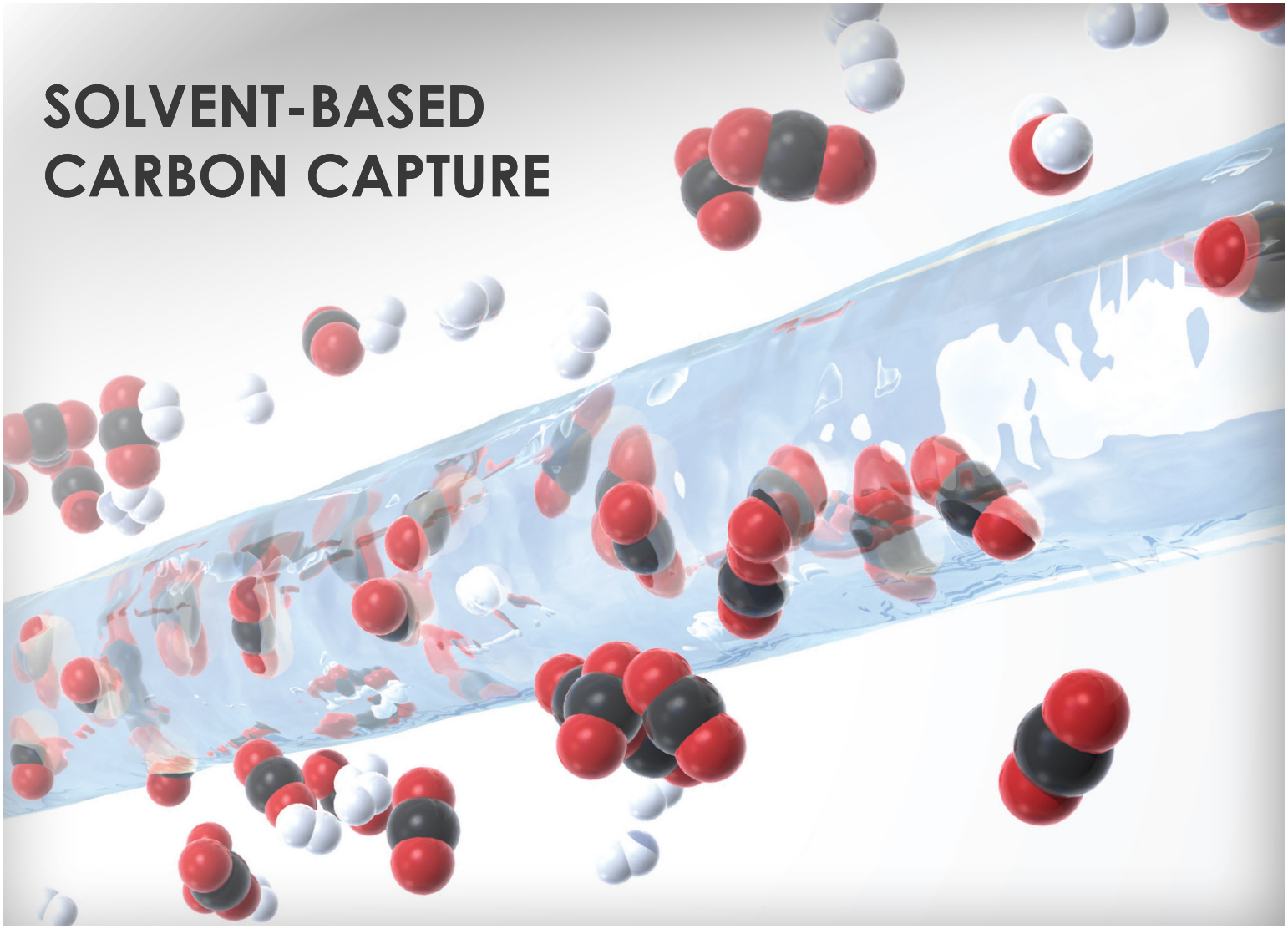
SOLVENT-BASED CARBON CAPTURE



Program 148, August 2024

NATIONAL ENERGY TECHNOLOGY LABORATORY

NETL's Point Source Carbon Capture (PSCC) Program is developing the next generation of advanced carbon dioxide (CO_2) capture concepts to support the United States in achieving ambitious goals for a greenhouse gas (GHG)-neutral economy by 2050, a carbon-pollution-free power sector by 2035, and a 50% reduction from 2005 levels in economy-wide net GHG pollution by 2030. The PSCC Program is accelerating commercially deployable solutions that can be applied to a wide spectrum of CO_2 emissions sources with varying characteristics, including facilities that produce power, hydrogen, chemicals, cement or steel, as well as exhaust CO_2 emissions from mobile sources, such as marine vessels, long-haul trucks and rail transport vehicles.

R&D efforts to date have led to reductions in both capital and operating costs through implementation of energy and process efficiencies and development of advanced CO_2 capture media (e.g., solvents, sorbents, and membranes). To achieve deep decarbonization of emissions sources, the program is focused on developing highly efficient, scalable carbon capture technologies with cost reductions that can operate under a flexible duty cycle and can achieve greater than 95% carbon capture.

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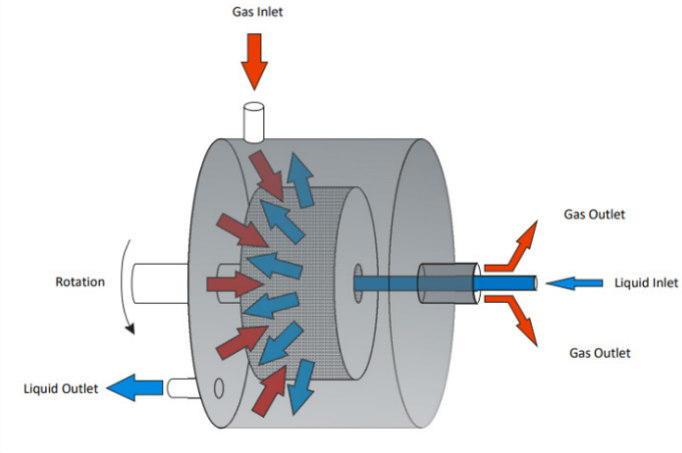
SOLVENT-BASED CAPTURE TECHNOLOGY

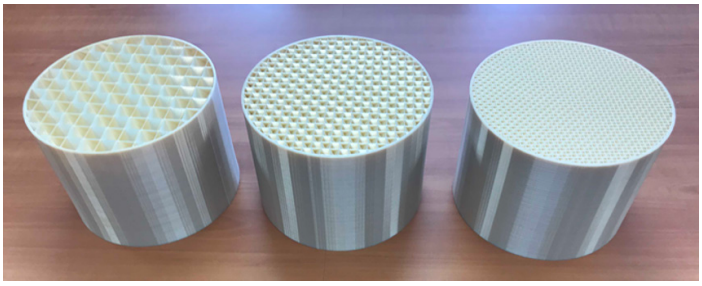
Solvent-based CO_2 capture involves chemical or physical absorption of CO_2 from a gas into a liquid carrier. The absorption liquid is regenerated by increasing its temperature or reducing its pressure, releasing the captured CO_2. Solvent-based systems offer opportunities for effective heat integration and management as well as selective capture from low-concentration gas streams.

Advancements in solvent-based technology development are being pursued along three main innovation pathways: materials, processes and equipment. R&D objectives include development of low-cost non-corrosive solvents that have a high CO_2 loading capacity, improved reaction kinetics, low energy investment and resistance to degradation. Targeted process R&D includes improvements in system configuration and operation that result in enhanced heat recovery and mass transfer rates.

The PSCC Program has examined a broad array of solvent-based capture approaches including water-lean solvents, phase-change solvents, high-performance functionalized solvents, amine solvents, carbonate-based solvents and catalyzed processes. Process innovations and equipment improvements (e.g. two-stage stripping and additive manufacturing) have contributed to overcoming technical challenges, including absorber and desorber designs for optimized gas-liquid contact, process intensification techniques, methods to mitigate aerosol formation, heat integration approaches and hybrid systems.



Process intensification using a rotating packed bed absorber



3D printed intensified packings for enhanced solvent-based CO_2 capture

NETL is a U.S. Department of Energy (DOE) national laboratory dedicated to advancing the nation's energy future by creating innovative solutions that strengthen the security, affordability and reliability of energy systems and natural resources. With laboratories and computational capabilities at research facilities in Albany, Oregon; Morgantown, West Virginia; and Pittsburgh, Pennsylvania, NETL addresses energy challenges through implementing DOE programs across the nation and advancing energy technologies related to fossil fuels. By fostering collaborations and conducting world-class research, NETL strives to strengthen national energy security through energy technology development.

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