998	310	8,000
Fuji	Japan	1997	160	4,000
Calumet	Shreveport, LA	1996	160	4,000
SK	South Korea	1996	240	6,000
Showa Yokkaichi Sekiyu	Japan	1996	310	8,000
Equistar	Houston, TX	1943, 1995	780	20,000
Chevron	Richmond, CA	1995	950	24,000
Chevron	El Segundo, CA	1995	780	20,000
PetroChina	China	1995	80	2,000
Raffineria di Milazzo	Italy	1986, 1995, 2002	80	2,000
Singapore Refining	Singapore	1995	240	6,000
Urumqi Petrochemical	China	1994	60	1,600

STRATCO® Alkylation Activity

Licensed/ Installed

Licensee	Location	Startup	Capacity (kmta)	Capacity (bpsd)
Shell	Deer Park, TX	1994	780	20,000
Hovensa	Virgin Islands	1993	550	14,000
Cosmo	Japan	1993	240	6,000
Sinopec	China	1993	160	4,000
Valero	Houston, TX	1992	160	4,000
TOC (NPRC)	Japan	1992	180	4,500
Total Fina Elf	France	1992	160	4,000
Western Refining	El Paso, TX	1966,1991	160	4,500
KOA (NPRC)	Japan	1991	120	3,000
MOC (NPRC)	Japan	1991	140	3,500
PBF	Delaware City, DE	1990	160	4,000
Irving Oil	Canada	1990	240	6,000
PES	Philadelphia, PA	1990	240	6,000
Motiva	Port Arthur, TX	1941, 1990	570	14,500
ErgMed	Sicily	1989	240	6,000
Sinopec	China	1989	160	4,000
Nippon Petroleum	Japan	1988	160	4,000
Chevron	Canada	1987	160	4,000
ExxonMobil	Baton Rouge, LA	1987	400	10,000
Idemitsu Kosan	Japan	1986	240	6,000
Naftgas	Yugoslavia	1986	160	4,000
Chevron	Pascagoula, MS	1961, 1980	640	16,200
Shell	Port Arthur	1858, 1980	240	6,000
Tesoro	Wilmington, CA	1968, 1980	430	11,000
Motiva	Norco, LA	1964, 1975	550	14,000
Shell	Wilmington, CA	1965, 1975	340	8,600
Imperial Oil	Canada	1975	310	8,000
PetroCanada	Canada	1964, 1973	120	3,100
Shell	Anacortes, WA	1958, 1973	310	8,000

STRATCO® Alkylation Activity

Licensed/ Installed

Licensee	Location	Startup	Capacity (kmta)	Capacity (bpsd)
BP	Texas City, TX	1953, 1972	900	23,000
Citgo	Lake Charles, LA	1969, 1972	630	16,000
Flint Hills	Pine Bend, MN	1961, 1972	400	10,000
Valero	Sunray, TX	1970	340	8,700
Tesoro	Anacortes, WA	1958, 1970	470	12,100
Marathon	Detroil, MI	1959,1968, 2004	240	6,000
Tesoro	Martinez, CA	1967	470	12,000
Hess	Purvis, MS	1966	180	4,500
Shell	Martinez, CA	1966	310	8,000
ConocoPhillips	Wood River, IL	1966	860	22,000
Motiva	Convent, LA	1966	630	16,000
Sunoco	Westville, NJ	1965	120	3,000
Sunoco	Toledo, OH	1965	270	7,000
Hess	Port Reading, NJ	1962	260	6,700
ExxonMobil	Beaumont, TX	1957, 1961	510	13,000
Chevron	Barber's Point, HI	1960	140	3,500
Sinclair Oil	Tulsa, OK	1960	120	3,000
Sinclair Oil	Sinclair, WY	1943	160	4,200

STRATCO® Alkylation Activity

Licensed/ Installed

Range of Feedstock Experience

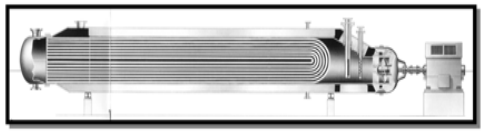
Commercial Alkylation Units

FCC Butylenes	FCC Amylenes
MTBE Butylenes	Coker Butylenes
FCC Propylene	High-Purity Isobutylene

Design / Pilot Plant

Dehydrogenation Butylenes	High-Purity 2-Butene
Dehydrogenation Propylene	C_6 Olefins
High-Purity 1-Butene	

Commitment to Innovation



1920

1929 – FIRST VERTICAL CONTACTOR INSTALLED

1928 – STRATFORD ENGINEERING

1930 – ALKYLATION PROCESS DEVELOPED

1940 – AVIATION FUEL AND WORLD WAR II

1960

1960s – EFFLUENT REFRIGERATED ALKYLATION

1957 – R&D LABORATORY

1977 – STRATCO, INC.

1980

1983 – FIRST BEST PRACTICES WORKSHOP USER CONFERENCE

1994 – ALKYSAFE PATENT
1992 – LOW TEMPERATURE ALKYLATION PATENT

1998 – SEGREGATED OLEFIN PATENT

1996 – HOUSTON OFFICE

2000

2003 – DUPONT ACQUIRES STRATCO

INNOVATIONS TO MARKET
2012 – XP2
2005 – ¾" TUBE BUNDLES
2002 – TUBE INSERTS

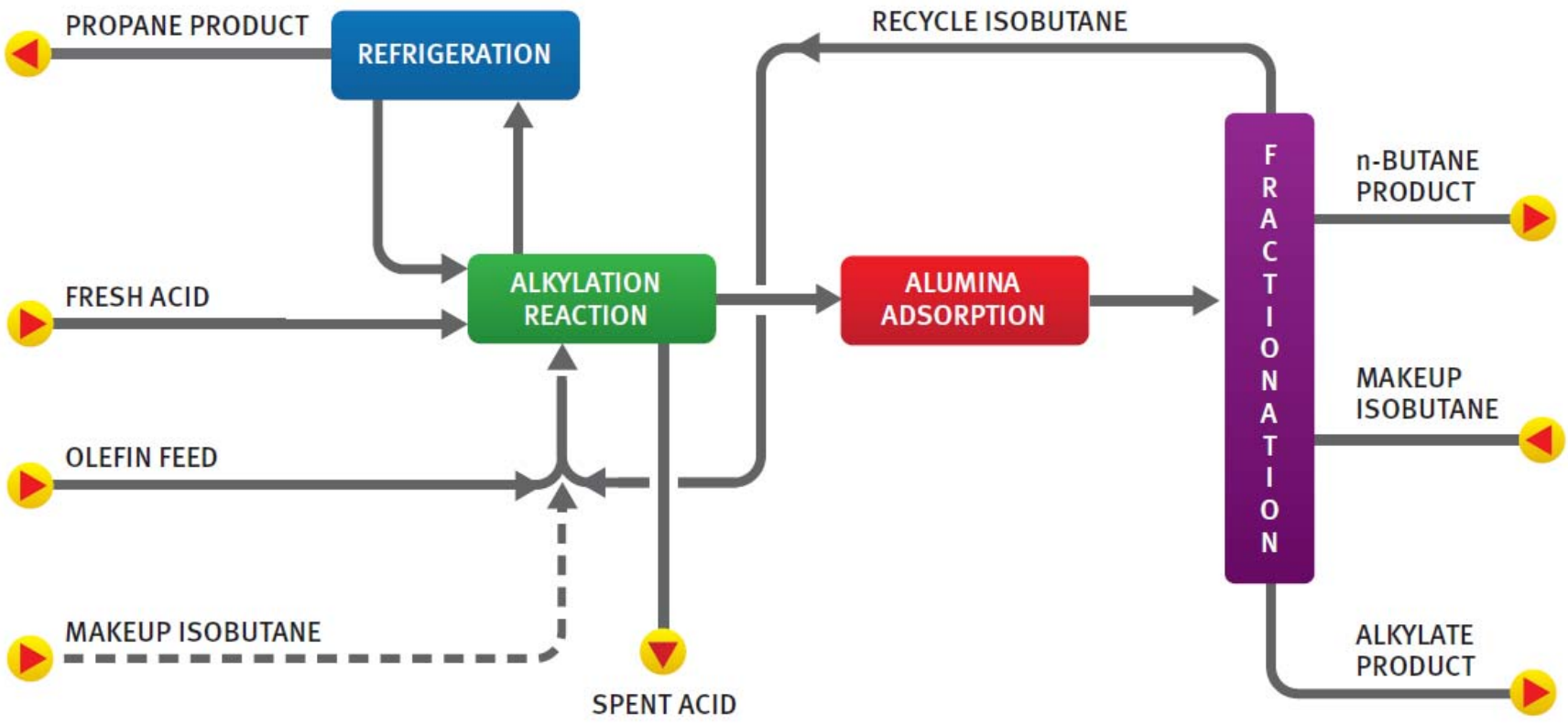
2010 –MECS (ACID REGENERATION)
2010 – SUSTAINABLE SOLUTIONS
2009 – OTS TRAINING SIMULATOR
2008 – GES – AFTERMARKET
2007 – ISOTHERMING
2007 – CLEAN TECHNOLOGIES

ALLIANCES
REACTOR SIZE
NEXT GENERATION

2016 -DRY ALUMINA TREATING
2017 -HF CONVERSION

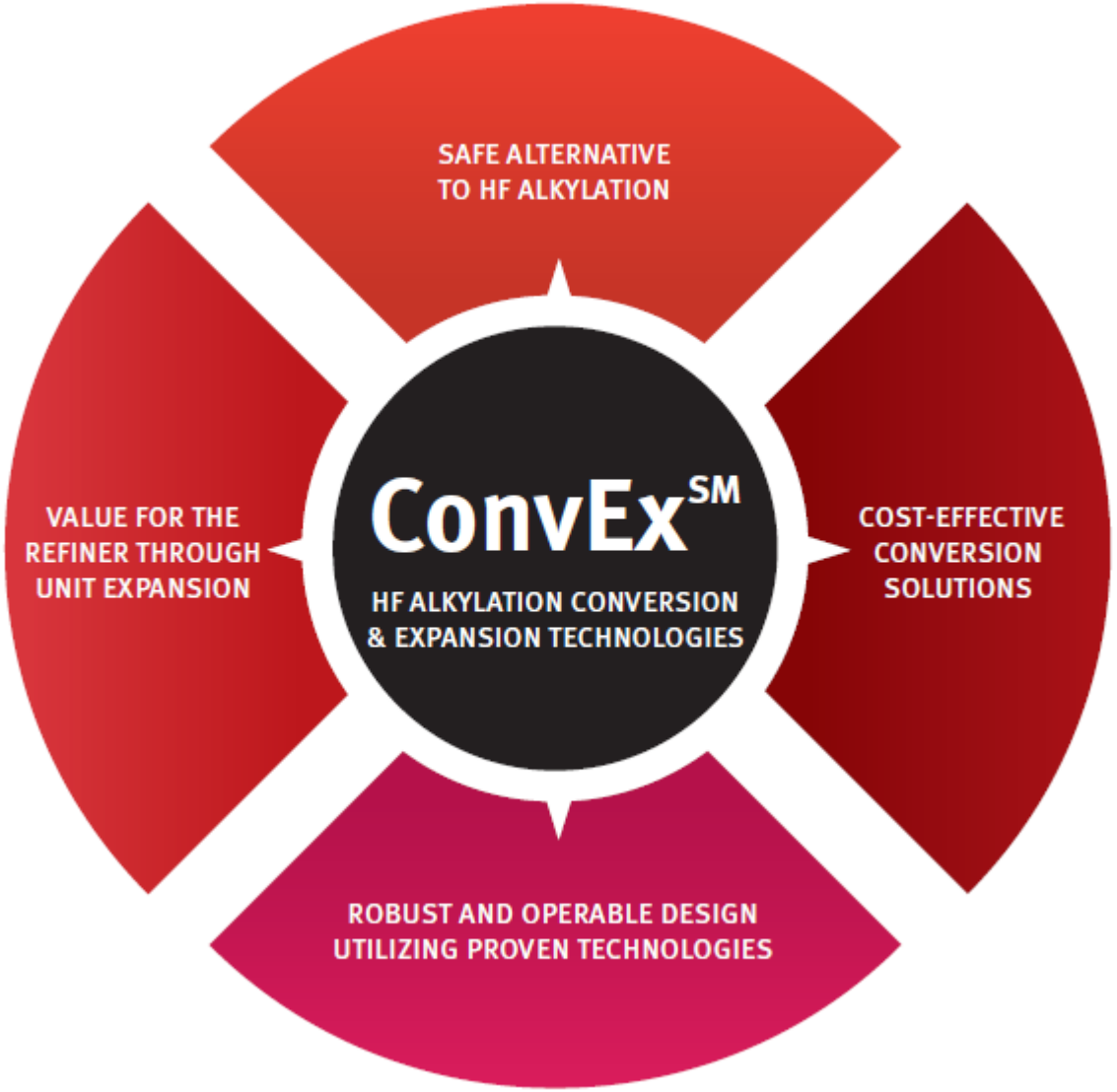
2020

Block Flow Diagram



ConvEx℠ HF Alkylation Conversion Technology

Value Proposition



ConvEx℠ Technology Overview

- Proprietary solutions developed for conversion of both of the major HF alkylation technologies (UOP and Phillips)
- Most cost-effective conversion technology on the market due to maximum reuse of existing HF alkylation unit equipment
- Although many aspects of this technology are new (patent pending), DuPont has leveraged its experience and know-how as the leading provider of sulfuric acid alkylation technology to develop proven, robust, and operable conversion solutions
- Significant unit expansion is possible in most cases in conjunction with the conversion to sulfuric acid with minimal additional cost

Conversion Cost

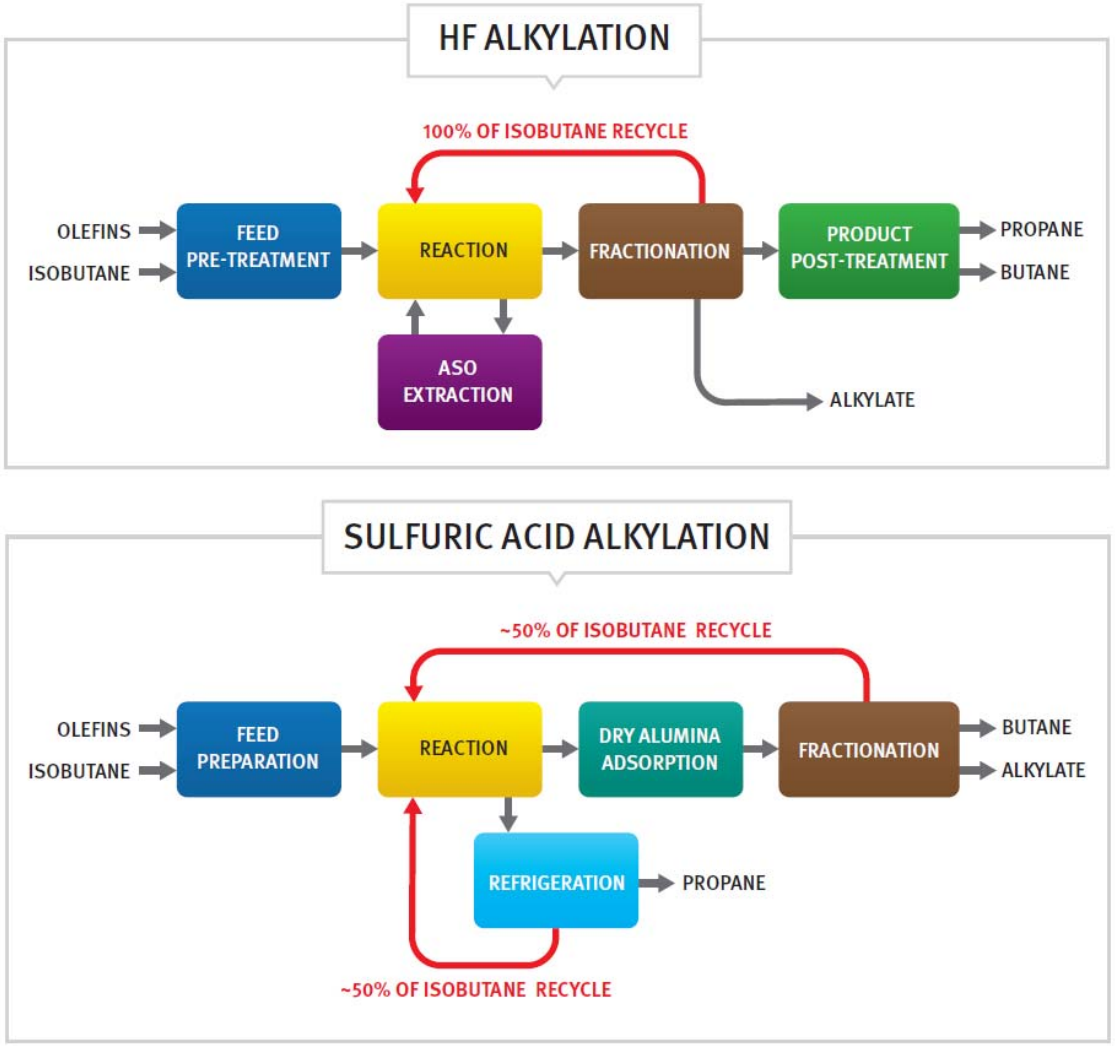
ConvEx℠ Technology	Competitor Claims
~40-60% the cost of a grassroots sulfuric acid alkylation unit	**80%** the cost of a grassroots sulfuric acid alkylation unit

- Based on alkylation equipment that is Inside Battery Limits (ISBL)
- Does not include Sulfuric Acid Regeneration
- Based on typical configuration and site with available plot space

Cost Reduction Achieved by:

- Reusing more of the existing HF alkylation unit equipment
- Much of the HF alkylation unit equipment is in the same or similar service which eliminates expensive unit reconfiguration
- Innovative design features which greatly reduce equipment count

Alkylation Unit Expansion



ConvEx℠ Case Studies

	% Capacity Increase
A	+68%
B	+178%
C	+114%
D	+96%

Unit Downtime for HF Conversion

The methodology and timing for completing a unit conversion of this magnitude **will vary greatly between refineries**

Some refiners may choose to build a grassroots alkylation at a new location on the site while operating the existing unit to reduce unit downtime, lost opportunity costs, and regional gasoline supply issues

For the ConvEx℠ technology and any other conversion to sulfuric acid alkylation, some new equipment will be required (refrigeration, e.g.)

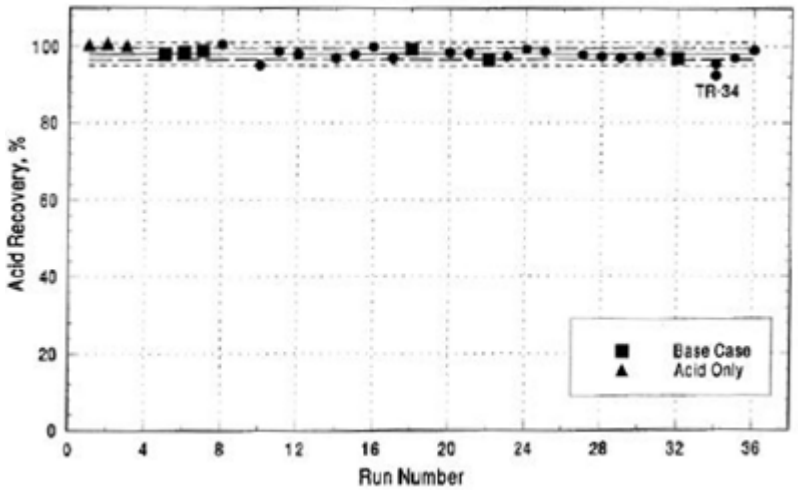
If adequate plot space near the existing unit is available, the installation of the new equipment can be done while the existing unit is operating

In this case, we estimate the remainder of the construction can be completed in a typical 30-45 day turnaround

Sulfuric Acid Safety

- Sulfuric Acid is the most widely used chemical in the world and is constantly being transported and stored in most large cities
- Used in fertilizers, detergents, pharmaceuticals, foods, water treatment, etc.
- Very little 'non-standard' PPE required in sulfuric acid alkylation units
- Sulfuric Acid does not form an aerosol when released to the atmosphere as a mixture with LPG (similar to alkylation conditions)

1991 Sulfuric Acid Release Test showed an average of 97.6% sulfuric acid recovery due to acid pooling



Source: http://www.questconsult.com/papers/sulfuric-acid-release-report/

Summary

Licensor Qualifications

STRATCO® Alkylation Technology

- *Global Leader in Sulfuric Acid Alkylation Technology*

- ✓ **Total Licenses – 90+**
- ✓ **Repeat Customers – 50+**
- ✓ **STRATCO®/MECS® Complexes - 35**

MECS® Spent Acid Regeneration Technology

- *Global Leader in Sulfuric Acid Technologies*

- ✓ **Total Alkylation SAR Licenses - 60**
- ✓ **Largest Alkylation, Metallurgical and Chemical SAR Acid Plants**
- ✓ **Over 1,000 Sulfuric Acid Plants Designed Worldwide**

Summary

- ✓ **Most Experienced Alkylation / SAR Licensor**
- ✓ **Proven Technologies**
- ✓ **Safe and Reliable Designs**
- ✓ **Strong Commitment to Innovation**
- ✓ **HF Conversion More Attractive Through Cost Reduction and Expansion**

Contact Information

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