



Renewable Fuels

Landfill Gas & Hydrogen



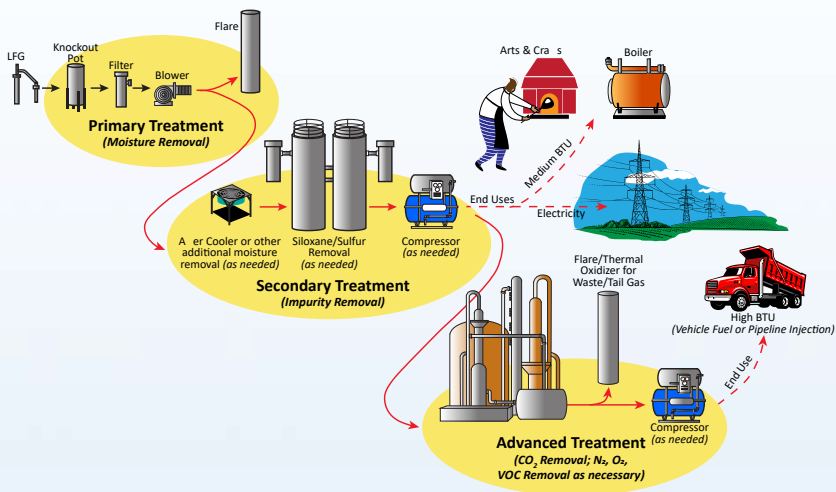
HENGYE

Table of Contents

| | |
|-------------------------------|----------------|
| Landfill Gas | Page 1 |
| Siloxane Removal | Pages 2-5 |
| 13X Applications | Page 3 |
| 13X Isotherm Data | Page 4 |
| 13X Specifications | Page 5 |
| H ₂ S Removal | Pages 6-8 |
| HYAS200 Applications | Page 77 |
| HYAS200 Specifications | Page 8 |
| Hydrogen Fuel | Page 9 |
| Hydrogen Purification | Pages 10-12 |
| 5A & 13X Isotherm Data | Page 10 |
| 5A & 13X Specifications | Page 11 |
| PSA vs. TSA | Page 12 |
| Why Choose Hengye Inc.? | Page 13 |



Landfill Gas



Landfill gas is a natural byproduct of the decomposition of organic material in landfills. This gas is composed of roughly 50% methane, 50% carbon dioxide, and a small amount of non-methane organic compounds. Landfill sites use various equipment and technology to treat this gas into achieving acceptable compositions of impurities for pipeline requirements. The treatment process of Landfill gas has three major stages:

1. Primary Treatment - Moisture Removal (H₂O removal)
2. Secondary Treatment - Impurity Removal
(H₂S and Siloxane removal)
3. Advanced Treatment - Purity Achievement Based (CO₂, N₂, O₂, VOC removal)

Siloxane Removal



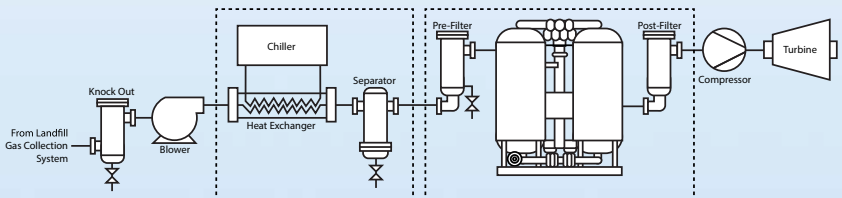
Removing siloxane is an important step in cleaning methane gases for use as fuel since siloxane is a form of crystalline silica that will essentially turn into glass when burned or combusted. The collection of combusted siloxanes inside of engine components can cause the buildup of heat, water, and other contaminants that can cause corrosion, leading to problems in the engine.

Molecular Sieve 13X Applications

HYD10A is manufactured to deeply dehydrate feed gas prior to cryogenic separation by removing water, carbon dioxide, and other contaminants from feed gas. The removal of these contaminants will allow the feed gas to be further separated into the desired product stream. This molecular sieve has an ideal selectivity for removing impurities that can freeze or block cryogenic separation processes.

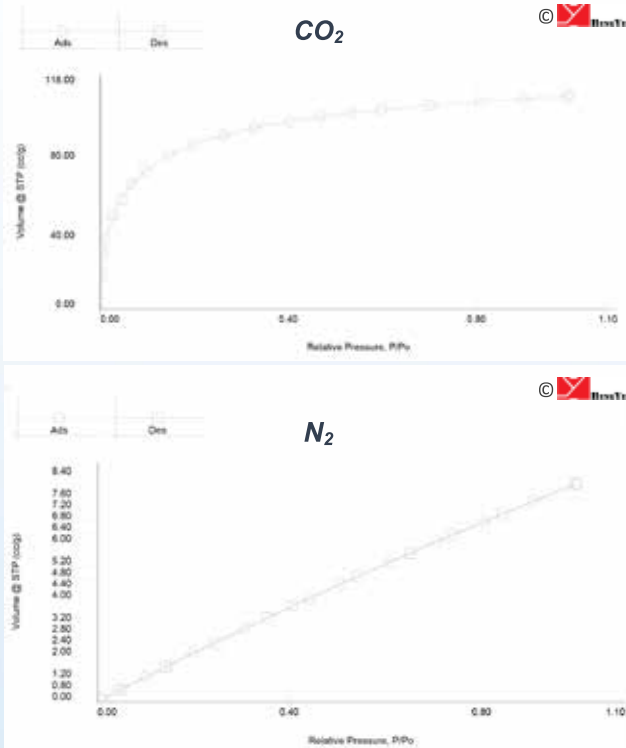
- Used to deeply dehydrate feed gas
- Capable of removing water, carbon dioxide, hydrocarbons, and more
- Allows gas to be further separated or otherwise used in compressors
- Offers an advantageous adsorption capacity for a wide range of impurities

Siloxane Removal Schematic



Aside from removing siloxane due to impurity specification requirements it also serves as the solution for better machinery life-cycles and ensures longevity of end products from landfill gas plant.

Isotherm Data



These charts indicate that HYD10A shows high N₂, and CO₂ separation under a very low pressure, which lowers the consumption of oxygen during generation and improves economic performance. HYD10A molecular sieve is most commonly used to remove contaminants such as water, carbon dioxide, and hydrocarbons from feed gas in air pre-purification units prior to cryogenic air separation. This molecular sieve will also remove hydrogen sulfide, mercaptans, and high molecular weight sulfur compounds in LNG, LPG, and liquid hydrocarbon streams, such as propane and butane.

Specifications of 13X

CHEMICAL FORMULA

$(Y)_a \times [(AlO_2)_a(SiO_2)_b] \times cH_2O$ ($Y = Na$)

SPECIFICATIONS

Molecular Sieve

| HYD10A | | Beads | | | | Pellets | |
|-----------------------------------|--|--------------------------|----------|----------------------------|-----------|----------------------------|----------------------------|
| Property | Unit | 4x8 Mesh | 4x8 *Avg | 8x12 Mesh | 8x12 *Avg | 1/16 Inch | 1/8 Inch |
| Diameter | mm | 2.36 - 4.76 | - | 1.68 - 2.36 | - | 1.5 - 1.8 | 3.0 - 3.3 |
| Bulk Density | g/mL (lb/ft ³) | 0.65-0.71 (40.6-44.3) | (40.90) | 0.66 - 0.72 (41.2-44.9) | (40.90) | 0.61 - 0.67 (38.1-41.8) | 0.60 - 0.66 (37.4-41.2) |
| Crush Strength | N (lbm*ft/s ²) | ≥80 (≥18) | (19.10) | ≥30 (≥6.7) | (19.10) | ≥30 (≥6.7) | ≥70 (≥15.7) |
| Static CO ₂ Adsorption | wt% | ≥17.5 | 28.34 | ≥17.5 | 28.34 | ≥16.5 | ≥16.5 |
| Attrition | wt% | ≤0.1 | 0.07 | ≤0.1 | 0.07 | ≤0.4 | ≤0.4 |
| Moisture Content | wt% | ≤1.5 | 0.45 | ≤1.5 | 0.45 | ≤1.5 | ≤1.5 |
| Packaging Options | Beads 1,000kg (2,204.6lb) / Super Sack; 140kg (308.6lb) / Drum Pellets 1,000kg (2,204.6lb) / Super Sack; 125kg (275.6lb) / Drum | | | | | | |

*Avg refers to a running average of lot analyses

H₂S Removal



Removal of H₂S is a critical procedure that helps reduce corrosion for power generation equipment, pre-treat LFG for high-BTU gas processing, and to reduce sulfur oxides (SO_x) emissions, associated with LFG combustion.

Activated Alumina for Desulfurization (HYAS200)

This special adsorbent is a smooth, spherical adsorbent which has demonstrated its superior performance applied in the selectivity of removing COS, H₂S, CS₂ and any other mercaptans impurity from hydrocarbon streams.

Removes H₂S from following sources:

- Biogas that originates in sewage treatment plants due to anaerobic conditions in sludge
- Agricultural biogas
- Gases from anaerobic industrial sewage treatment facilities
- Landfill gas
- Industrial combustion and synthetic gases
- Waste and co-fermentation plant biogas after anaerobic digestion
- Miscellaneous H₂S containing industrial exhaust gas (i.e. paper industry, oil-mill applications)
- The treatment of H₂S containing exhaust from industries and wastewater treatment facilities

Specifications of HYAS200

(Activated Alumina for Desulfurization)

HYAS200 eliminates H₂S and Mercaptans from landfill gas and deactivates gradually from inlet to outlet through a packed bed, discarding behind a free-



flowing, non-hazardous by-product. Typical H₂S Removal System units will have 2-3 vessels in place to achieve this removal process.

HYAS200 is a very porous form of aluminum oxide of high surface, typical chemical formula $\text{Al}_2\text{O}_3 \times n\text{H}_2\text{O}$.

| Activated Alumina | | | |
|--------------------------------|--|------------------|------------------|
| HYAS200 | | Beads | |
| Property | Unit | 7x14 Mesh | 4x8 Mesh |
| Particle Size | mm | 1.0 - 3.0 | 2.0 - 5.0 |
| Bulk Density | g/mL (lb/ft ³) | ≥0.75 (≥46.8) | ≥0.75 (≥46.8) |
| Crush Strength | N (lbm*ft/s ²) | ≥45 (≥10) | ≥160 (≥36.0) |
| Al ₂ O ₃ | wt% | ≥92 | ≥92 |
| Fe ₂ O ₃ | wt% | ≤0.03 | ≤0.03 |
| Loss on Ignition | wt% | ≤6.0 | ≤6.0 |
| Attrition | wt% | ≤1.0 | ≤1.0 |
| Packaging Options | Super Sack options available; 160kg (352.7lb) / Drum | | |

Hydrogen Fuel



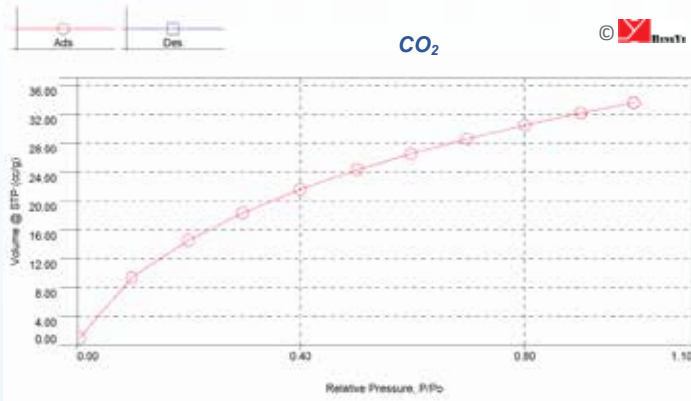
Hydrogen is remarked as the fuel of the future because of the clean environment it produces when being used and the many resources that it can be obtained from. Hydrogen can be produced from fossil fuels, biomass, and water electrolysis with wind, solar, or grid electricity. Hydrogen fuel can provide motive power for liquid-propellant rockets, cars, trucks, trains, boats and airplanes, portable fuel cell applications or stationary fuel cell applications, which can power an electric motor.

Hydrogen Purification

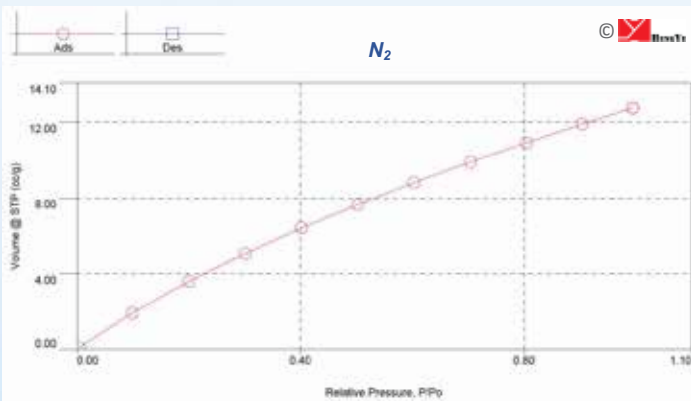


Hydrogen fuel is the most promising clean energy source in the near future and in order for it to be used in fuel cells it must meet certain purification levels that adsorbents can help achieve. Fuel cells can be used in a wide range of applications, including transportation, material handling and stationary, portable, and emergency backup power.

Isotherms for 5A & 13X



HYGB500B shows high CO₂ separation under a very low pressure, which lowers the consumption of oxygen during generation and improves economic performance.



HYGB500B shows high CO₂ separation under a very low pressure, which lowers the consumption of oxygen during generation and improves economic performance.

HYGB500B Molecular Sieve is commonly used for H₂ purification in PSA and VSA applications due to its high adsorption capacity and fast adsorption rate for nitrogen, strong adsorption selectivity, ability to achieve nearly complete desorption at vacuum or atmospheric pressure, high crush strength, and low attrition, which all increases the lifespan and efficiency of the product.

Specifications of 5A & 13X

HYD05C & HYD10A molecular sieve are the adsorbents available that can achieve high purification levels of Hydrogen. These particular adsorbents remove common impurities found within hydrogen streams in steam methane reforming processes. Although both sizes can get the job done, for high production volumes of Hydrogen fuel HYD10A would be recommended over the HYD05C (due to higher quality and better sustainability over time). These adsorbents are either used in Thermal Swing Adsorption Units (TSA) or Pressure Swing Adsorption Units (PSA) in order to achieve the desired gas separation.

CHEMICAL FORMULA

$(\text{¥})_a \times [(\text{AlO}_2)_a(\text{SiO}_2)_b] \times \text{cH}_2\text{O}$ (¥ = Na, Ca)

SPECIFICATIONS

| Molecular Sieve | | | | | | | |
|-----------------------------------|--|--------------------------|------------------|--------------------------|-----------------|--------------------------|--------------------------|
| HYD05C | | Beads | | | | Pellets | |
| Property | Unit | 4x8 Mesh | 4x8 *Avg | 8x12 Mesh | 8x12 *Avg | 1/16 Inch | 1/8 Inch |
| Diameter | mm | 2.5 - 5.0 | - | 1.6 - 2.5 | - | 1.5 - 1.8 | 3.0 - 3.3 |
| Bulk Density | g/mL (lb/ft ³) | 0.69-0.75 (43.1-46.8) | 0.72 (44.78) | 0.72-0.78 (44.9-48.7) | 0.73 (45.65) | 0.69-0.75 (43.1-46.8) | 0.68-0.74 (42.4-46.2) |
| Crush Strength | N (lbm*ft/s ²) | ≥70 (≥15.7) | 127.1 (28.58) | ≥25 (≥5.6) | 41.8 (9.4) | ≥30 (≥6.7) | ≥60 (≥13.5) |
| Static Water Adsorption | wt% | ≥21.5 | 22.13 | ≥21.5 | 21.62 | ≥21.0 | ≥21.0 |
| Static CO ₂ Adsorption | wt% | ≥15.0 | - | ≥15.0 | - | ≥15.0 | ≥15.0 |
| Attrition | wt% | ≤0.1 | 0.08 | ≤0.1 | 0.08 | ≤0.4 | ≤0.4 |
| Moisture Content | wt% | ≤1.5 | 0.39 | ≤1.5 | 0.50 | ≤1.5 | ≤1.5 |
| Packaging Options | 1,000kg (2,204.6lb) / Super Sack; 150kg (330.7lb) / Drum | | | | | | |

*Avg refers to a running average of lot analyses

Why Choose Hengye Inc?

What We Offer You

- Molecular Sieve, Activated Alumina, Silica Gel
- ISO certified manufacturing, world class quality
- Ideal adsorption capacity and product durability

We Can Supply

- Reliable molecular sieve with proven success
- Inventory in Omaha, Nebraska and Houston, Texas
- Super sacks and drums available
- Sales, engineering, and technical service support
- Material analysis and capacity evaluation
- Change out, turnaround services

Support Services

- Remote and on-site support available
- Dehydration unit optimization and operation analysis
- Design engineering and bed loading calculations
- Systems training and activities support
- Material application education and product selection
- Change out services and commissioning
- Analyze remaining working life of products
- Breakthrough testing, product performance analysis

A Global Manufacturer

In 2014, Hengye Inc. was established in the USA to meet the growing, dynamic adsorption needs in the American market. Our team provides a full range of services, including design work, bed sizing, technical support, optimization, turn around services, and more. Feed streams are unique and the superior design of Hengye products can meet the industry specifications required to maximize the value of product streams. Our engineers and technical advisors will provide the data and education to support and bring confidence to those who use Hengye products.



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