How proper CO_2 Compressor Selection can Improve the Economics on CCUS

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CCUS is a critical technology for decarbonization. Many projects are in the early days of development and efforts are increasing rapidly as companies work out their business cases supporting investment decisions.

Compression typically represents a large component of CCUS system ownership cost and has a significant impact on a project's underlying economics. This presentation will provide an overview of various compression technologies for CCUS applications (e.g., post-combustion capture, blue hydrogen production, direct air capture (DAC), CO_2 transportation via pipeline, underground injection/storage, etc). It will discuss the importance compressor selection has on overall system efficiency, as well as CAPEX and OPEX.

Siemens Energy has built and executed multiple CO2 compression units based on integrally geared, single-shaft, and reciprocating compressor technology. Generally speaking, integrally geared compressors offer the highest efficiency, but are limited in discharge pressure. Reciprocating compressors, on the other hand, can be applied for systems with low flows and very high discharge pressures; however, they are typically associated with increased maintenance. Single-shaft turbocompressors offer higher discharge pressures than integrally geared machines, but lower than reciprocating compressors. One particular advantage they possess is a smaller footprint. The presentation will provide an overview of each compression technology, with the aim to help operators make more informed decisions on equipment selection by outlining the benefits and trade-offs that each technology provides under various operating conditions.
The presentation will also explore methods for driving down the energy demand and thus costs of the capture system itself. The provision of low-pressure steam accounts for a large portion of capture system energy consumption. Siemens Energy recently developed a novel CO_2 compression heat recovery concept, where significant amounts of this low-pressure steam can be provided from the waste heat that is produced by the CO2 compressor downstream of the capture system. For a typical amine-based capture system, 60-80% of the required steam and heat energy can be provided, while only requiring between 1/4 to 1/6 of that heat as additional mechanical power for the compressor at comparable CAPEX and footprint. Initial calculations for amine-based systems show that the specific energy demand per ton of CO_2 captured by utilizing the waste heat from compression could be reduced by up to 1.3 GJ/t. This concept can also help to improve the economics of Direct Air Capture, where the energy demand is significant (5-10 GJ/t).