

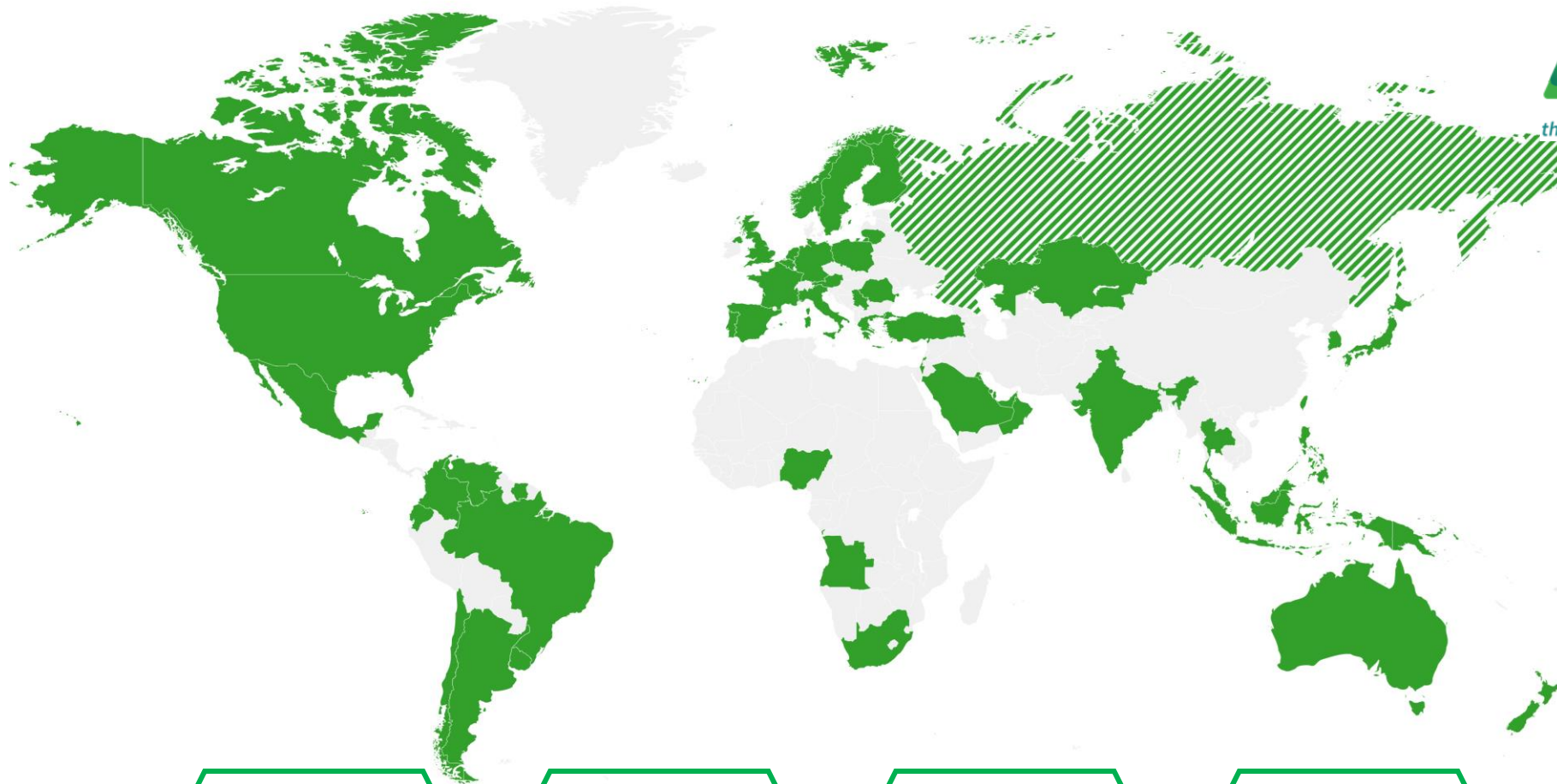


LIBERTY ENERGY
SOLUTIONS

 **ZymeFlow**[®]



Decontamination of Catalyst
in Fixed Bed Reactors



35+

Years of global
decontamination
experience

55+

Countries
ZymeFlow is
active in

200+

Turnaround
Projects/ year

0

Recordable
injuries

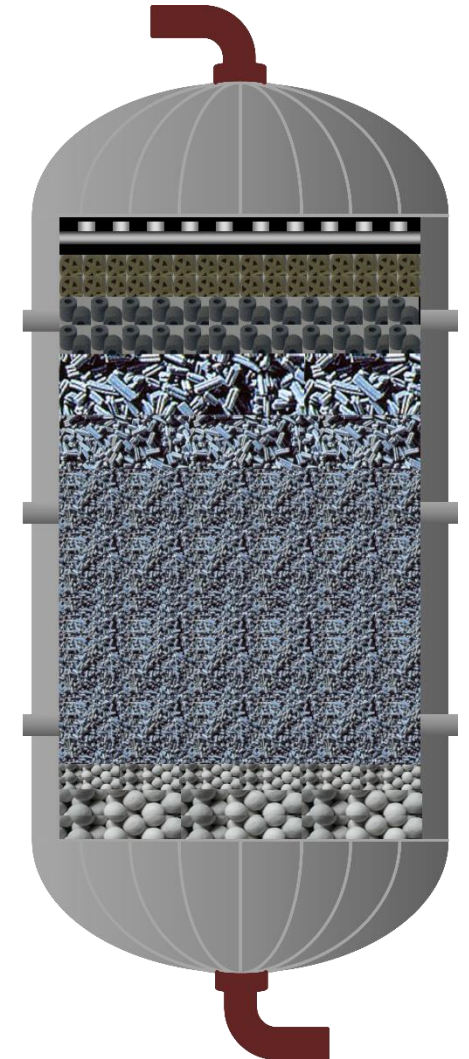
Catalyst unloading in Fixed-Bed Reactors

Common issues:

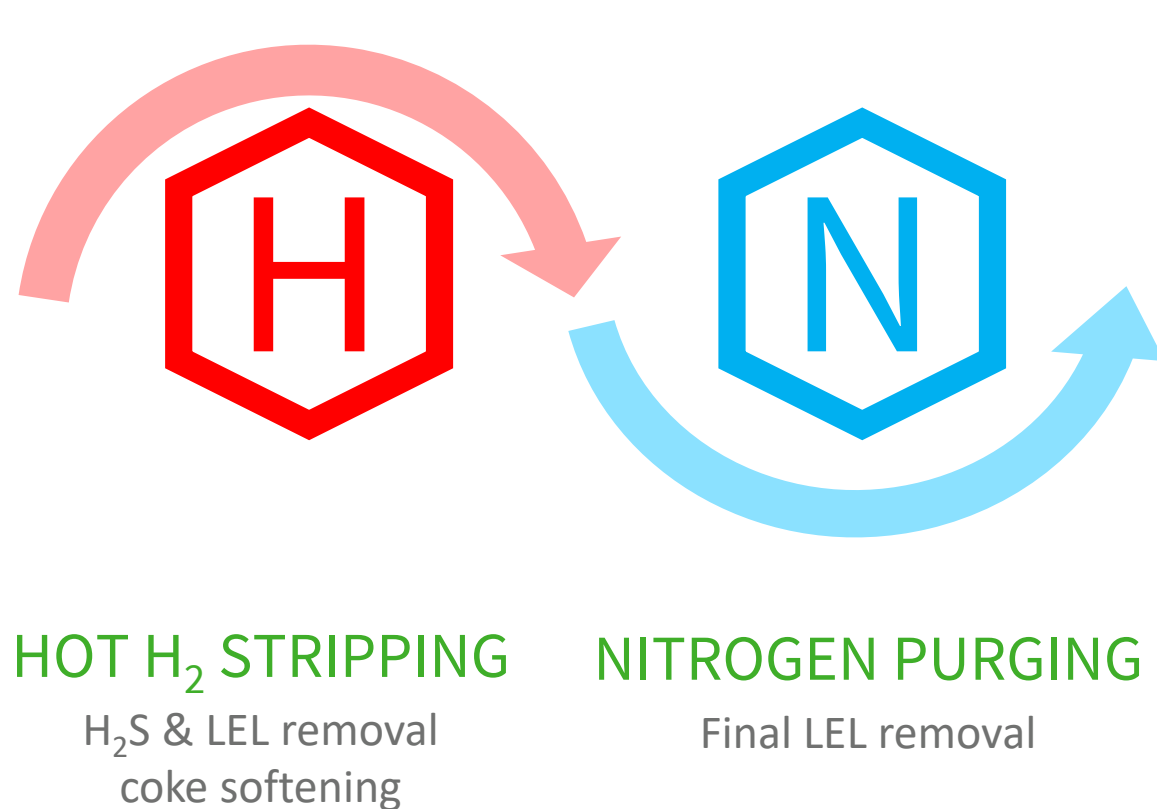
- Pockets H₂S
- High LEL
- Plugged catalyst
- Unpredictable process

Projects completed:

- Hydrocrackers
- Diesel Hydrotreaters
- Kerosene Hydrotreaters
- HVGO Hydrotreaters
- Naphtha Hydrotreaters
- Isomerizers
- Reformers



Historical Approach to Reactor Cleaning



DISADVANTAGES:

- Excessive time to clear the LELs
- High consumption of Hydrogen
- High consumption of Nitrogen
- Unpredictable process and delays
- Business disruption

CatZyme Chemistries

ZymeFlow[®] Effective Option

- Solvent-based
- Patented chemistry
- Injected during the hot H₂ sweep
- Powerful scrubber highly effective at clearing LEL
- High Kb value for removing coke binders



Surfactant-free

Nitrogen-free

Sulfur-free

Phosphorus-free

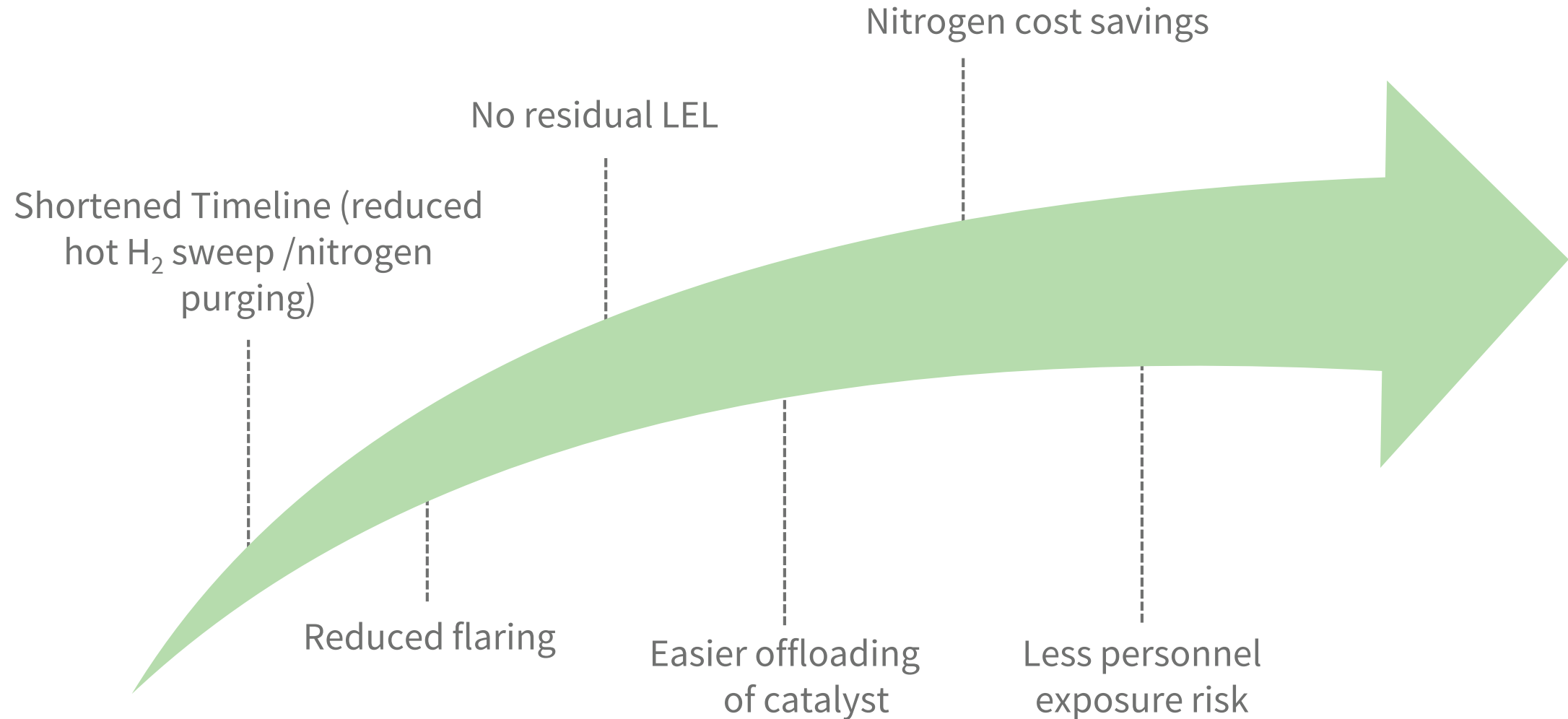
Cation &
Metals-free

Application

- Chemistry injected during H₂ sweep once hydrocarbon carry over is minimal
- Non-condensables routed to Fuel Gas Recovery system or Flare, condensable chemical routed to slop for reprocessing
- Injection for about 4-6 hours
- Injection is once-through



Benefits of CatZyme Technology



Fully Controlled Process

REACTOR ENGINEER



- *Project Manager / Planner*
- *Monitor Board Temperatures*

REACTOR TECHNICIAN

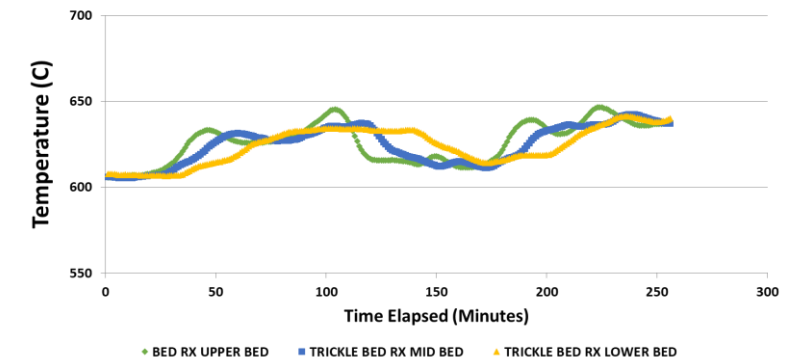
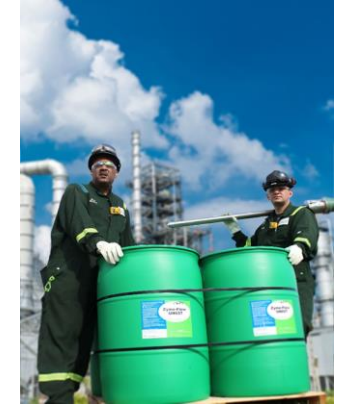


- *Liaison between Board and Pump*
- *Liaison between Operations – drain low points*

PUMP OPERATOR



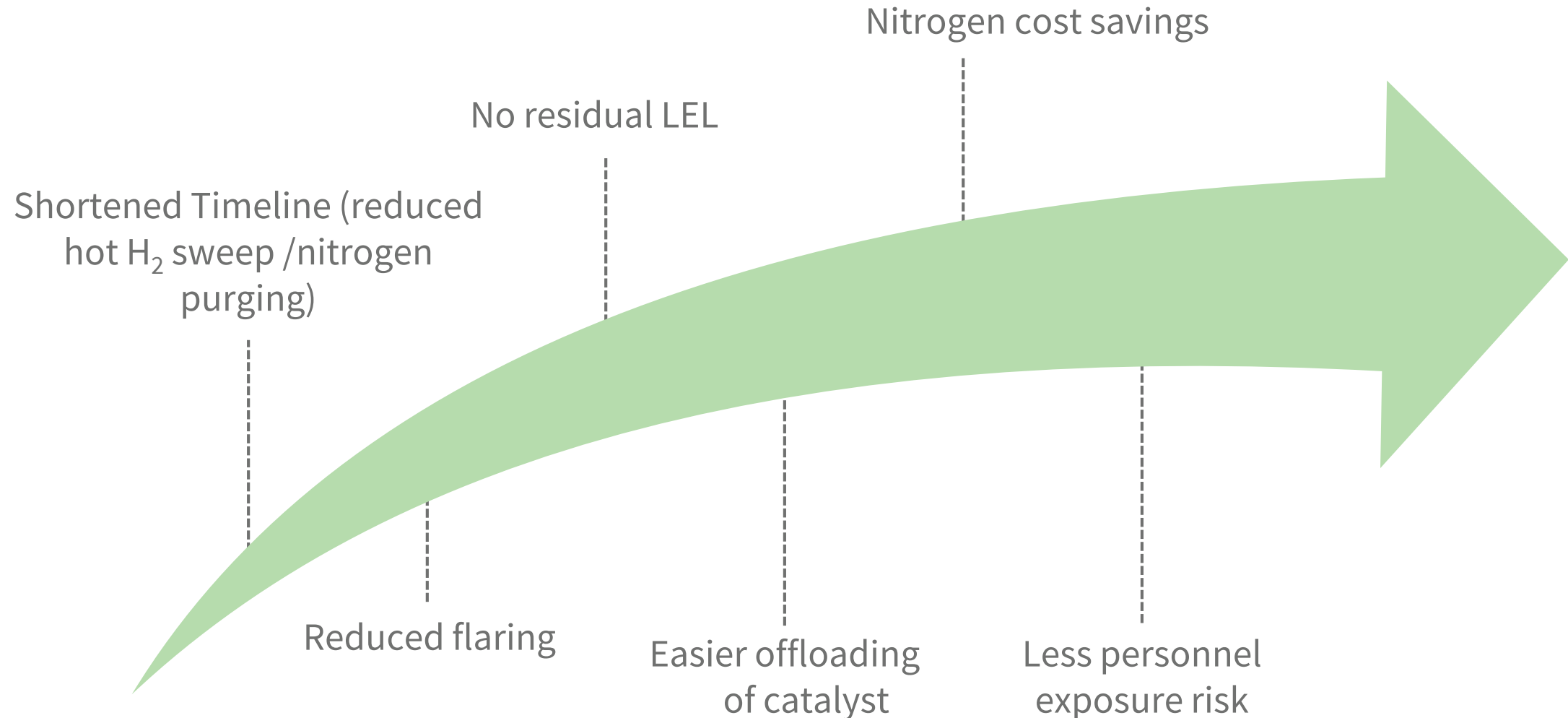
- *Operate pump*



Reactor Cleaning Animation



Summary of CatZyme Technology

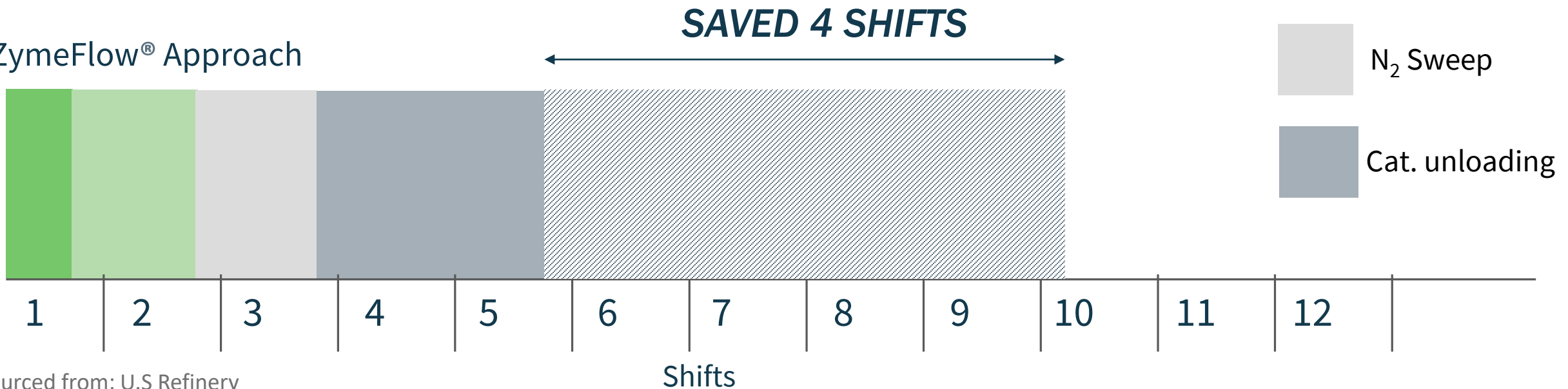


Case Study Diesel Hydrotreater Timeline Reduction

Previous Approach



ZymeFlow® Approach



Sourced from: U.S Refinery

March 2026 GOHT in Europe Feedback

GOHT catalyst unloading proceed very well. Catalyst was free flowing from both reactors. There was low level of residual hydrocarbons. Reactors decontamination was successful.



Thank You

