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ABSTRACT SCIENTIFIC PAPER

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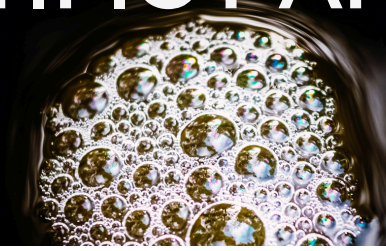

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Advancing Methane Capture Technology with Dual-Layer Nanocomposite Membranes and Genetically Engineered Bacteria

Aiden Digital Labs, in collaboration with Nanogeios, is pioneering a breakthrough in methane capture and carbon dioxide separation with its **dual-layer nanocomposite membrane technology** and genetically engineered **methanotrophic bacteria (5GB1C-RO1)**. This innovative approach aims to address one of the most pressing global challenges: reducing methane emissions, a potent greenhouse gas with a global warming potential 28–36 times greater than carbon dioxide (CO_2) over a 100-year period.

Methane concentrations have significantly risen in recent decades, contributing to climate change. Traditional methods for methane capture, including cryogenic distillation and pressure swing adsorption, are energy-intensive and costly. Membrane-based solutions present a promising alternative due to their potential for operational simplicity, scalability, and energy efficiency.

However, existing membrane technologies face challenges in balancing permeability and selectivity, especially for the separation of gases like methane (CH_4) and CO_2.

Aiden Digital Labs' Advanced Two-Stage Nanocomposite Membrane Technology represents a transformative solution. The dual-layer membrane system features a **CO_2-selective primary membrane** and a **CH_4-selective secondary membrane**, utilizing a hierarchical structure of **nanoparticles** and polymers. This system has demonstrated unprecedented performance in separating gases from both atmospheric air and water sources.

Key Findings and Performance Metrics:

- The dual-layer membrane operates effectively across a wide range of gas concentrations, reducing methane levels from **100-500 ppm to 5-10 ppm**, even in challenging aerobic and anaerobic conditions.
- CO_2 permeances between **200-2000 GPU** and CO_2/N_2 selectivities of **30-500** at typical operating temperatures surpass conventional polymer membrane technologies. Methane-specific permeances achieved **500-2000 GPU** with **CH_4/CO_2 selectivities >50**.

- **Long-term testing (10,000 hours)** validated the membrane's durability, with methane capture efficiency consistently above **90%**, and energy consumption as low as **0.3 kWh per kg of CH_4** captured.

The membrane's layered structure incorporates **graphene oxide** and **zeolite nanoparticles**, optimizing gas selectivity and enhancing separation efficiency. The integration of nanotechnology not only achieves superior performance but also opens the door for scalable deployment in both industrial and atmospheric applications, from oil fields to waste treatment facilities.

Alongside the nanocomposite membrane, **genetically engineered methanotrophic bacteria (5GB1C-RO1)** play a crucial role in the system. These bacteria, modified through advanced genetic engineering techniques including CRISPR, are optimized for methane oxidation and carbon fixation. Our team has worked on enhancing three key metabolic pathways—rump, oxidation, and carbon fixation—since March 2023, to improve methane bioconversion into useful byproducts like biofuels and biofeed.

Strategic Benefits:

- **Scalable Technology**: The nanocomposite membrane system's energy-efficient operation enables large-scale applications across various industries, reducing the carbon footprint of methane-emitting sources globally.
- **Bioconversion of Methane**: The modified bacteria not only capture methane but also convert it into clean biofuels, surfactants, and even biofeed for animals, contributing to a circular economy.
- **Industrial and Environmental Impact**: This system positions Aiden Digital Labs as a leader in sustainable methane capture technologies, with applications ranging from biogas upgrading to atmospheric methane removal.

Conclusion:

Aiden Digital Labs' dual-layer nanocomposite membrane and methanotrophic bioreactor technology represent a significant advancement in methane capture and bioconversion, promising substantial contributions to climate change mitigation. The successful completion of **10,000 hours of testing**, combined with the low energy requirements, positions this innovation as a leading solution for industries seeking to meet ambitious sustainability targets.

Investors and scientists are encouraged to engage with Aiden Digital Labs as we advance toward the commercial scale-up of this transformative methane capture technology, offering a path to both environmental sustainability and profitable carbon management.

Email us at **contact@kaigen.io** for more information about this scientific paper or to receive the full copy