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Baker Hughes Carbon Capture Technologies Portfolio: A Review Of Current Development Plan

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Abstract

The energy sector is changing, faster than ever before. As the world faces the "energy trilemma" of achieving energy security, affordability, and sustainability, Baker Hughes has a clear role to play. Our purpose of taking energy forward, making it safer, cleaner, and more efficient for people and the planet, has never been more relevant. Robust and scalable development methods are key to realizing the potential of advanced processes in industrial-scale deployments of climate technology solutions. More importantly, the role that the industry plays in accelerating such technologies is central to the operationalization of projects at scale.

Baker Hughes is an energy technology company with a diverse portfolio of solutions – ranging from equipment to service capabilities that span the energy and industrial ecosystem. The company's two operating segments are organized based on the nature of markets and customers in the energy industry and beyond. The Oilfield Services and Equipment (OFSE) segment provides solutions for onshore and offshore oilfield operations across the lifecycle of a well, ranging from exploration, appraisal, and development, to production, rejuvenation, and decommissioning. The Industrial & Energy Technology (IET) segment combines a broad array of domain expertise, technologies, and services for industrial and energy customers.

Baker Hughes solutions unlock the ability to transform, transfer, and transport energy efficiently while capturing and cutting emissions – reducing environmental impact while maximizing efficiency, productivity, and reliability. Furthermore, IET's Climate Technology Solutions business line covers various segments including carbon capture, utilization, and storage (CCUS), hydrogen, clean power, and emissions management capabilities to enable both energy operators and broader industry, particularly the hard-to-abate sectors, to achieve a reliable, net-zero energy systems.

Among the various existing CO_2 capture technologies, chemical absorption approaches based on organic solvents such as amines is the most mature solution. However, amine solvents are sensitive to impurities contained in the flue gases (e.g. SO_x, NO_x), and may degrade to form nitrosamines. Atmospheric emission of amines and their degradation products gains increasing attention due to environmental concerns. Baker Hughes' solvent-based post-combustion carbon capture technology portfolio relies mainly on inorganic solvents which are tolerant to flue gas contaminants,

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unaffected by thermal and oxidative degradation, with environmentally friendly effluents.

This paper is a review of Baker Hughes' carbon capture technologies and their current development status. It covers the following technologies:

- Chilled Ammonia Process (CAP): CAP is a post-combustion carbon capture technology based on chemical absorption of CO_2 with aqueous ammonia. Ammonia is a low-cost, inorganic commodity chemical, readily available on the global market from multiple sources and not bound to any specific supplier. It is applicable to a wide range of flue gases (e.g., fossil-based power generation, waste to energy and biomass power generation, hydrogen production through steam methane reforming, cement production, etc.) and has been validated in several test facilities, operated over 22,000 hours, with varying feed and up to 100 ktpa. The technology is currently at TRL 7
- Mixed-Salt Process (MSP) – MSP uses a novel solvent formulation based on readily available potassium carbonate and ammonia with improved reaction kinetics and reduced emissions. MSP is designed to address middle to large scale energy and/or industrial CO_2 emitters. It has achieved a technology readiness level (TRL) of 4 and a pilot project for demonstrating TRL 6 at National Carbon Capture Center (NCCC) is under execution by SRI International, funded by the US Department of Energy (DoE) and Baker Hughes
- Compact Carbon Capture (CCC): CCC is a pioneering solvent-based technology development in the Baker Hughes CCUS portfolio. CCC employs the Rotating Packed Bed (RPB) technology instead of conventional absorption and regeneration columns. By using RPB technology, CCC drastically increases the vapor-liquid contact area, overcoming the traditional hydraulics limitations. Compared to conventional solvent-based systems using static equipment, CCC's enhanced mass transfer results in reduced residence time in the absorber and the regenerator requiring much smaller equipment. CCC also proposes the regenerator and the reboiler integrated into one unique equipment, which results in a further reduction of the plant's footprint. CCC is solvent agnostic and can be employed with a broad range of organic and inorganic solvents
- Regenerative Froth Contactor (RFC): the RFC, conceived by Industrial Climate Solutions (ICS), a Baker Hughes company, stands out as a ground-breaking solution poised to revolutionize carbon absorption processes through process intensification. The RFC is equipped with Corrugated Screen Packing (CSP) and operates in co-current flow under the pulse regime generated by the gas and liquid phases that flow through the CSP packing, a static equipment. The RFC provides an increase of effective mass transfer surface that reduces the required packing volume, within admissible pressure drop values for the process
- Mosaic Materials: Direct air capture (DAC) is an engineered atmospheric carbon dioxide (CO_2) removal technology aimed at mitigating climate change impacts. With only a limited number of currently deployed units globally, DAC technology is still at its embryonic stage. Mosaic's metal organic framework (MOF) technology is a proprietary sorbent material, i.e., a high-capacity nano-sponge to capture CO_2 selectively. Baker Hughes is leveraging their advanced technical capabilities, such as modular design and advanced material science expertise, to develop and scale this MOF-based DAC technology with a lower cost and higher efficiency. Furthermore, Baker Hughes is also engaged in global partnerships with key market players in the space – using the captured CO_2 for further utilization, such as e-fuels.

Keywords: Post-combustion capture ; Direct air capture ; Inorganic solvent ; Process intensification