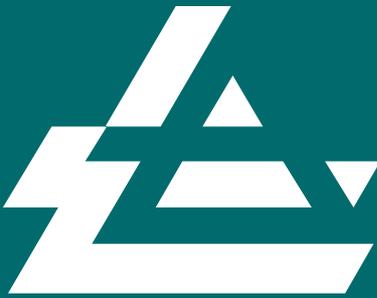


AIR
PRODUCTS 

Recovery Process Using Pressure Swing Adsorption Technology

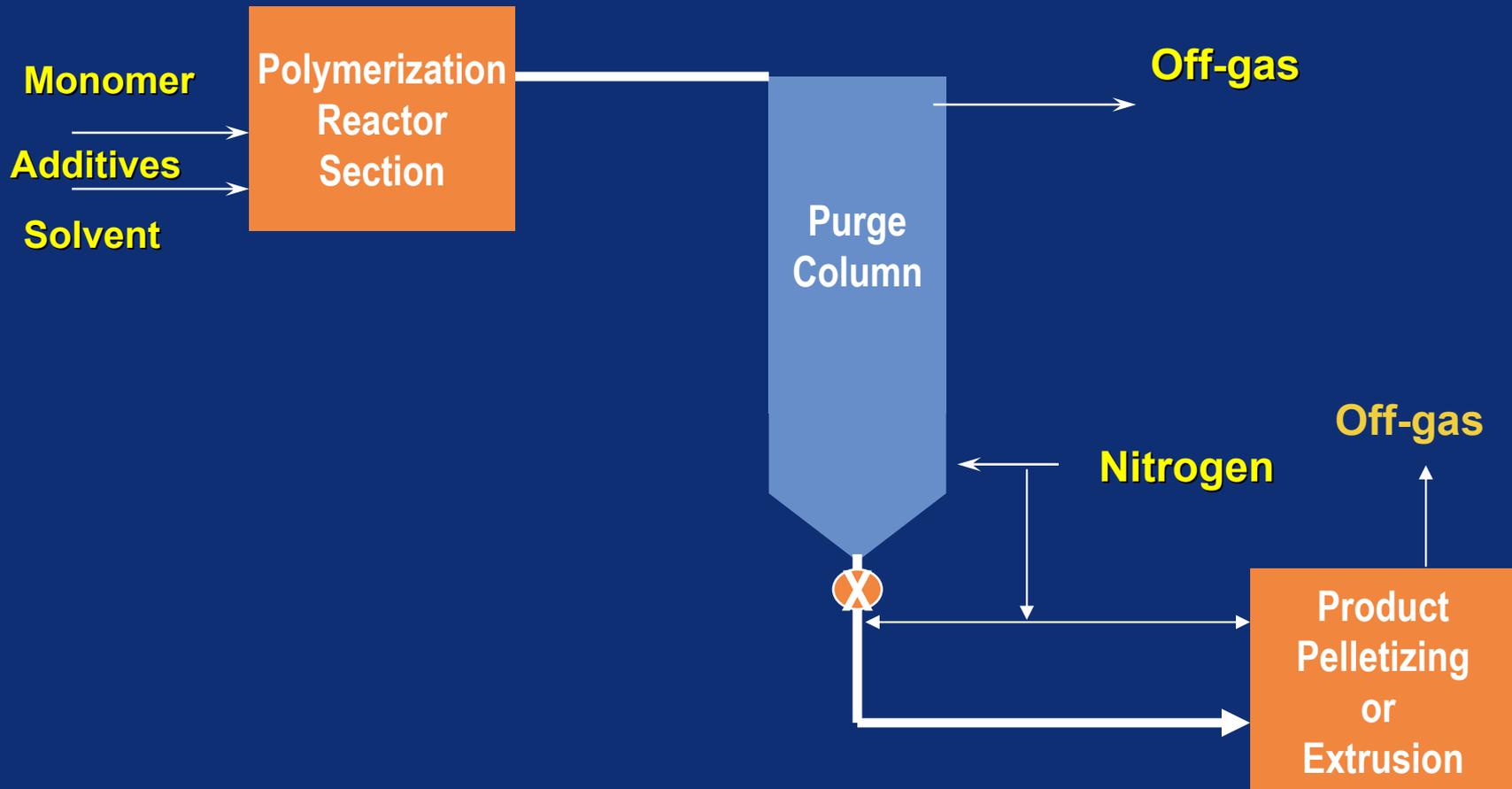
Texas Technology 2003 Showcase -
Houston, Texas March 17 - 19, 2003

Philip Cook
Air Products & Chemicals, Inc

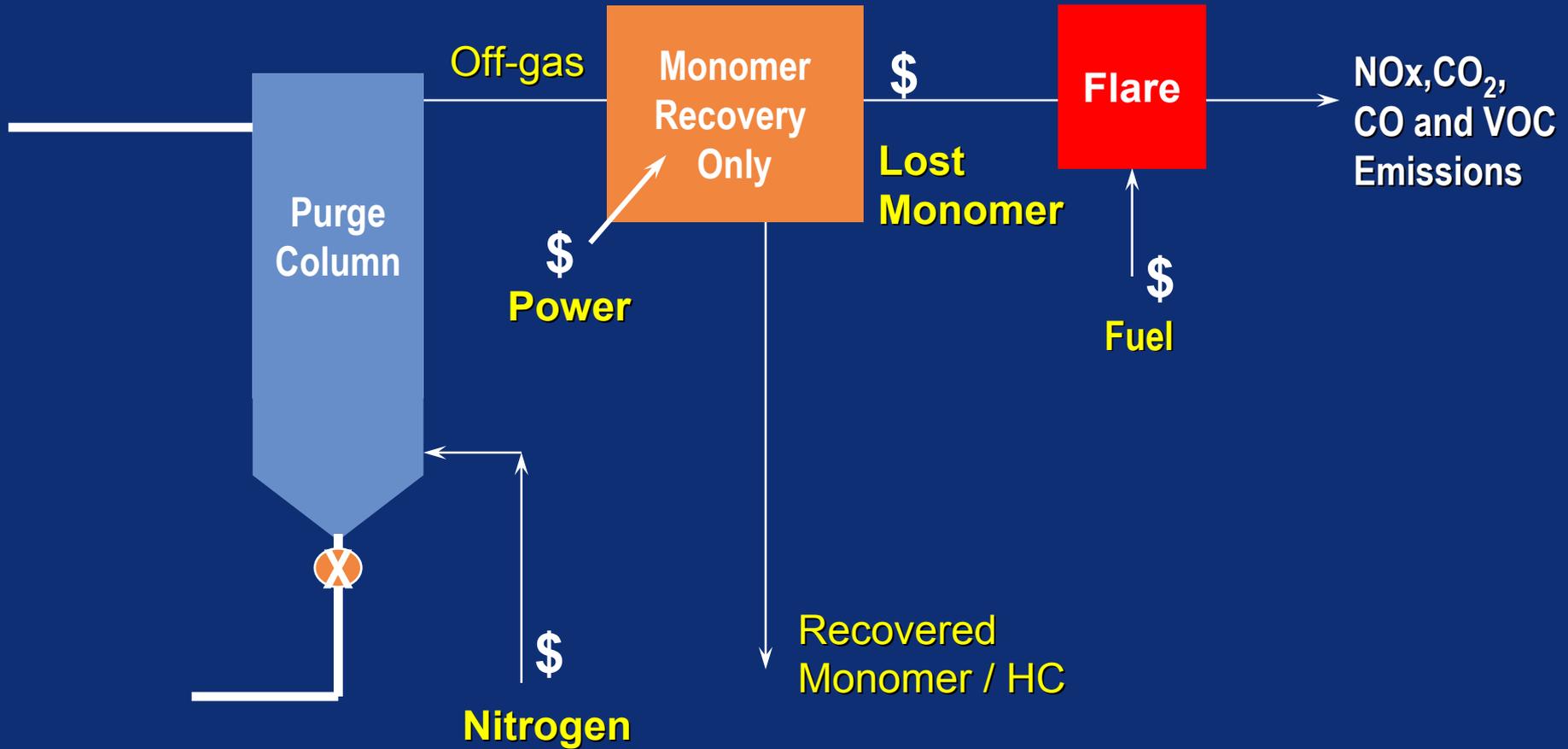
Agenda

- Describe PE and PP Plant Off-gas source
- New recovery process using PSA
- Example Cases
 - 320 MTA Polyethylene Plant
 - Polypropylene Plants
- Conclusions
 - “Best in class” technology development
 - Great example of Industry – DOE cooperation to commercialize technology advancements

Degassing resin is a common step in polyolefin plants



Degassing Costs for the Producer

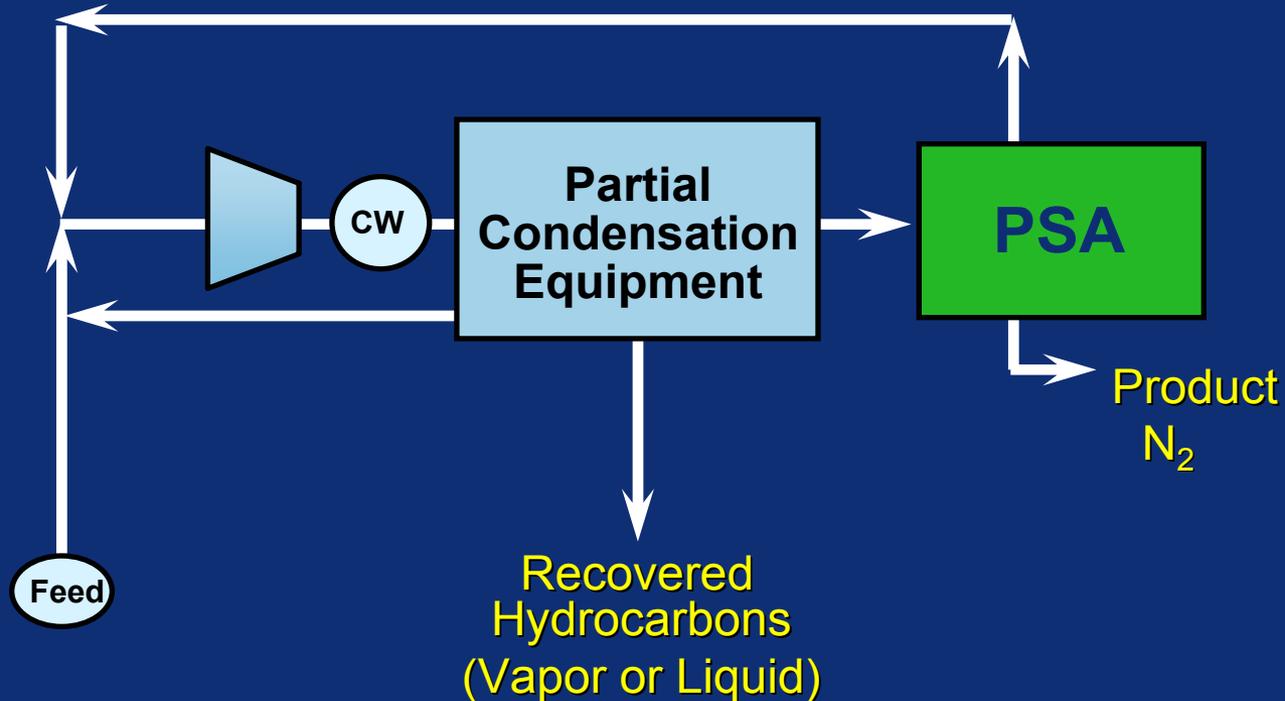


PSA Process Development

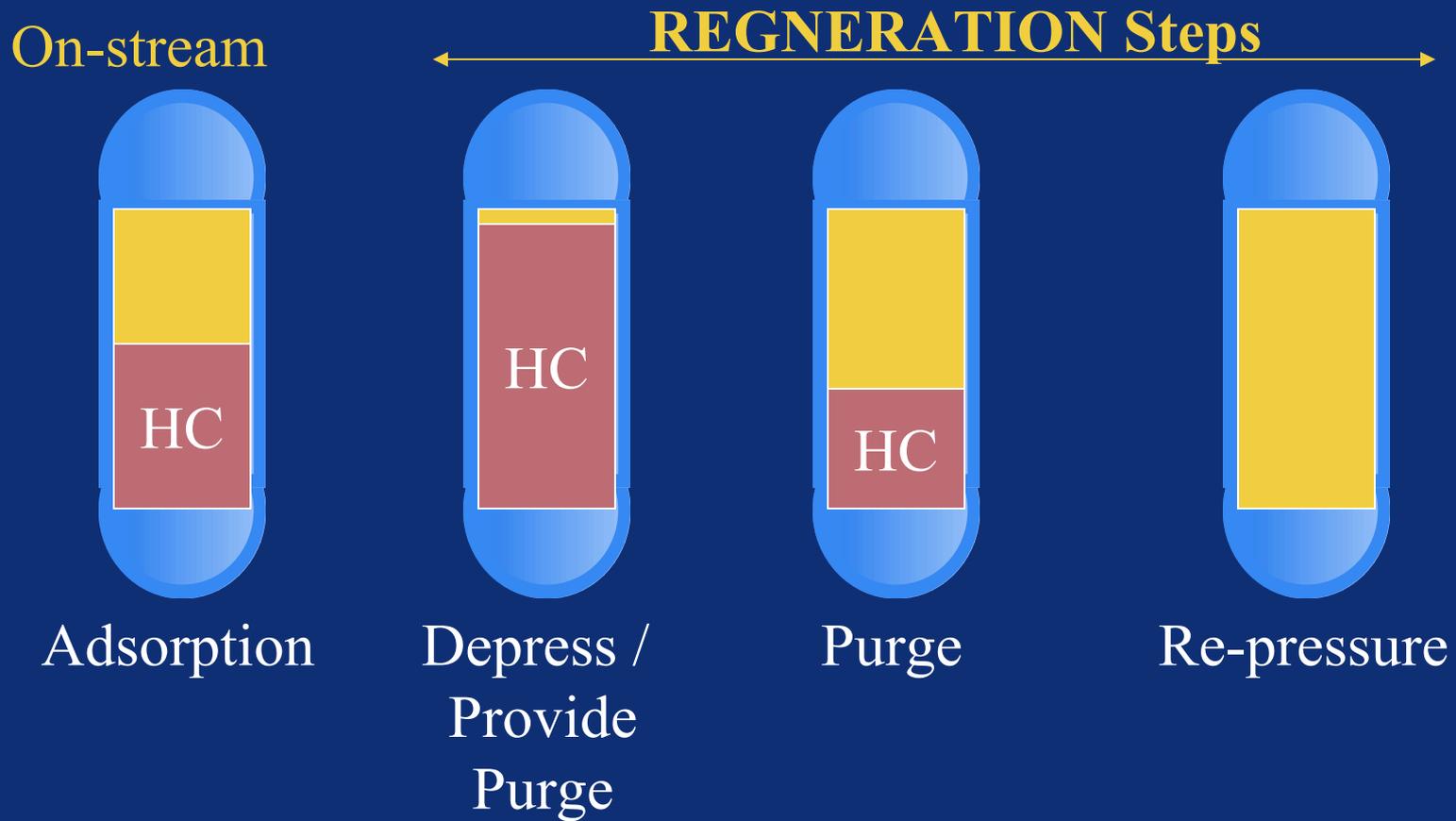
- Air Products works with industry to understand desired separation
- Degassing generates low pressure N₂ and hydrocarbon off-gas
- Conventional processing used partial condensation only; shortcomings
 - incomplete recovery, emissions, equipment freezing
- Air Products recognized PSA utility
 - required select development steps addressing materials selection, data, and demonstration
- Award No. DE-FC02-00CH11022 “Development of New Pressure Swing Adsorption Technology to Recover High Valued Products from Chemical Plant and Refinery Waste Streams (High Performance PSA)”

POLYOLEFIN PLANT RECOVERY SYSTEMS

The Process

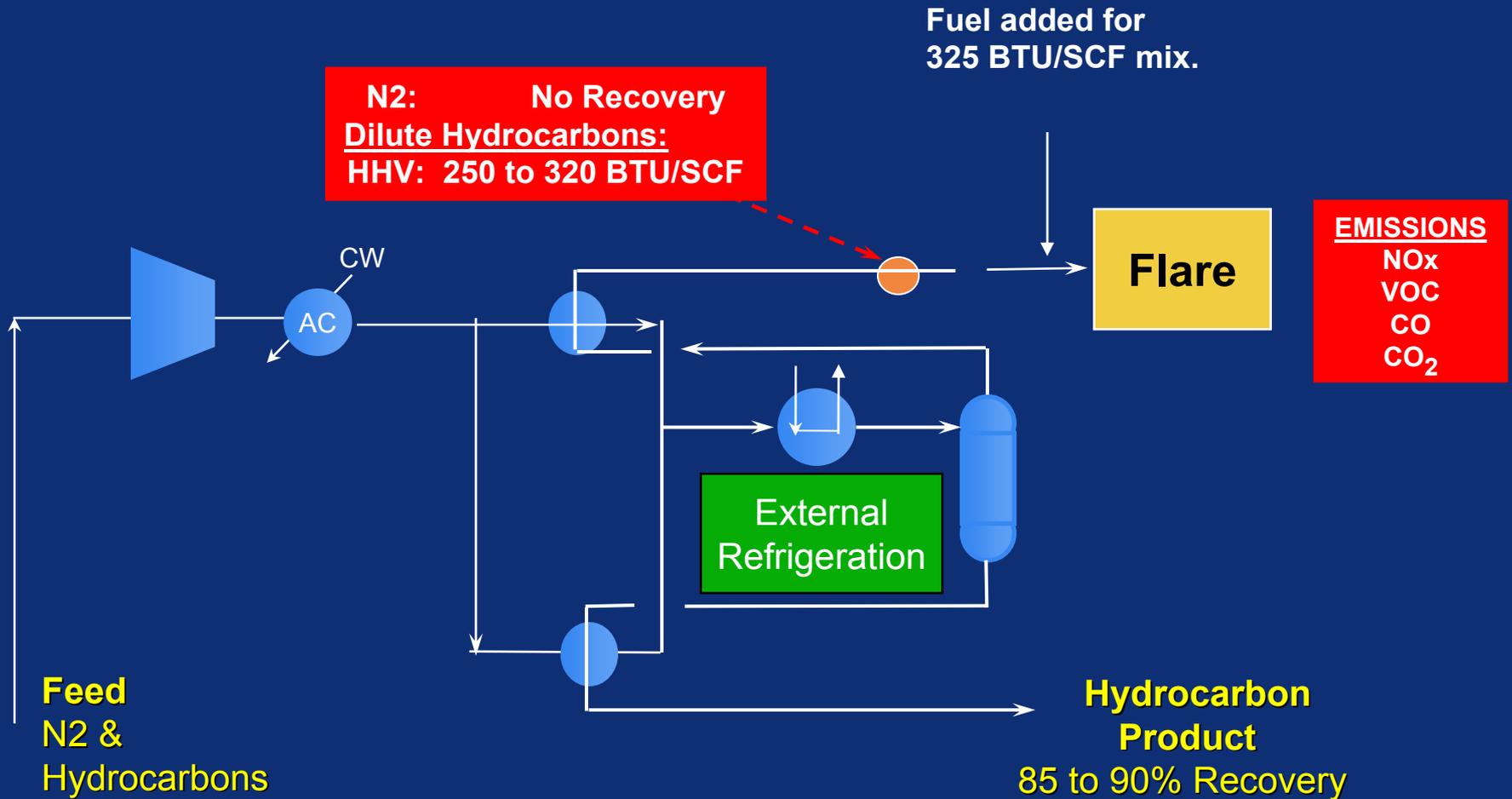


How PSA Works

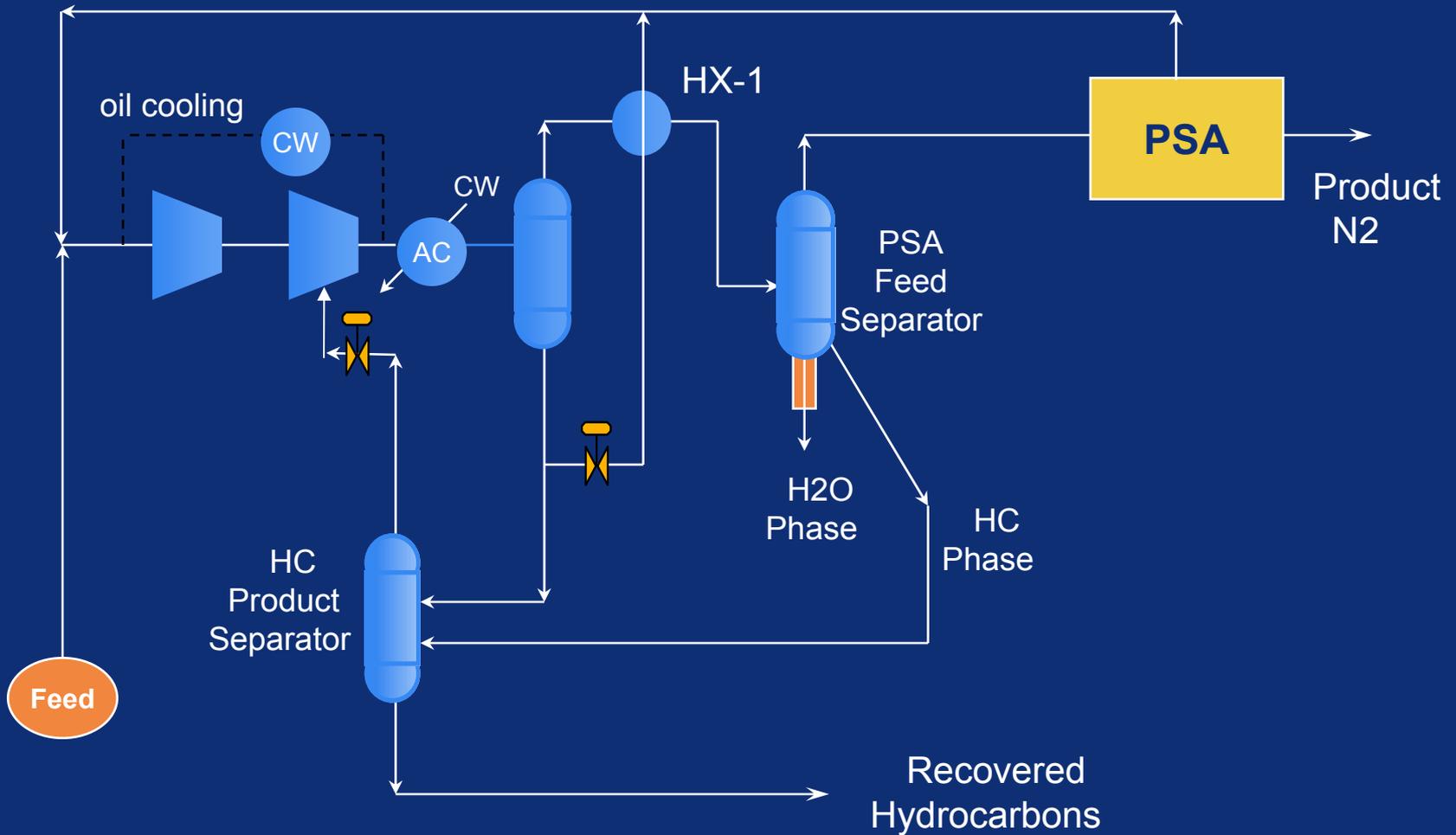


PSA materials selectively remove (adsorb) hydrocarbons from N₂
Capacity to hold hydrocarbons influenced by operating pressure
Multiple beds deliver steady flow process

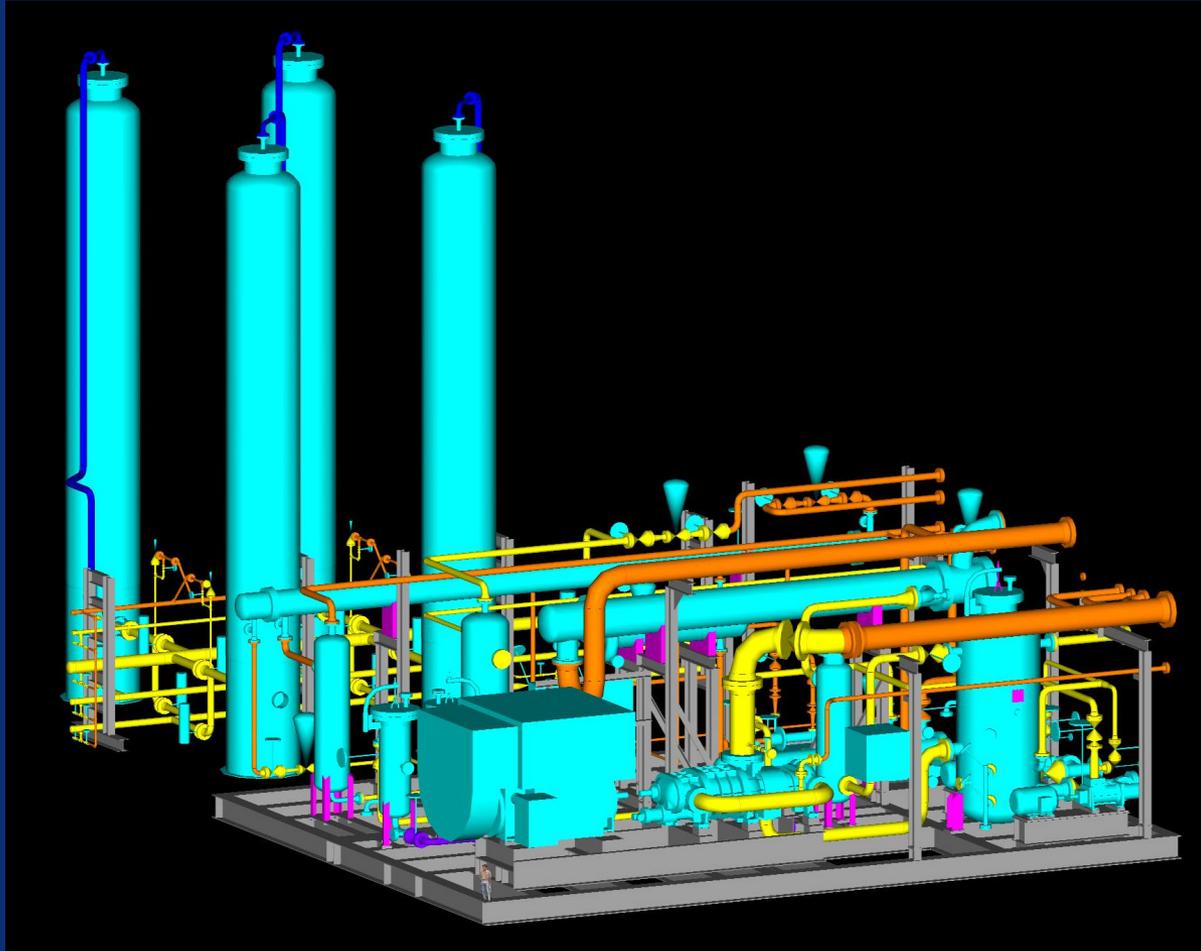
Example PE Plant Conventional Recovery Process



PE Plant Recovery Process Using PSA



Recovery Process Using PSA for 320 MTA PE Plant



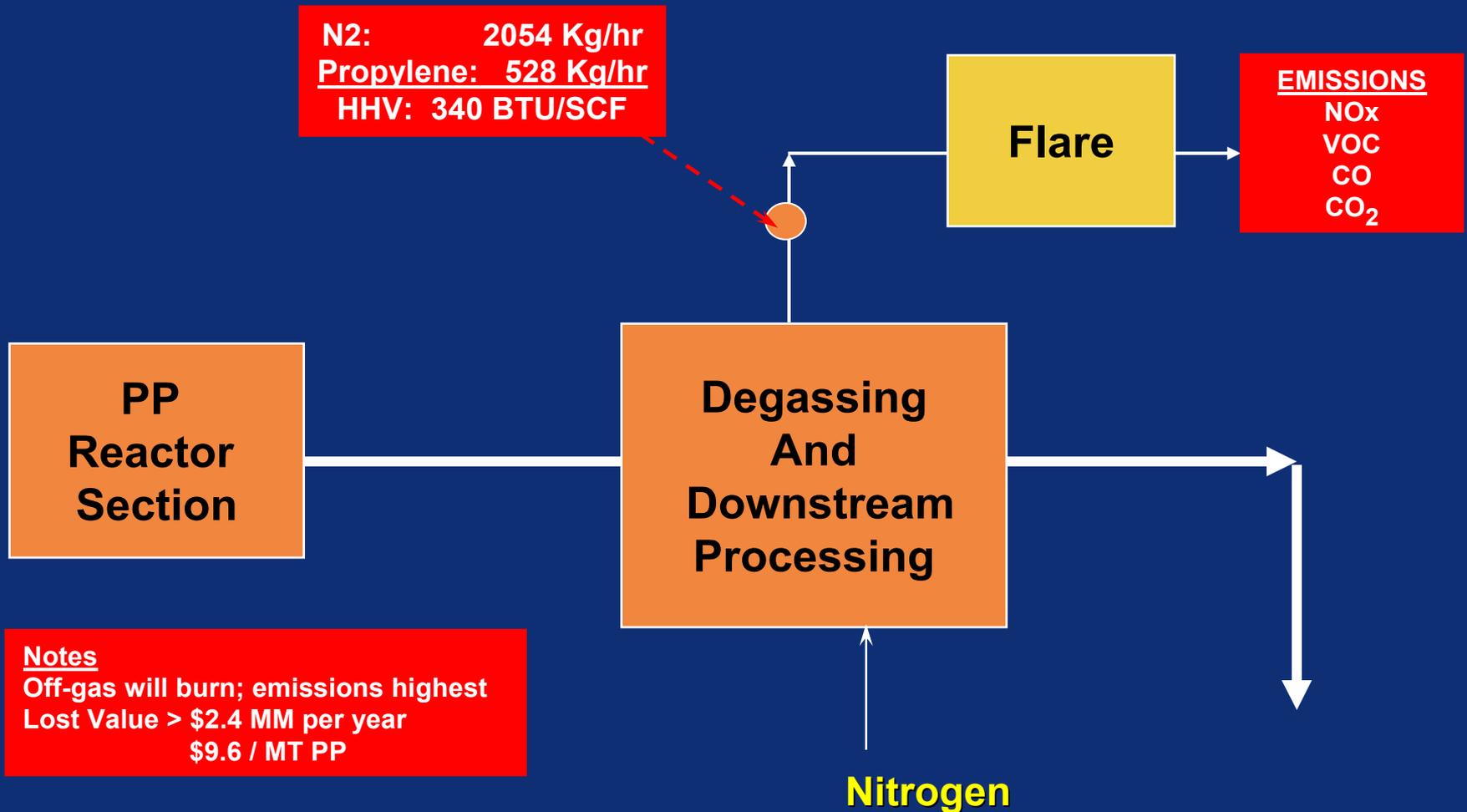
Air Products Recovery System using PSA - Benefits

- **Processes and recovers off-gas components valued at >\$18 MM annually**
- **Provides Lowest Emissions...**
 - improvement over conventional processing**
 - **20 MTPA VOC**
 - **1.7 MTPA NO_x**
 - **15 MTPA CO**
 - **3750 MTPA CO₂**

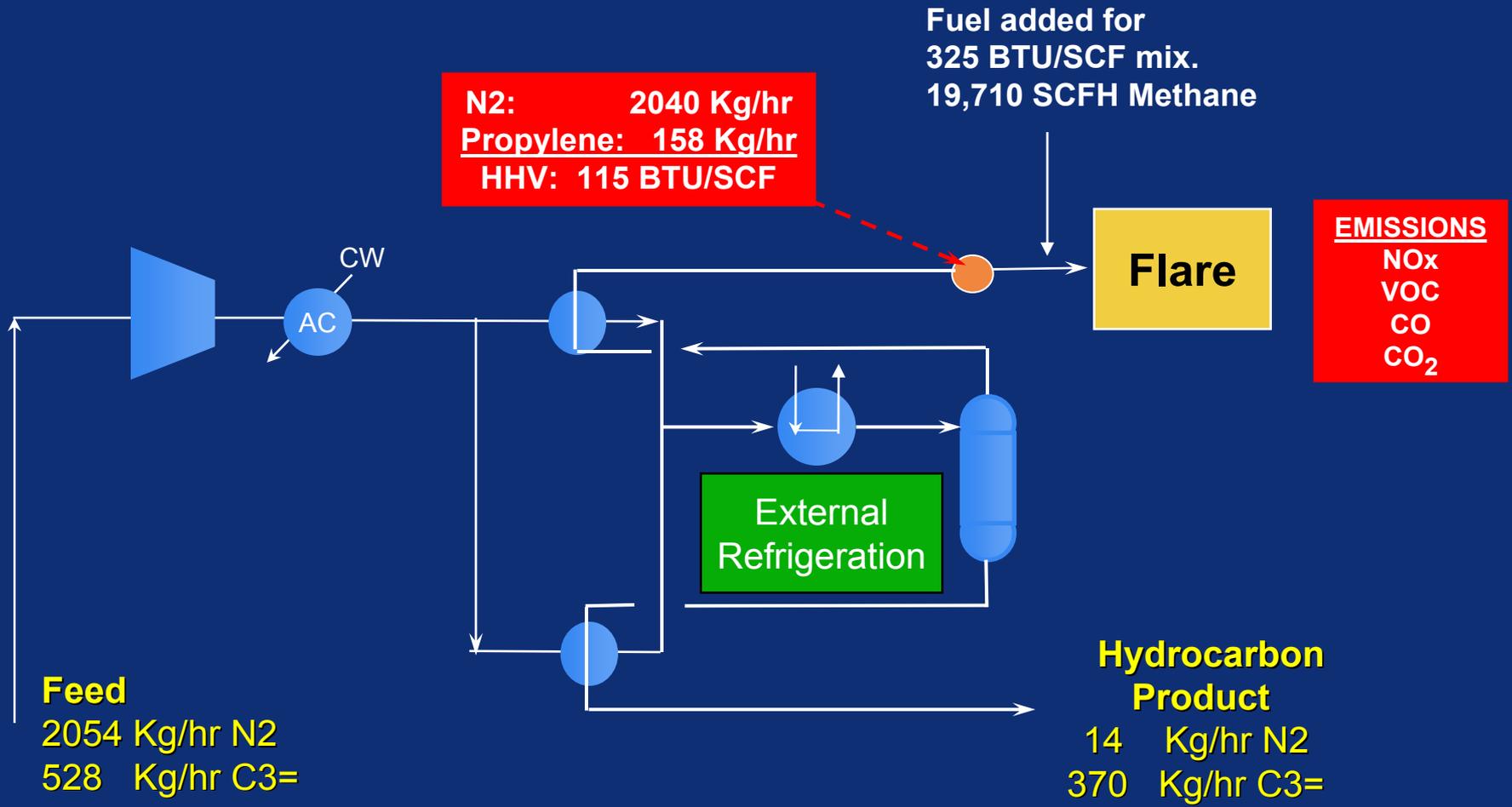
Air Products Recovery System using PSA - Benefits

- **Air Products Recovery System with PSA evaluated to be “best in class”**
- **Benefits**
 - **Lowest emissions**
 - **Easier plant permitting**
 - **Lowest polymer degassing costs**
 - **Lowered Plant Investment**

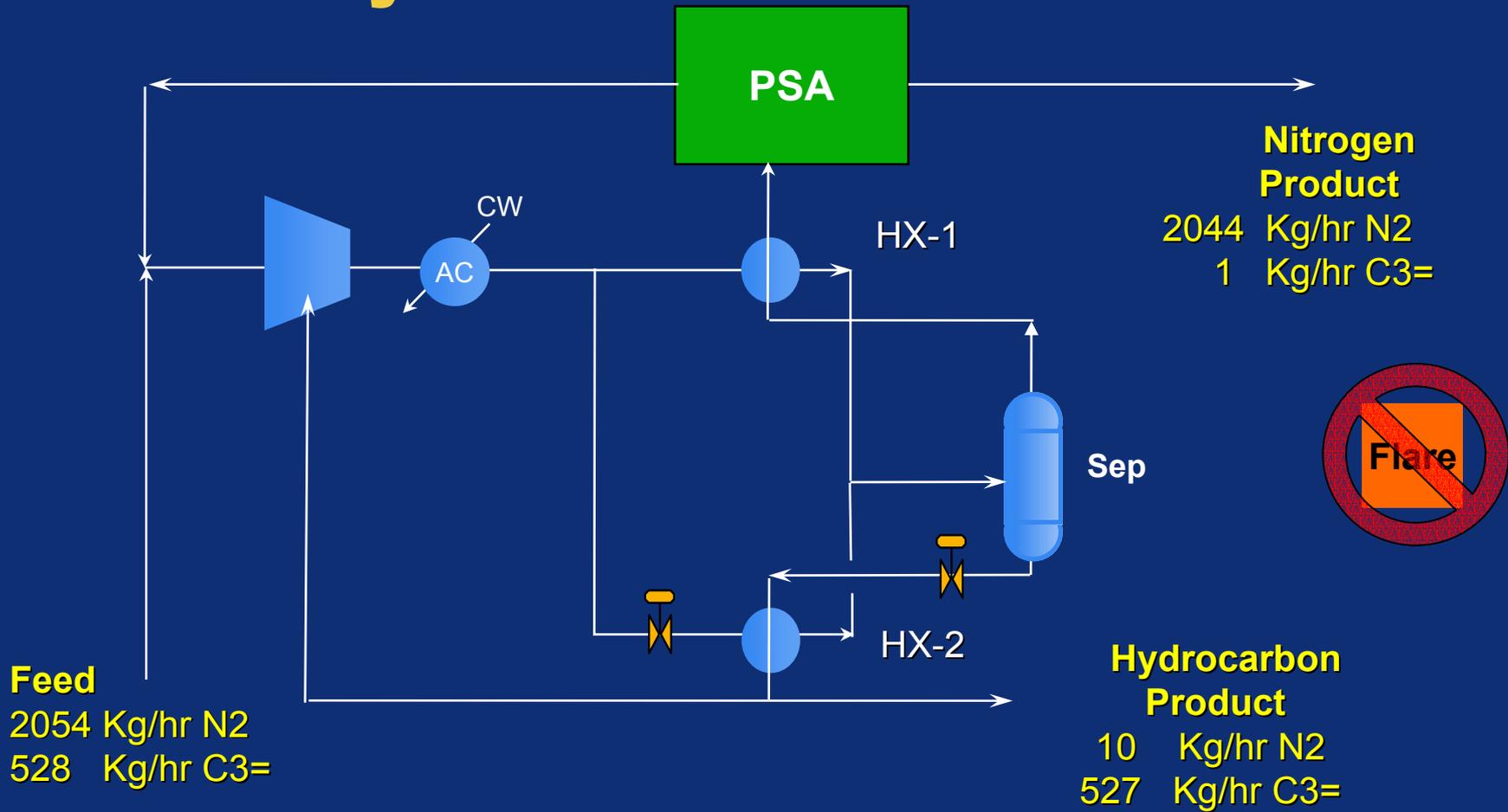
Retrofit Example for 250,000 MTPA PP Plant



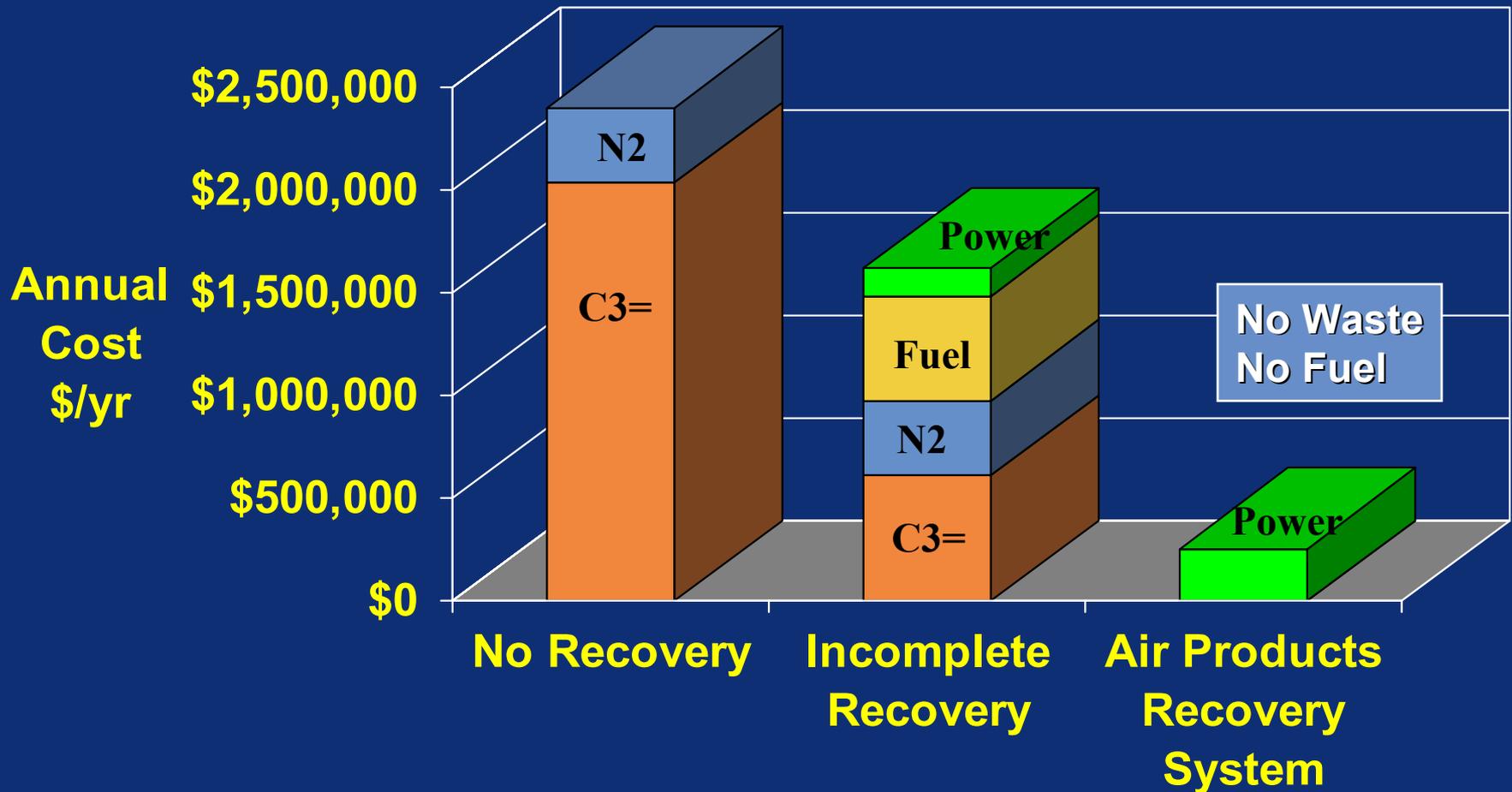
Example with Incomplete Recovery System



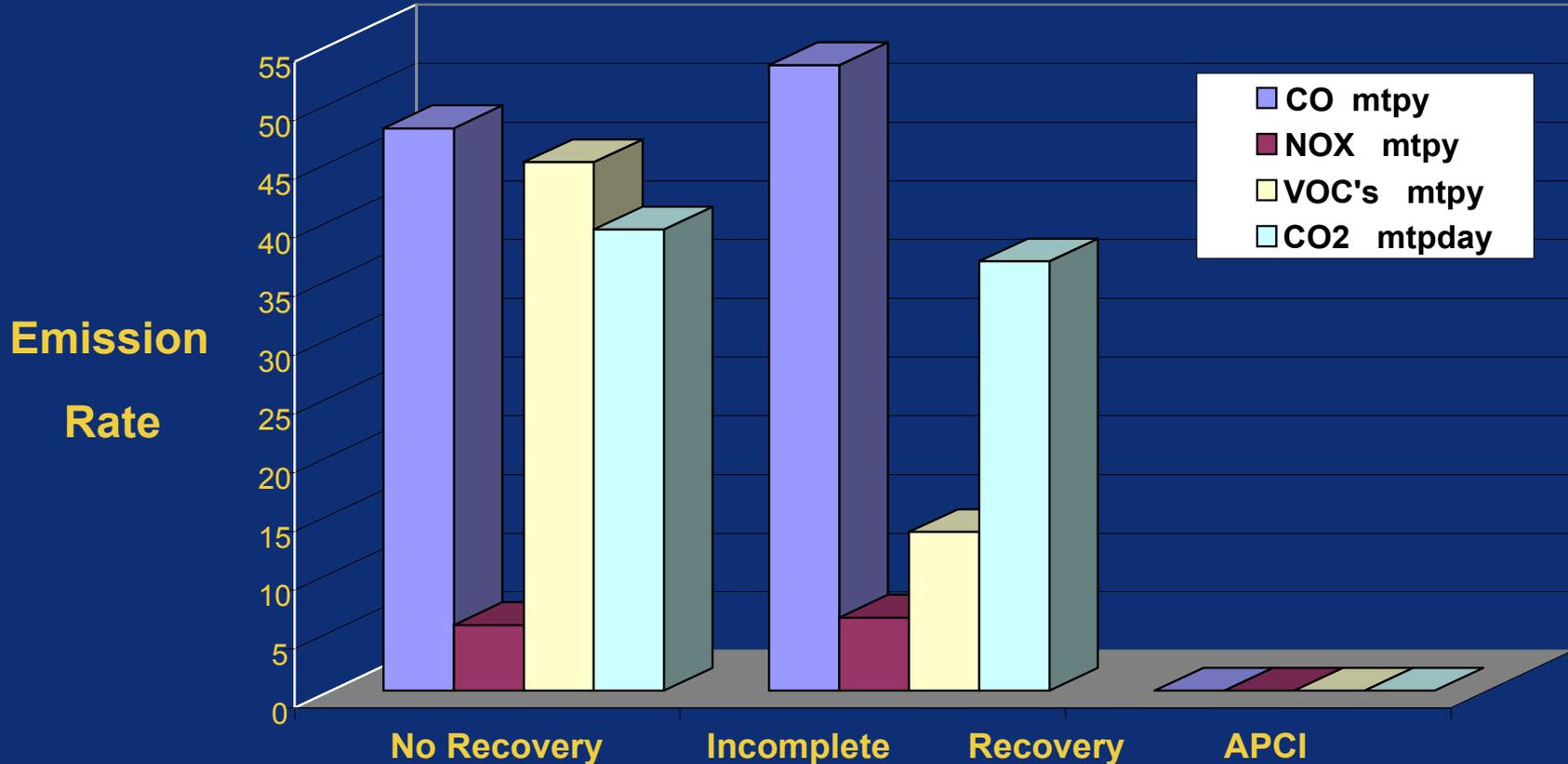
Polypropylene Plant Recovery System



Lowering the cost of degassing operations



Eliminating Emissions



Air Products Polyolefin Plant Recovery Systems provide:

- **Lowest operating cost and emissions**
 - Easier permitting (Grassroots)
 - Advances licensing efforts
 - Can be retrofitted (existing plants)
- **Simple paybacks of 12 to 18 months**
- **All of the vent gas as reusable products – no emissions**
- **Savings between \$600M to > \$5MM annually**

Conclusions

- **Best in class technology commercialized**
- **Great example of Industry – DOE cooperation to adapt and advance new technology**
 - **save energy**
 - **reduce emissions**

Thank you

tell me more
www.airproducts.com

Retrofitting an existing facility

