



TRICAT's XpresS Pre-sulfiding Process

**The Benefits of
True Ex-situ Pre-sulfiding**

Conventional In-situ Sulfiding

- Gas or Liquid Phase Using Sulfiding Agent

- Sulfiding Reactions

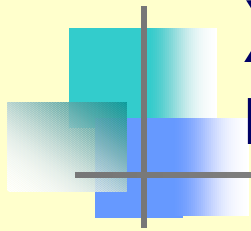




Conventional In-situ Sulfiding

Problems

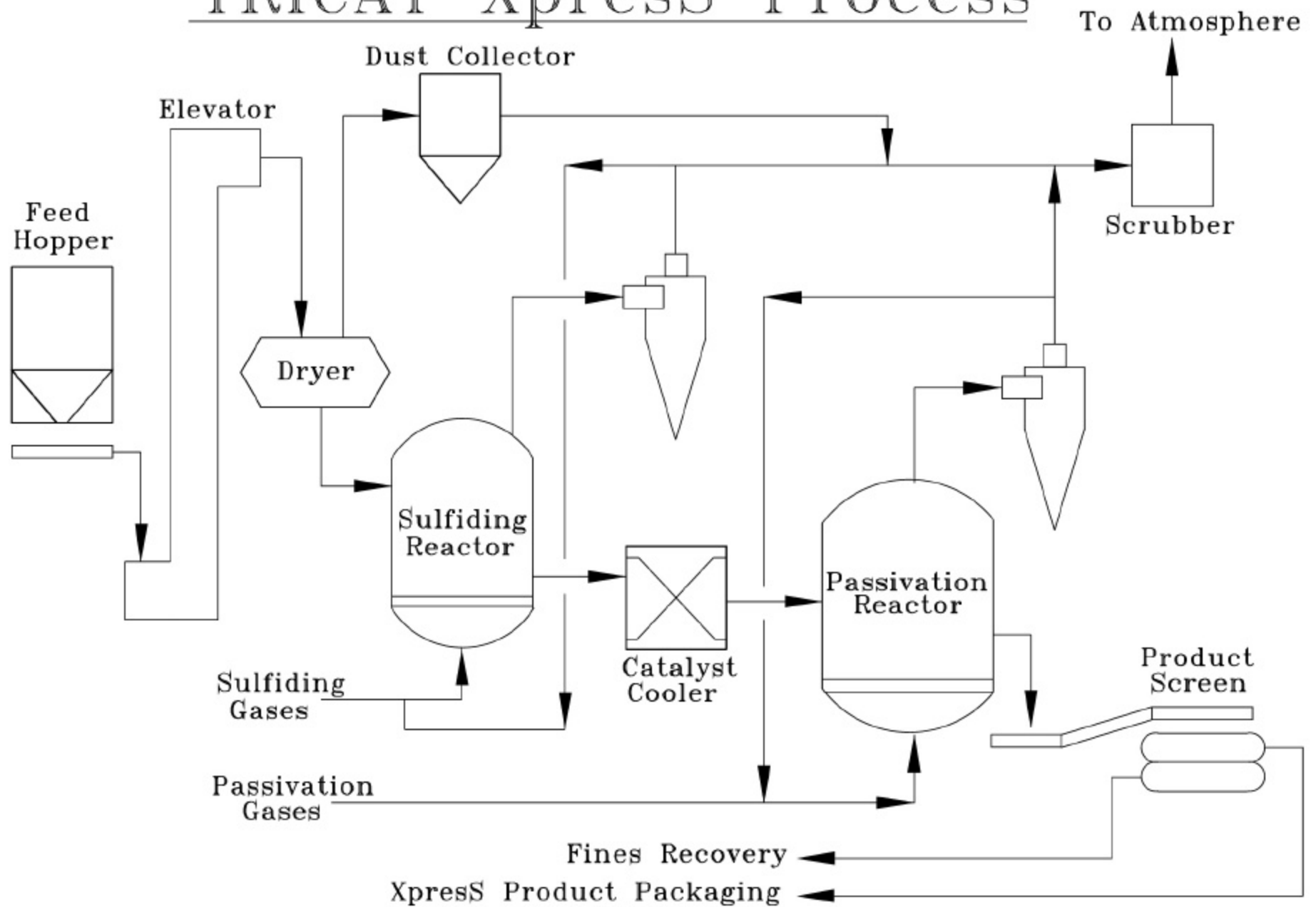
- **Time Consuming and Often Results in Unexpectedly Poor Performance**
- **Exothermic Reactions**
- **Yields Large Quantities of Water**
- **Sulfiding Agents Can Be Toxic, Flammable, Odorous**



XpresS Pre-sulfiding Features

- **True Ex-situ Pre-Sulfiding**
- **Sulfiding in Ebullated Bed Reactor**
- **Catalyst Stabilized via Patented Gas Treatment**

TRICAT XpresS Process





“XpresS”

Benefits vs. In Situ Sulfiding

- **Homogeneously Sulfided, Odor-Free Catalyst**
- **No External Sulfur Supply or Addition System Required**
- **Minimal Reactor Exotherms at Start-up**
- **No Water Release**
- **Greatly Reduced Start-up Time**



“XpresS”

Benefits vs. Pre-Sulfurizing

- **Minimal Reactor Exotherms at Start-up in gas or liquid phase**
- **No Temperature Holds**
- **Minimal H₂ Consumption during Heat-up**
- **No Product Recycle due to Discoloration**
- **No Water Release**
- **Reduced Start-up Time**



Pre-Sulfiding Step

Benefits of XpresS Process

- **Sulfiding Medium: H_2S/H_2**
 - Absence of carbon containing compounds (eg. DMDS) eliminates coking
- **Ebullated Bed Operation**
 - Optimizes Solid/Gas mixing
 - Eliminates concerns about H_2 reduction due to breakthrough
 - Permits high temperature sulfiding to maximize activity
- **Minimal H_2S evolution during heat-up**
 - Protects sensitive catalysts upstream or downstream of reactor



Passivation Step

Benefits of XpresS Process

- Passivation process works by converting surface sites from metal sulfide to stable oxysulfide state
- Use of gaseous passivation step avoids use of smelly, difficult-to-handle hydrocarbon coating
- Ebullated bed also ensures that each particle is treated uniformly and that H_2S is effectively removed from pores



Reactivation Step

Activity Enhancement with XpresS

- Once loaded, stabilized catalyst completes activation with H_2S evolved during feed processing.
- Literature strongly suggests that sulfiding/gas passivation/re-activation enhances activity of the sulfided catalyst by decreasing metal-support interactions.



The XpresS Start-up

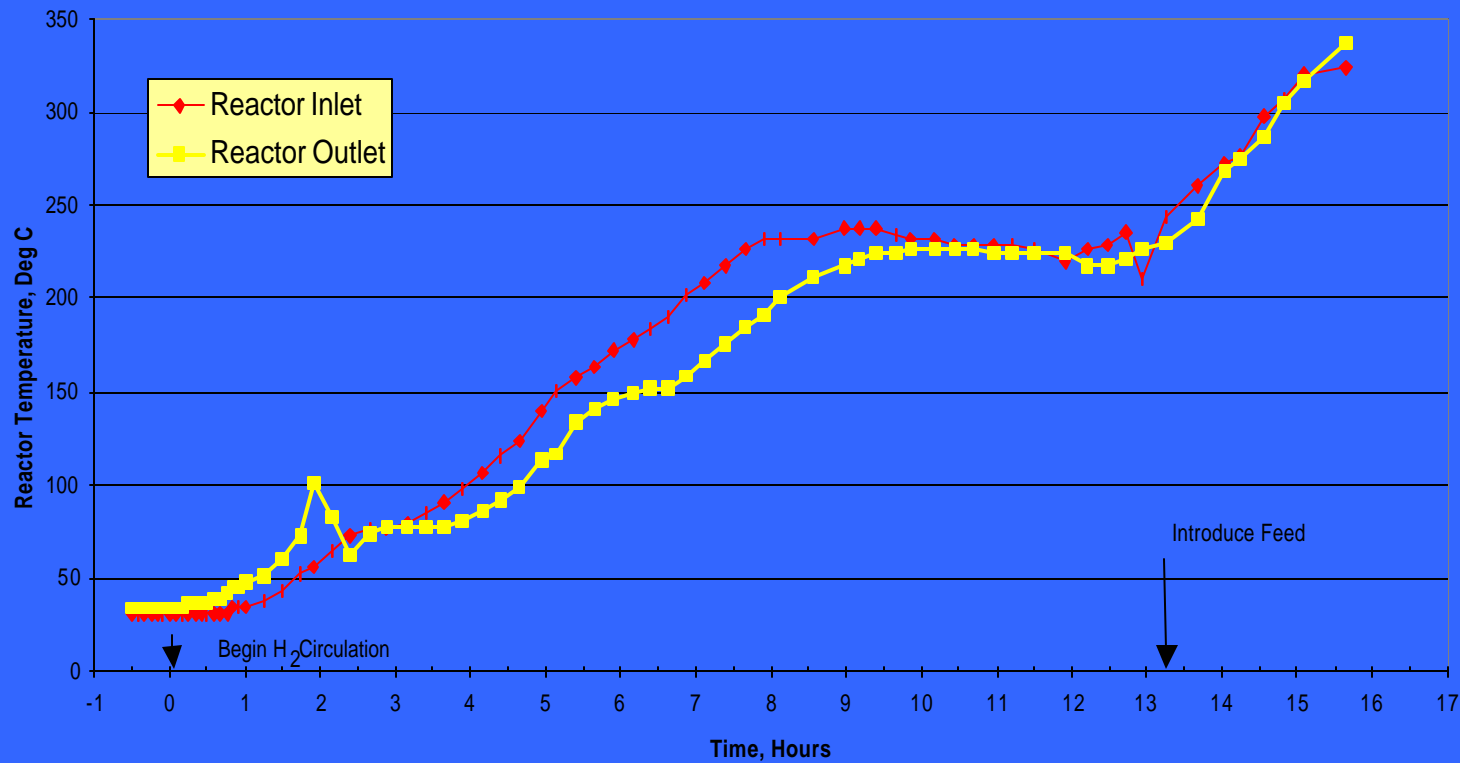
- Catalyst is dry and free-flowing. Loading in air or inert.
- No external sulfur supply required.
- No high temperature exotherms.
- Liquid or gas phase heat-up.
- If gas phase heat-up, introduce feed at normal operating temperature.



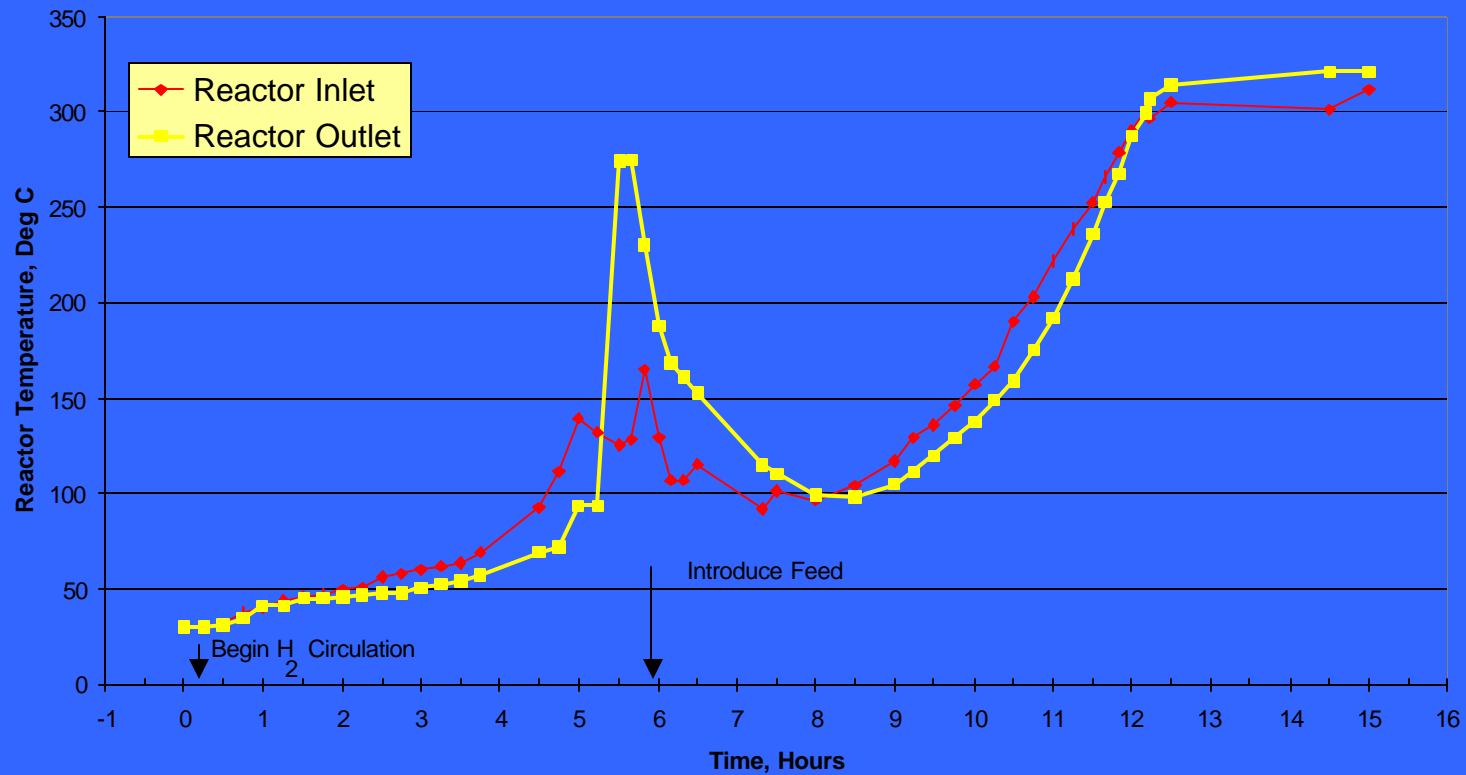
Recent Commercial XpresS Start-Up Belgian Refining Corp.

- TRICAT supplied regenerated/XpresS pre-sulfided catalyst to refinery.
- Catalyst dense loaded into distillate HDT unit w/N₂ purge. No exotherms experienced during loading.
- Unit heat up in gas phase with circulating H₂ to 230°C with only minor exotherm at H₂ introduction.
- Refiner reported:
 - Turnaround length halved from 12 to 6 days through TRICAT initiatives.
 - Greatly simplified start-up versus in-situ sulfiding or earlier pre-sulfurized catalysts.
 - ~10°C lower SOR temp than previous cycle.

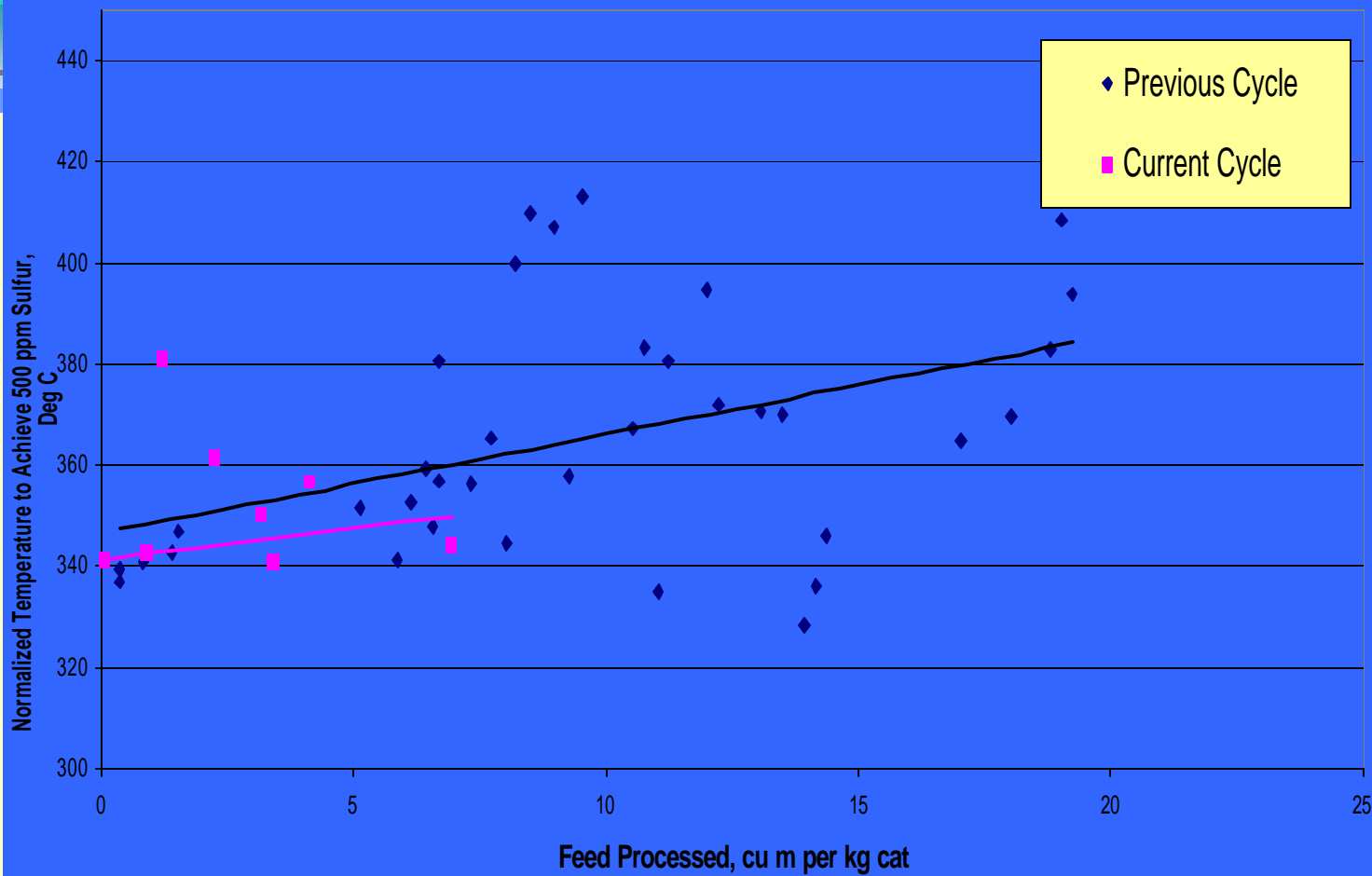
Belgian Refining Corp. #2 HDS Unit XpresS Start-Up Temperature Profile June 1999



Belgian Refining Corp. #2 HDS Unit Pre-Sulfurized Catalyst Start-Up Temperature Profile April 1997



Catalyst Deactivation Rate





XpresS Users

- Bayern (BP Affiliate)
- Agip
- Shell
- BP – Hamburg
- ExxonMobil
- OMV
- PCK
- Veba
- Wilhelmshavener Raffinerie
- Belgian Refining Corp.
- DEA
- Erdoelchemie
- TotalFinaElf
- Universal Refining
- Idemitsu Kosan (Japan)
- Ultramar Diamond Shamrock (US)
- INA
- Synetix
- Haldor Topsoe
- Procatalyse
- Miro



XpresS Pre-Sulfiding

Conclusions

- **Quality - XpresS Provides Refiner With True Pre-Sulfided Catalyst**
- **Convenience - Eliminates In-situ Procedures and Activation Steps**
- **Safety - Eliminates Sulfiding Chemicals and Exotherms During Start-up**
- **Timeliness - Fastest Start-up Possible**