SELECTIVE NITROGEN ADSORPTION USING A VANADIUM METAL-ORGANIC FRAMEWORK

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PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,311,856	04/26/2022	2018-072

ABSTRACT

Natural gas, composed primarily of methane, has many potential uses as a cleaner and more renewable source of energy than other fossil fuels. However, about 20% of US natural gas reserves contain levels of N_2 that are too high for pipeline processing. Using natural gas from renewable sources also encounters this problem. Furthermore, in processing steps to create high-purity methane from its various sources, the removal of N_2 remains a significant energetic cost. This separation is typically performed through cryogenic distillation, and improvements in energy efficiency of this separation are necessary to utilize the many available sources of methane. Switching to membrane or adsorbent-based technologies could potentially alleviate this challenge. Size selective molecular sieves and membranes have demonstrated some ability for separating N_2 from CH_4, but face problems with scalability and selectivity; and current adsorbents need significant improvements in selectivity and capacity for N_2 to be commercially viable.

To address this situation, researchers at UC Berkeley have developed a new adsorbent V_2Cl_2(btdd) with exceptional affinity for nitrogen, such that early experiments already demonstrate a N_2/CH_4 selectivity of over 10x greater than any reported material. The Berkeley material is a permanently porous vanadium(II)-containing metal-organic framework (MOF). It represents the first example of a MOF with five-coordinate vanadium(II) centers as the primary metal node. The electronic properties of these five-coordinate V(II) centers make this MOF uniquely reactive towards relatively inert and weak electron acceptors, such as nitrogen, creating a stronger M–N_2 interaction than any known MOF. Additionally, the high-density of V(II) centers translates to a high gas uptake capacity, qualifying this material as a promising N_2/CH_4 selective adsorbant. Key performance parameters can be tuned as the building blocks are synthetically modifiable.

APPLICATION

Removing dinitrogen from natural gas

FEATURES/BENEFITS

- Lower costs
- Less energy usage

RELATED MATERIALS

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Next-Generation Metal-Organic Frameworks With High Deliverable Capacities For Gas Storage Applications
- Porous Polymer Networks For Per- And Poly-Fluoroalkyl Substance Separations
- Selective Carbon Monoxide Uptake via Metal Carbanion Functionalized Metal-Organic Frameworks
- Structures and Apparatus using Three-Dimensional Linked Networks
- Gas Separations With Redox-Active Metal-Organic Frameworks

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OTHER INFORMATION

KEYWORDS

Metal-Organic Framework, MOF

CATEGORIZED AS

- **Energy**
  - Other
- **Materials & Chemicals**
  - Other

RELATED CASES

2018-072-0

- Metal-Organic Frameworks For Aromatic Hydrocarbon Separations
- Novel Porous Organic Polymers for Ammonia Adsorption
- Isothermal Carbon Capture And Release Of Carbon Dioxide With Molecular Polyamines
- Metal-Organic Frameworks for H2 Adsorption and Drug Delivery
- Redox-Active Metal-Organic Frameworks for the Catalytic Oxidation of Hydrocarbons
- Phase Change Adsorbents For Storage And Separation Applications

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