

INNOVATIVE PATHS TO CLEANER SKIES

2025 HONEYWELL APAC SAF CONFERENCE

SAF Plant Operations & Maintenance Experience

ANOOP MATHEW

May 29, 2025

Honeywell



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AGENDA

TITLE

I. Feedstocks to an Ecofining Unit

II. Damage Mechanisms in Ecofining

III. Ecofining Catalyst Offering

IV. Digital Offering

V. Summary

FEEDSTOCKS FOR ECOFINING PROCESS

Plant Based Oils

- Rapeseed/Canola
- Soybean
- Palm, PFAD
- Carinata, Camelina
- Jatropha
- Inedible Corn Oil
- Tobacco oil



Metals Contamination	→
Processing Difficulty	↓
H2 Consumption	↑

Animal Fats

- Tallow (beef)
- Choice White Grease (pork)
- Poultry Fat



Metals Contamination	↑
Processing Difficulty	↑
H2 Consumption	↓

Waste Greases

- Used Cooking Oil
- Yellow Grease



Metals Contamination	↑
Processing Difficulty	→
H2 Consumption	→

Algal and Microbial Oils

- **Tall Oil Fatty Acid (TOFA)** - Rosin (or Resin, used interchangeably) Acids (RA)
- **Algal Oils:** Production of algal oil for commercial scale biofuels feed production remains very limited

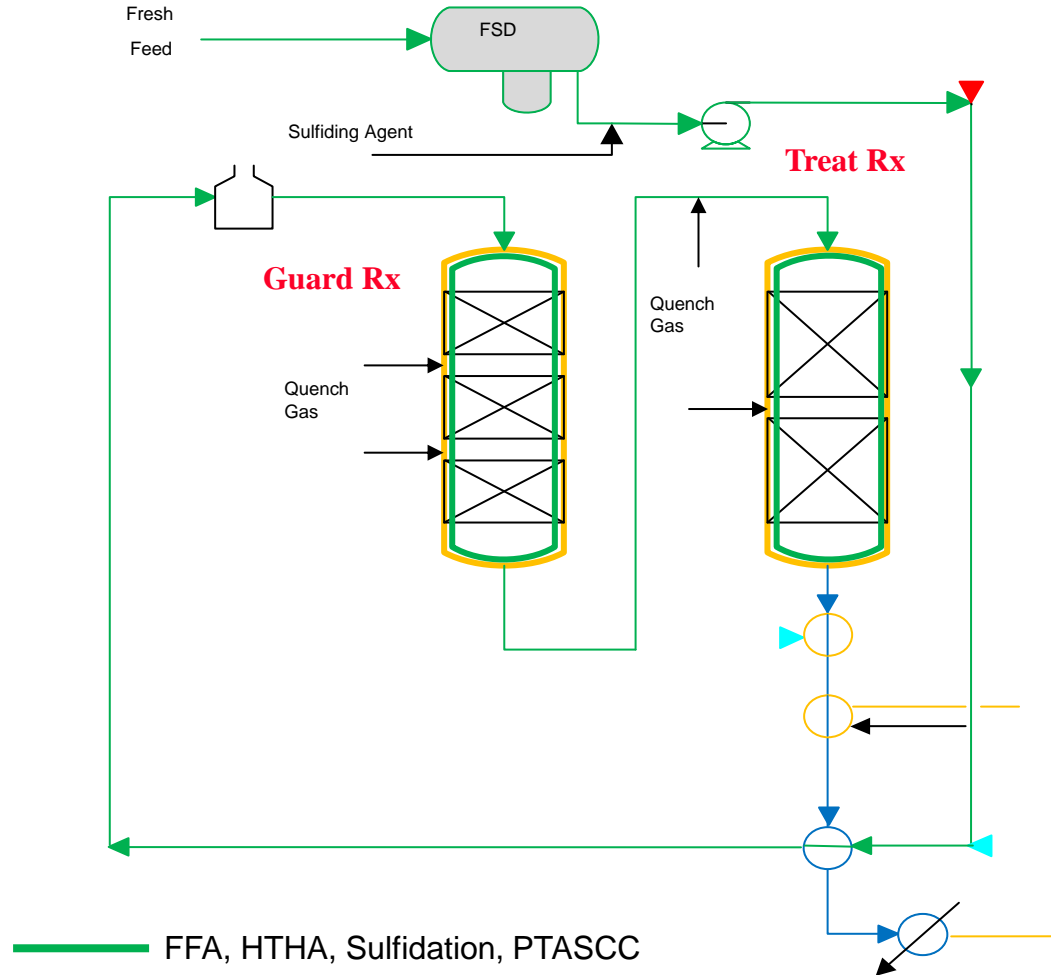


Metals Contamination	↓
Processing Difficulty	↑
H2 Consumption	→



Extensive Operating Experience and Understanding of Renewable Feedstock Characteristics

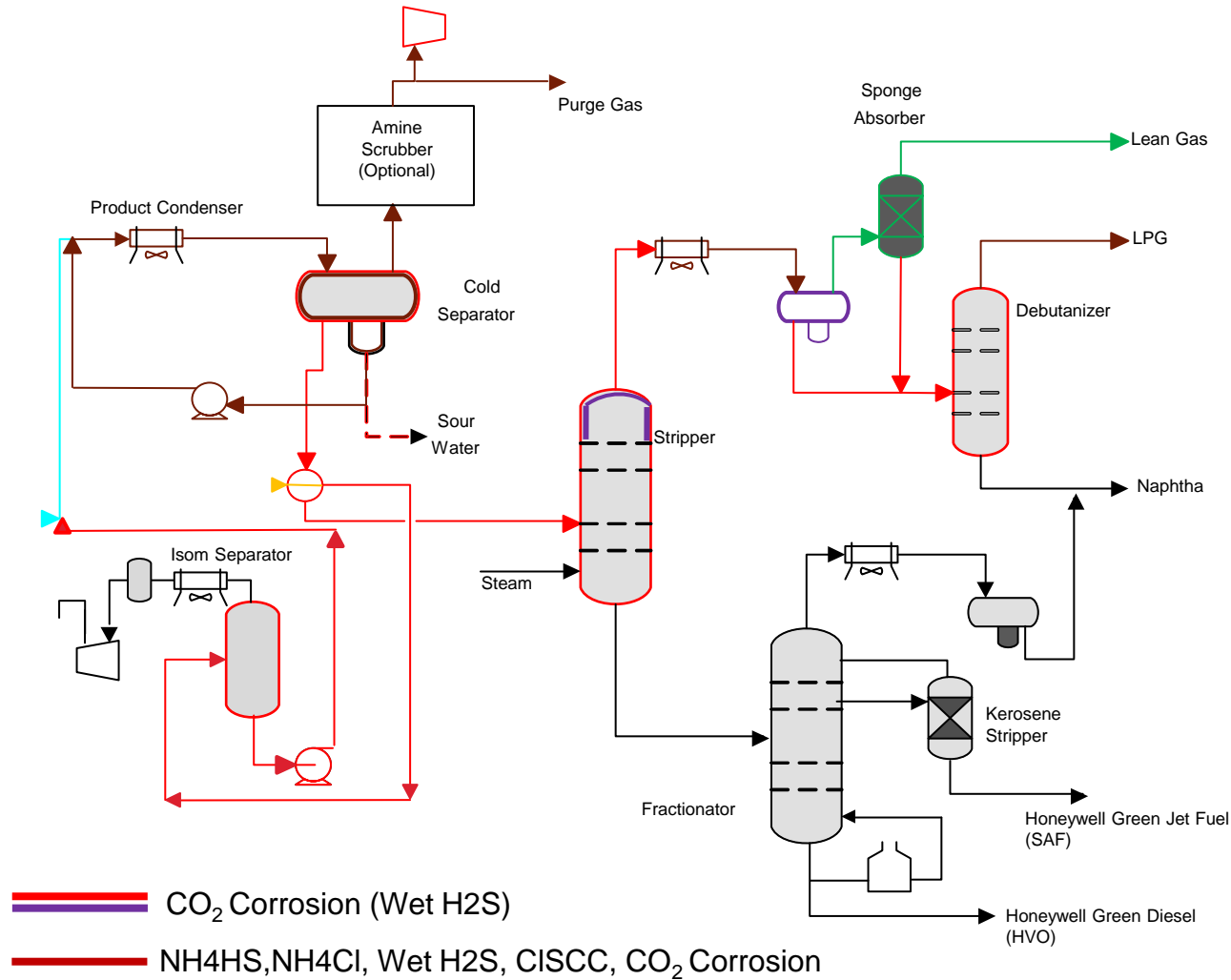
ECOFINING – UNIQUE DAMAGE MECHANISMS



Fatty Acid Corrosion

- Free Fatty Acid (FFA) corrosion is a significant corrosion risk in the feed & reactor system
- All oils has the potential to produce FFA
- Fatty Acid Corrosion resistance requires Molybdenum containing Stainless Steel or higher alloys
- UOP can design units to enable processing of up to 100% FFA content

ECOFINING – UNIQUE DAMAGE MECHANISMS



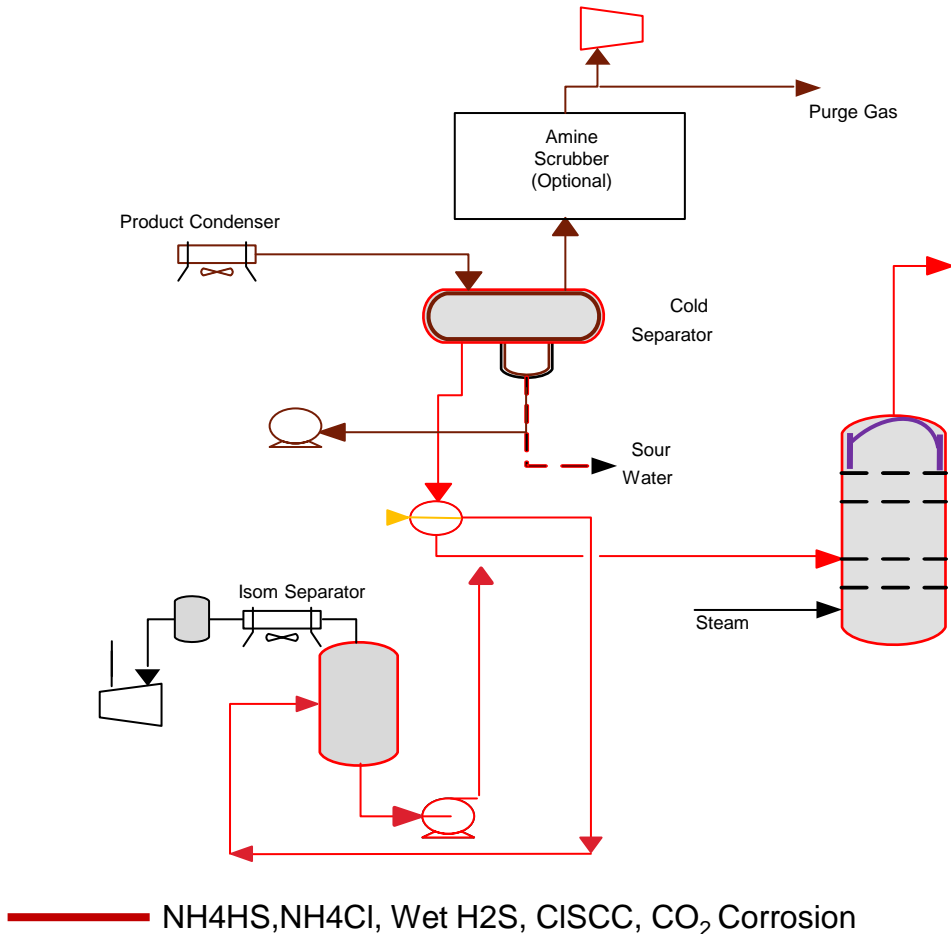
Carbonic Acid Corrosion

- **Fatty acids are converted to water and CO₂ in the Reactor**
- **As the effluent cools, it forms Carbonic acid that is corrosive to Carbon Steel and low-Chrome Steels**
- **Dead legs where water condenses would be at risk of increased corrosion**
- **Nickel Alloys are selected in design**

ECOFINING – UNIQUE DAMAGE MECHANISMS

Chloride Damage

- Damage due to HCl, Ammonium Chloride & Chloride Stress Corrosion Cracking
- Dead legs and high point vents where water condenses would be at risk of increased corrosion
- Nickel Alloys are selected in design
- Locations and grades optimized based on commercial data to balance investment and on-stream reliability

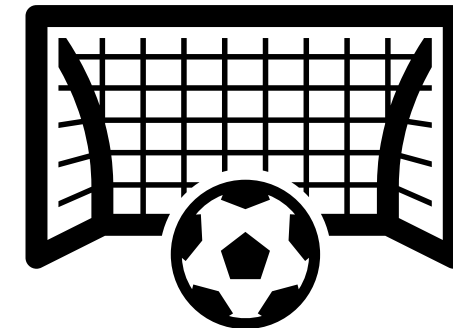


Robust, Reliable Unit Design - Developed from Extensive Commercial Knowledge

UOP PROVEN TRACK RECORD MEETING GUARANTEES

UOP Designed Units						
Test Run from Commercial Start-ups	US Refinery 2-Stage Unit	US Producer 2-Stage Unit	US Refinery 2-Stage Unit	US Refinery 2-Stage Unit	EU Project 2-Stage Unit	Asia Unit 2-Stage Unit
	Guarantee Test Run Results					
Feed Capacity, min	✓	N/A	✓	✓	✓	✓
Yield, min	✓	✓	✓	✓	✓	✓
Product Properties	✓	✓	✓	✓	✓	✓

Non-UOP designed Units		
Test Run Data for takeaways	US Refinery 1-Stage Unit	US Producer 1-Stage Unit
	Guarantee Test Run Results	
Yield, min	✓	✓
Product Properties	✓	✓



Performance Guarantees in Commercial Units were Met and Accepted

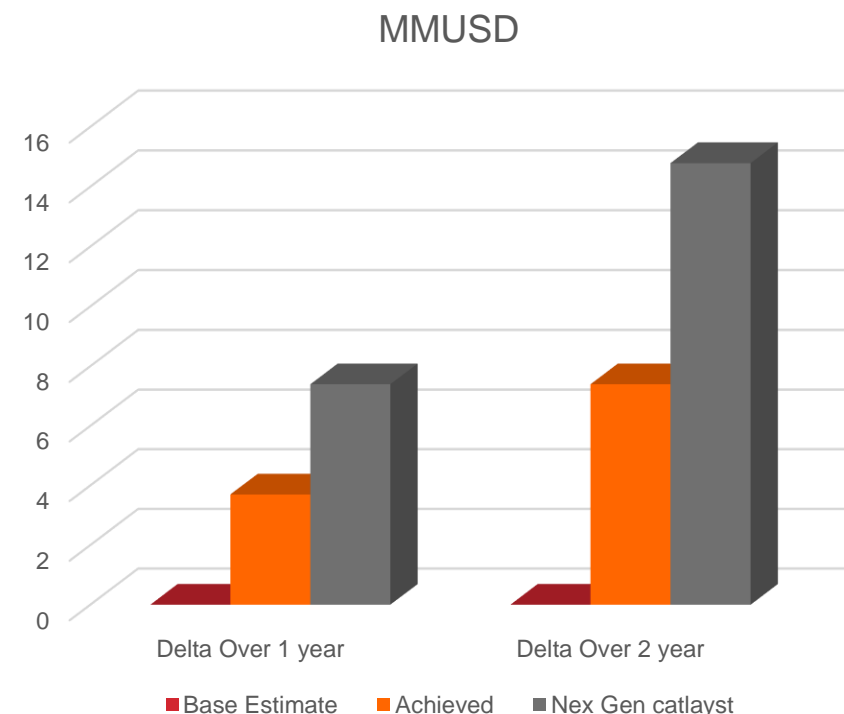
ECOFINING CATALYST OFFERINGS

SYSTEMS	FEATURES	REACTION
Stage 1 <i>Guard Bed</i> (BGB-300, BGB-350)	<ul style="list-style-type: none"> Active graded-bed materials to remove/convert foulants and avoid pressure drop build-up Lower activity catalysts and operating conditions selected to remove metals and promote HDO over DCO reactions → >95% HDO selectivity achieved commercially 	<p>DEOXYGENATION STAGE</p> <p>ISOMERIZATION STAGE</p>
Stage 1 <i>Hydrotreating</i> (BDO-400)	<ul style="list-style-type: none"> Higher activity catalysts and operating conditions selected to complete HDO and HDN reactions Flexibility to handle a broad range of feedstocks and contaminants 	
Stage 2 <i>Isomerization</i> (DI-100, DI-200, DI-300)	<ul style="list-style-type: none"> Catalysts and operating conditions selected to “dewax” products to adjust diesel cloud point with minimal yield loss of distillate Flexibility to shift product mix between diesel and jet 	

Proven to deliver longer cycle lengths and higher distillate yields

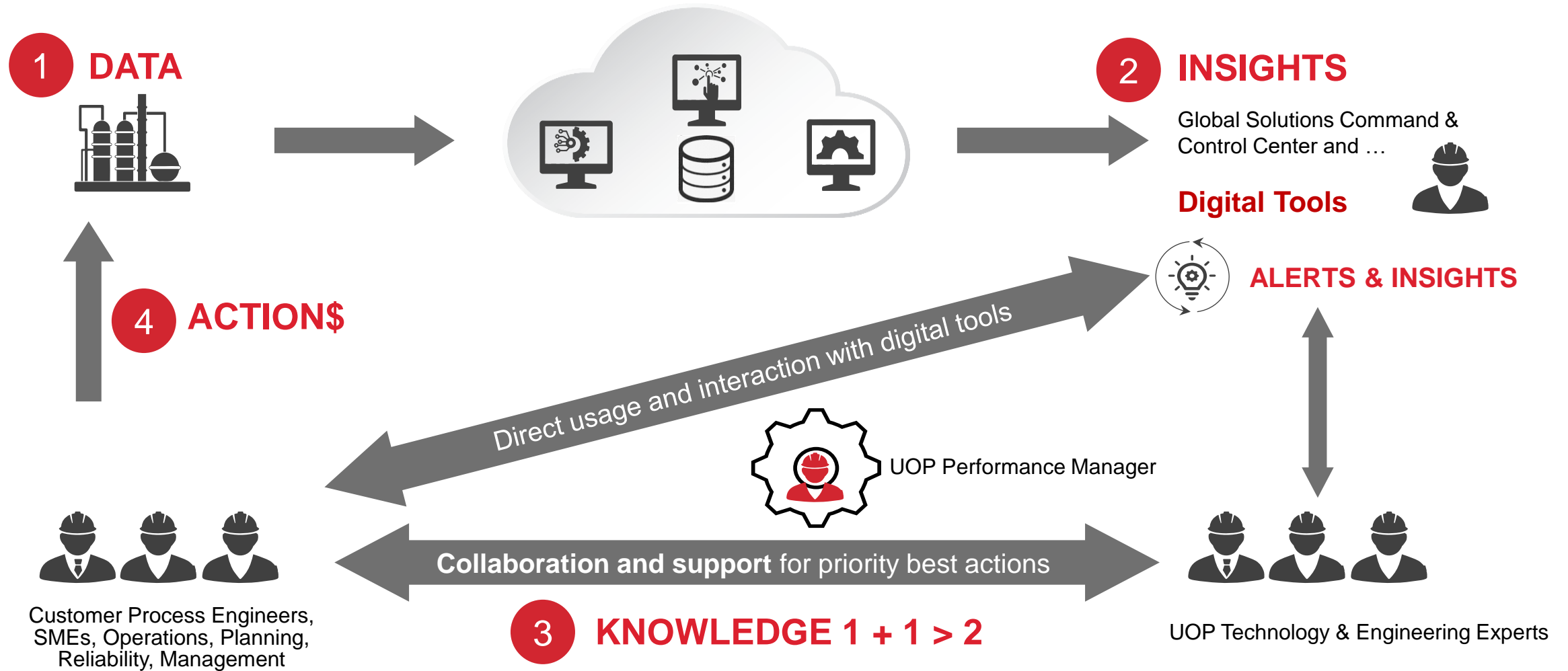
EUROPEAN REFINER – CATALYST PERFORMANCE - CASE STUDY 1

- UOP Ecofining technology produces Sustainable Aviation Fuels (SAF) Meeting **ASTM D7566** specification for Aviation Fuel under Annex A2 for HEFA-SPK
- **Feed Flexibility:** Operating with a different feed blends- as per the market availability
- **Excellent Stability :** Guard, Treating and Isomerization catalyst operating for more than 16 months. +20% Extra Cycle length anticipated
- **SAF Yields:** + 2 vol% incremental SAF from Estimates leading to > 8 MMUSD over the cycle
- Next Generation Commercialized Catalyst: Estimated to > 14-15 MMUSD
- **Continuous Interactions:** With changing Feed, continuous interactions & optimizations to maximize the benefits SAF yields



Despite processing a more challenging feed, catalyst continues to demonstrate excellent performance

OPERATING MODEL | PERFORMANCE+ SERVICES



Digitally Enabled, Proactive Services – Better, Faster, Higher Value Services

SUMMARY

- UOP Ecofining technology produces Sustainable Aviation Fuels (SAF) which meets the ASTM D7566 specification for Aviation Fuel under Annex A2 for HEFA-SPK
- Extensive commercial experience managing the unique characteristics of renewable feedstocks and associated damage mechanisms
- Proven, reliable performance across multiple global installations
- Continuous Innovation in Catalyst – Driving high SAF yields across various feeds
- Ongoing operational support through UOP's Technical Experts and Digital Tools – Maximize Value from your Unit

Honeywell UOP is the Lowest Risk, Most Reliable Choice for SAF Projects

THANK YOU

Honeywell

