Zhigang Shang
UOP Limited, Guildford, UK

Hydrogen Management and Purification Technology

2017 Honeywell Oil & Gas Technologies Symposium

May 15, 2017
Cairo, Egypt
May 17, 2017
Alexandria, Egypt
Agenda

- Hydrogen Management
- Polybed™ PSA Systems
- Polysep™ Membrane Systems
Why Does It Matter?

• Economic Impact of lack of hydrogen:
  - Less production of high value products
  - Sub-optimal crude oil selection

• Refineries do not usually store $H_2$

• Lack of hydrogen requires mitigation:
  - Reduce hydroprocessing unit throughput (short term)
  - Reduce refinery throughput (short term)
  - Change to easier feed (mid term)
  - Revamp $H_2$ system / $H_2$ plant (long term)

Lack of Hydrogen Can Limit Refining Margin
The H₂ System Management Sequence

The refinery configuration sets the H₂ needs

- H₂ supply and network are configured to meet these needs
- H₂ purification can improve the economics of H₂ supply
- Manage network operation in order to retain efficiency and avoid constraining refinery operation.

A Good H₂ System Maximises the Value of Hydroprocessing
In this example a new PSA links the Medium and High purity headers

- Alleviates constraints and saves H₂
- But can it be done better?
- Will investment pay back?

A Hydrogen Study Can Help
Sources of Hydrogen

Refining

- Catalytic reforming
- Hydrocracker vents/purges
- Hydrotreater vents
- FCC off-gas/fuel gases
- Steam reforming

General Rule

- Hydrogen concentrations > 55% are usually economically justified
- Between 40 and 50% H₂ can sometimes be economically upgraded
- Below 40% H₂, economics become more difficult to justify
**Hydrogen Recovery & Purification Technologies**

**Pressure Swing Adsorption (PSA)**
- Very High purity
- Up to 90% recovery
- High Pressure H₂
- Tail gas to SR burners
- Flexibility

**Permeation Membrane**
- High purity
- Up to 95% recovery
- Low Pressure H₂
- Non-permeate to fuels
- Needs pre-treatment

*PSA offers enhanced flexibility, high reliability, and economies of scale*
H₂ Purification – Polybed PSA Systems

**H₂ + Impurities**
High Pressure

**FEED GAS**

**PRODUCT**
H₂ @ High Purity
High Pressure

**TAIL GAS**
Impurities (+H₂)
Low Pressure

**H₂ Purity** 99.9 – 99.9999%
**H₂ Recovery** 60 – 90%
**H₂ Feed pressure** 6 - 40 bar g
**H₂ Product pressure** 5 - 39 bar g
UOP PSA Applications

Steam Reformers 42%
No. of Units : 426

Ethylene Off-Gas 14%
No. of Units : 142

Specialty Applications 20%
- Ammonia Plants
- Coke Oven Gas
- Gasification
- Methanol Off-Gas
- Styrene Off-Gas

Refinery Streams 24%
No. of Units : 238

>1,000 Polybed PSA Units
UOP is a Leading Provider of PSA technology
H₂ Purification – Polysep Membrane

H₂ + Impurities
High Pressure

FEED GAS

H₂ Purity 90 – 95 %
H₂ Recovery 70 – 98 %
H₂ Feed pressure 15 - 80 bar g
H₂ Product pressure 5 - 30 bar g

Non-Permeate
High Pressure
ΔP ≈ 1.5 bar

Membrane System

Permeate
Low Pressure

Purification – Polysep Membrane

10
Example of study results

• Fundamental basis for idea generation
  - Value from hydrocarbon recovery and process improvements

• Significant benefit identified
  - In excess of $10 million/yr

• Implementation sequence defined
  - Some no cost ideas
  - Many requiring piping and controls
  - Some requiring higher cost equipment

• Client implements through investment and change management processes

• Aligned with client’s continuous improvement efforts
Another Recent Study Example

• Hydrogen Value Chain Review
  - Identified constraints limiting value generation
  - Value in relaxing constraints

• Significant benefit identified
  - Again in excess of $10 million/yr

• Implementation sequence defined
  - Some no cost ideas
  - Larger benefits rely on investment projects
  - Optimum extent of sequence implementation clearly identified

• Implementation initiated by client during study execution
H₂ Management by UOP

- Whether high-purity H₂ with Polybed PSA Systems,
- low-cost H₂ with Polysep membrane
- or overall system advice

UOP is the name you can trust for H₂ Management
Question and Answer