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# Extending the life of a dehydration unit

*Case studies from an LNG and NGL plant*

*GPA Midstream Presentation*
*Peg Greene*
*Market Manager*

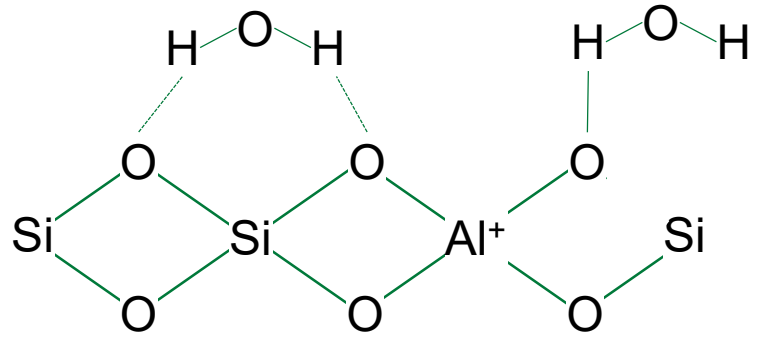
# Agenda

1. Comparing Adsorbent Material Types
2. Combination Bed Designs
3. Customer Case Studies
4. Summary

# Adsorption with Silica Gel Materials

- Physical adsorption is selective binding of molecules on active surfaces of solids by non-valence forces like hydrogen bridging, Van-der-Waals forces and **dipole-dipole interactions**
- Adsorption takes place in porous solids providing **high internal surface** areas of 500 – 1000 $m^2/g$
- The driving forces for adsorption
  - Water is adsorbed by hydrogen bridging and capillary condensation
  - Hydrocarbons are adsorbed by capillary condensation

**H-Bonding**




**Capillary Condensation**



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# BASF Durasorb Aluminosilicate Gel Materials

- Durasorb HD is an amorphous, aluminosilicate gel with unique properties
  - Micro- and meso-porosity
  - High surface area
  - High crush strength
  - Low attrition
  - Low heat of adsorption
  - Acid Resistant
  - Stable to water and liquid hydrocarbon

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# Comparison of Silica Gels and Molecular Sieves

| BASF Aluminosilicate Gels | Molecular Sieves |
|---|---|
| Selectivity based on chain length and polarity | Selectivity based on size only |
| Low heat of adsorption | High heat of adsorption |
| Acid resistant | Known to degrade in acidic conditions |
| Amorphous material | Leaching of clay binder leads to caking |
| Maintain structural integrity in refluxing environment | Break down in refluxing environment |
| Resistant to retrograde condensation | Coke formation in presence of hydrocarbons |

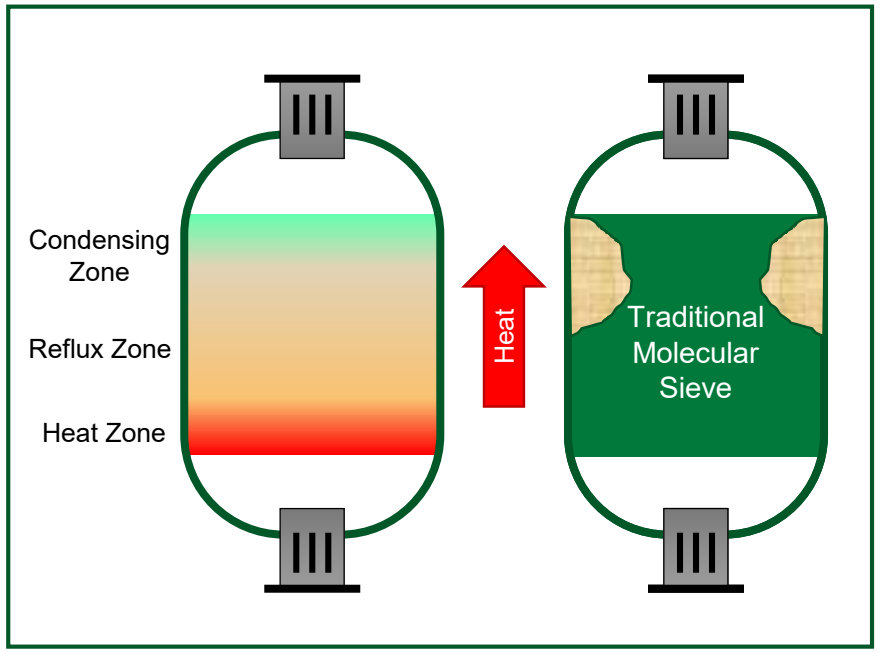
# The Problem of Regeneration Reflux

## The Problem

- When heated, condensation can occur on the sides and top of the bed
- Traditional Molecular Sieves lose structural integrity during regeneration

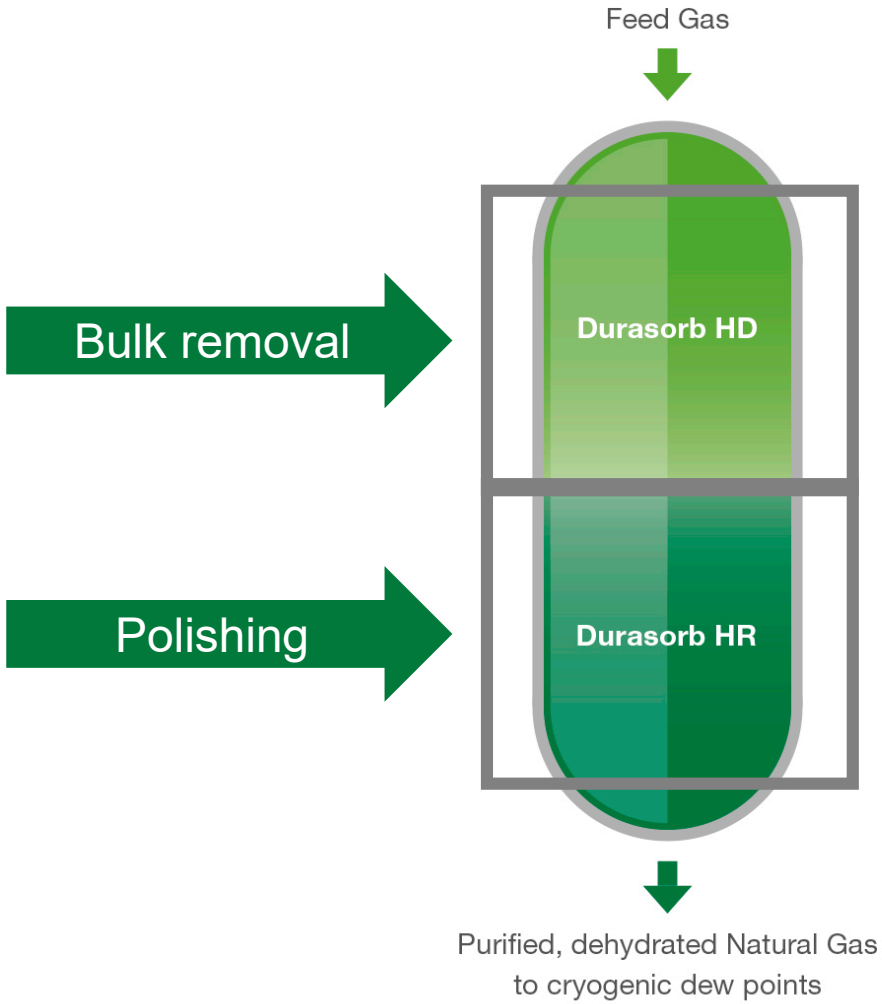
## The Solution

- Durasorb HD is resistant to liquid water and maintains mechanical stability, protecting the molecular sieve part of the bed
- Durasorb HR is attrition resistant and produces less fines



# Durasorb Dehy Combination Bed Design

- Durasorb Dehy is the combination of two BASF products into a single solution to capitalize on the benefits from each product
  - **Durasorb HD** (**H**igh **D**urability): water resistant adsorbent
  - **Durasorb HR** (**H**igh **R**esistant): reflux resistant molecular sieve
- The combination of HD and HR increase the overall bed capacity by optimizing the ratio of the two products

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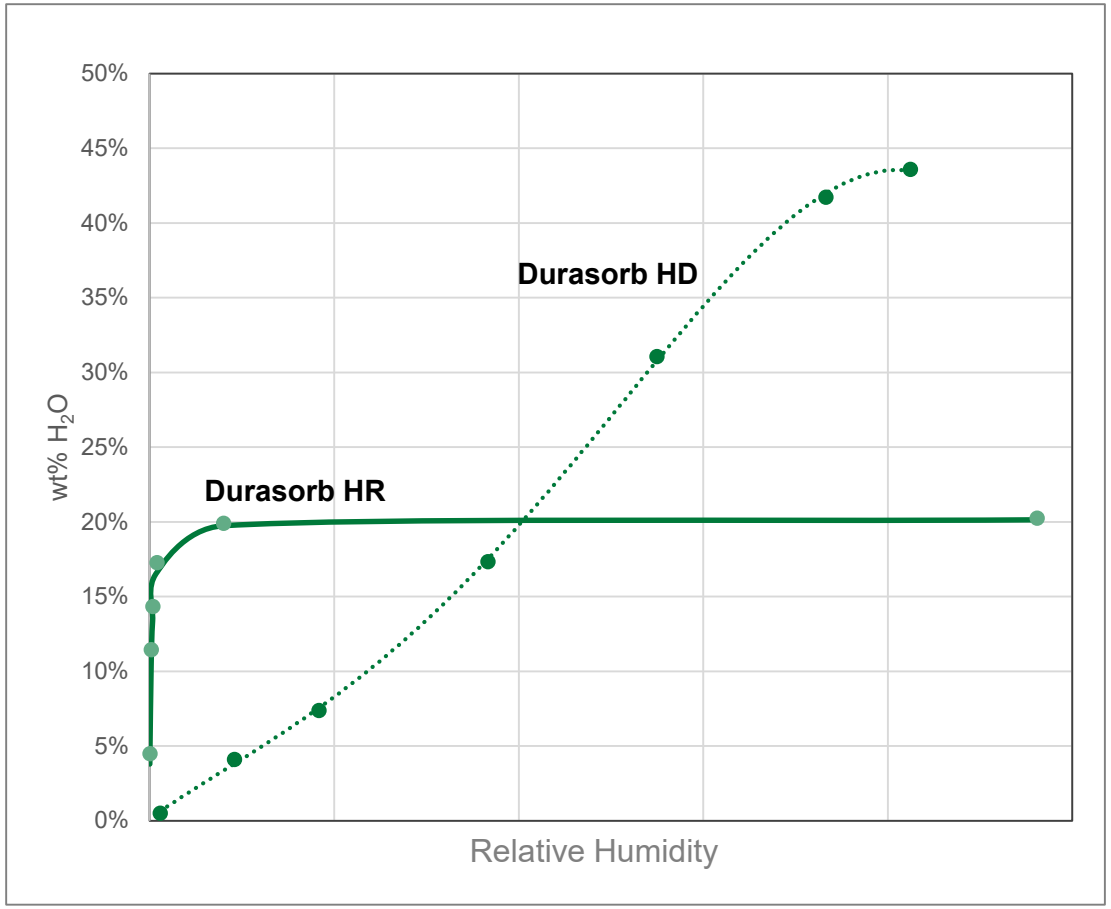
# Combination Bed Technology Creates a Superior Product

- Leverage the differences in performance between Durasorb HD and Durasorb HR for optimal water adsorption
  - Durasorb HD has a higher adsorption capacity at **higher** water saturation
  - Durasorb HR has higher adsorption capacity at **lower** water saturation values
- Durasorb HD is a very robust adsorbent that also adsorbs hydrocarbons
- Durasorb HR can reach very low water dewpoints required by a cryogenic unit



# Customer Case Studies

*Durasorb Design Improves Performance and Saves Costs*

# Case Study 1: Eliminating the effects of regeneration reflux

*LNG Facility Experiencing Poor Dehydration Unit Performance*

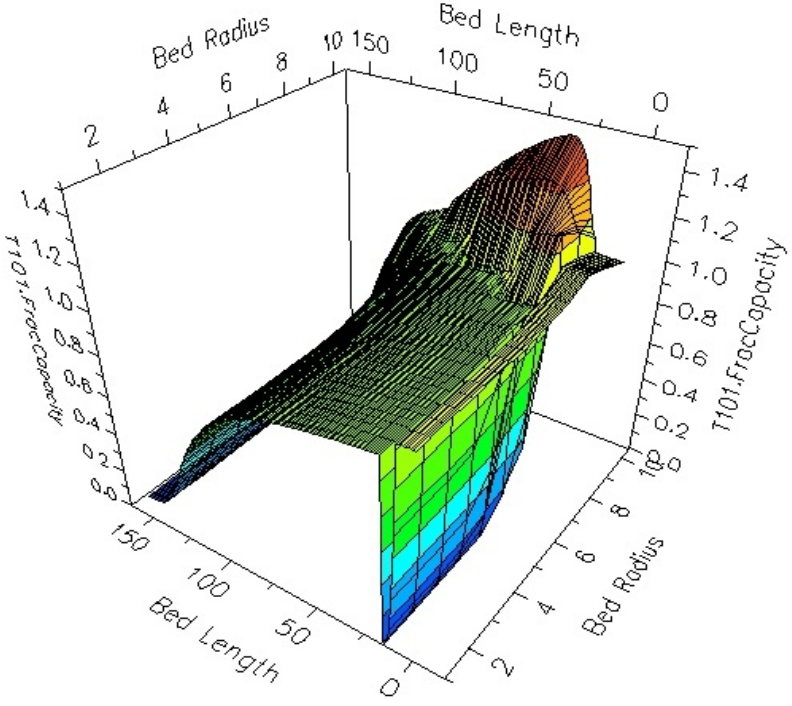
- **684 MMscf/d plant requiring deep dehydration prior to cryogenic separation**
- **Dehydration unit experiencing premature breakthrough**
  - Caking of the molecular sieve lead to increased pressure drop and maldistribution of gas flow
  - Operations continuously decreasing cycle to meet spec, until there was no longer enough time for regeneration

Donut-ring formation from molecular sieve caking in the dehydration vessel

# Case Study 1

*BASF Used Modeling Tools to Predict Refluxing Location*

- **Computational analysis was performed to predict the location of reflux in the bed**
- **Technology experts used analysis to design a combination bed**
  - A 30% layer of water resistant Durasorb HD was placed at the inlet of the bed
  - The remainder of the bed was filled with specialty molecular sieve
    - As COS formation was a concern, a 3A type molecular sieve was chosen




Computational analysis of regeneration reflux



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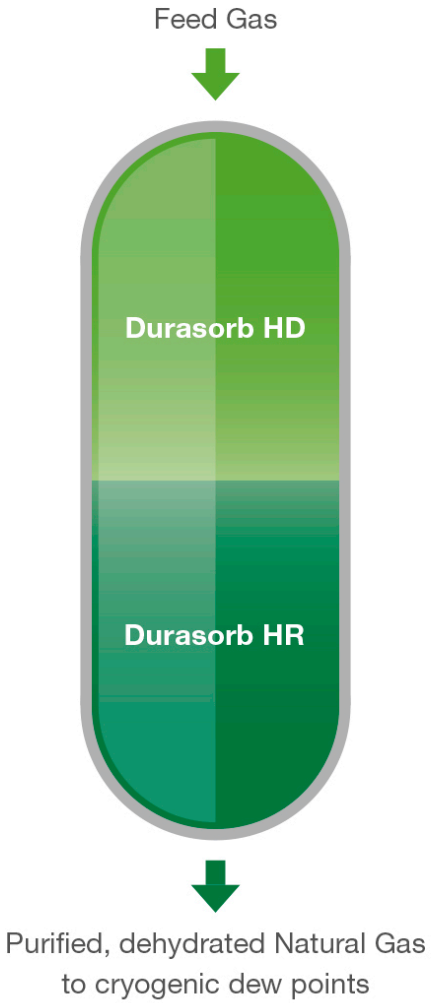
# Case Study 1

*Combination bed design increased unit lifetime 100%*

- **Using a Durasorb design, BASF increased bed life from 2 years to 4 years**
  - After 28 months of operation
    - Still on extended adsorption cycle time
    - No sign of dP increase
  - Increased lifetime results in 1 less turnaround and saves over $1.8MM in turnaround costs
  - No modifications to the internal structure of the vessel were necessary

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# Case Study 2: Reducing the effects of retrograde condensation

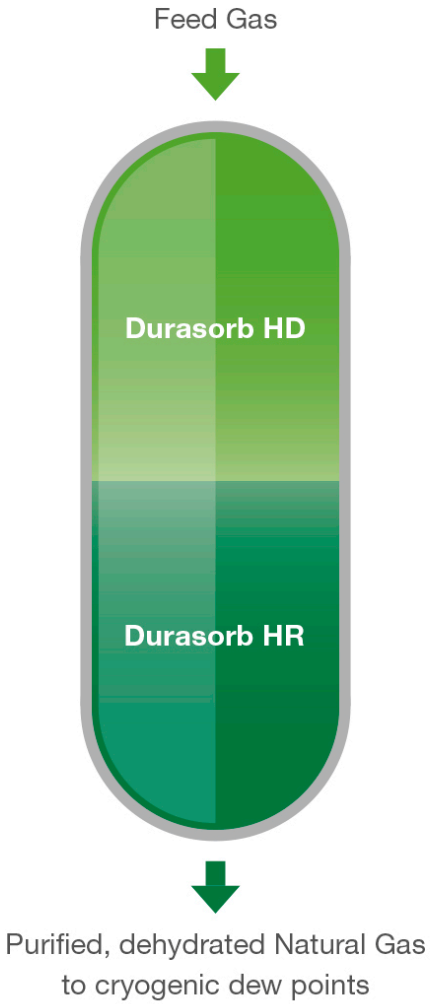
*Problems caused by high acid concentration and heavy gas feed*

- **North America NGL extraction plant experiencing reduced cycle time and pre-mature dehydration bed change out**
  - Operations was experiencing freezing in the distillation column, causing unit shutdown and loss of production
- **Analysis performed to identify the problem**
  - Levels of heavy hydrocarbons were detected in the feed gas
  - Spent sample analysis of the molecular sieve showed both degradation (acidic environment) and coke formation (coking from hydrocarbons)
  - High CO2 containing feed gas was degrading the “acid-resistant” grade molecular sieve

# Case Study 2

*Combination bed design addresses plant performance issues*

- **Combination bed design is robust and reliable in high acid gas and heavy gas conditions**
  - Durasorb HD adsorbs HHCs, reducing the effects of retrograde condensation on the molecular sieve
  - Durasorb HD removes water from the feed gas with a high equilibrium capacity
  - Durasorb HD is an acid resistant adsorbent, therefore the high acid gas feed conditions do not impact the performance

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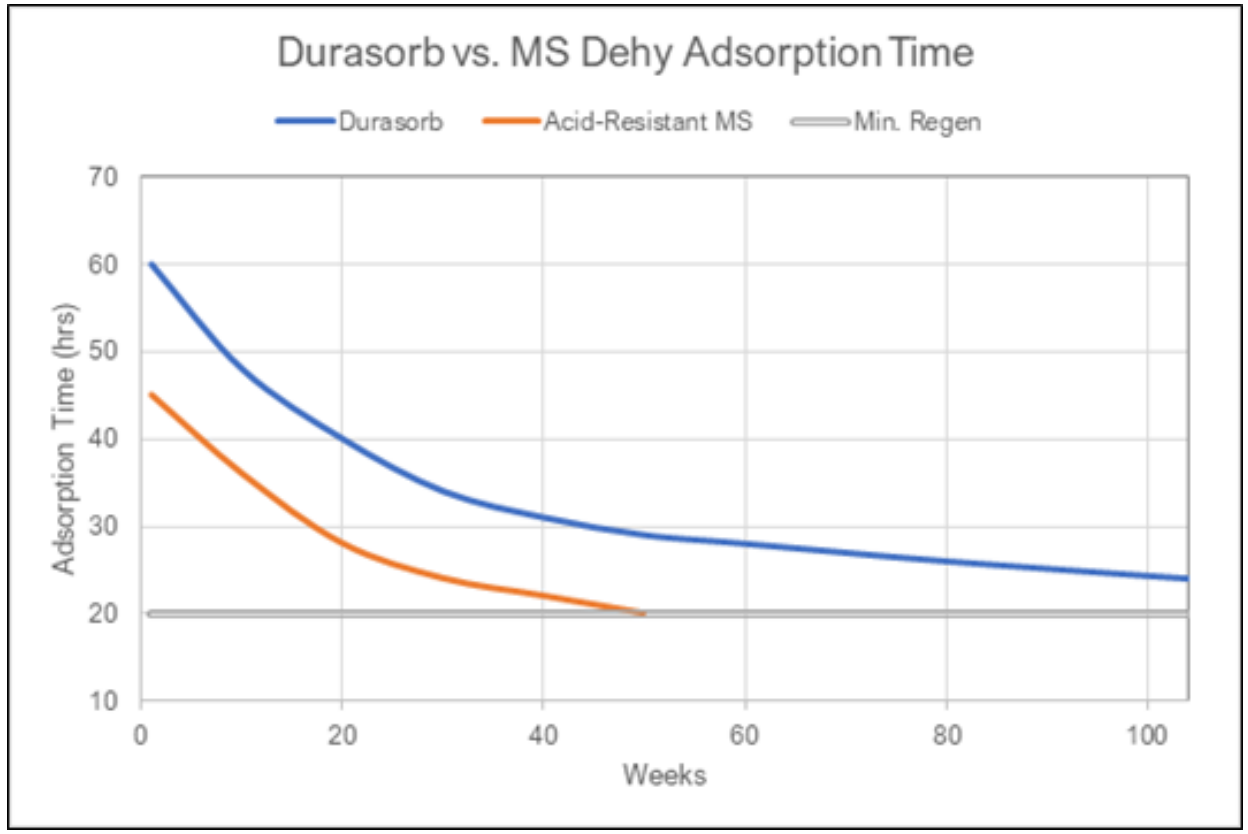
# Case Study 2

*Extending the life of the dehydration unit with high acid feed gas*

- **Performance from combination bed design**
  - Longer cycle times = longer lifetime
    - Extended lifetime from 9 months to 24 months
  - Reliable performance
    - No freezing of the distillation column
    - Continuous production
  - Decreased operational costs
    - One less turn around saved 150 kUSD



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# Conclusion

- Durasorb dehydration bed designs solve problems caused by regeneration reflux and retrograde condensation, issues associated with molecular sieve dehydration beds
- Durasorb combination bed installation is a drop-in solution that, on average, doubles the lifetime previously achieved
- Durasorb HD is a robust material employed in current dehydration units to solve the problem of pre-mature failure
  - liquid hydrocarbon and water resistant
  - ability to adsorb both water and hydrocarbons
  - stability in acidic environments
- Reliable operation and performance leads to a reduction in operating costs and ensures continuous production

To learn more, visit: www.catalysts.basf.com/durasorb



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