Sandia National Laboratories

Energy, Climate & Infrastructure Security

Recompression Closed Brayton Cycle

Goal: Raise electricity production efficiency from the current 33% up to 50% using a cost effective system.

Sandia National Laboratories is developing a thermal-to-electric power conversion technology that utilizes carbon dioxide (CO_2) as the working fluid in a closed Brayton cycle. This technology possesses the capability to generate electricity at high efficiencies while reducing both costs and greenhouse gas emissions.

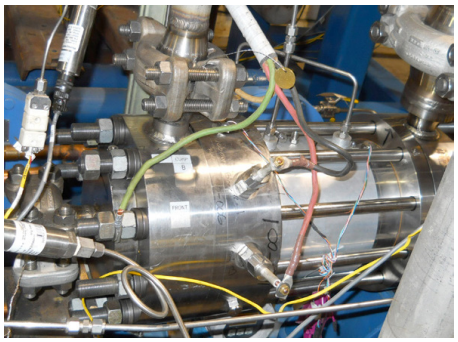
Generating Electricity at High Efficiencies

Sandia National Laboratories is working to create a thermal-to-electric power conversion technology in a configuration called the recompression closed Brayton cycle (RCBC) that uses supercritical carbon dioxide (SCO_2) as the working fluid, rather than steam, thereby dramatically increasing conversion efficiency compared to the steam Rankine cycle.

The primary reason for improved efficiency is that a sensible temperature difference between the hot turbine discharge and the cold compressor discharge drives heat transfer within the cycle, which provides the vast majority of the heat addition to the high pressure fluid. The heat rejected while condensing steam at constant temperature in a Rankine cycle is avoided. While this process of internal heat recuperation applies to any gaseous working fluid, SCO_2 remains relatively incompressible and dense at normal atmospheric temperatures. Therefore, the low temperature condition in the cycle that minimizes the work of compression is easily and cheaply achieved.

Reduce the Costs of Energy Production,

The benefits of this technology will dramatically reduce the costs of energy production, reduce greenhouse gas emissions, and is applicable to any heat source. By utilizing the Brayton cycle instead of the Rankine cycle, power plants can produce much more electricity from the same amount of fuel. The thermal-to-electric conversion efficiency of the closed Brayton cycle can be dramatically higher than other cycles for applications such as nuclear energy, concentrated solar power, and waste heat sources. System size is also significantly reduced compared to steam cycles, and it can generate electricity form any heat source, including waste heat, making it highly versatile.



Above: Turbine Alternator Compressor

Below: Nuclear Energy Systems Laboratory (NESL) Site, Sandia National Laboratories

Commercialization Path

The Sandia Brayton Team has set a goal of demonstrating a Supercritical Carbon Dioxide Recompression Close Brayton Cycle scalable to 300 MWe by 2020. The system would be ready for pilot plant operation at up to 50% energy conversion efficiency with dry heat rejection at that time.

To reach that goal, Sandia is exploring business arrangements with commercial vendors to specify, design, construct, and test the demonstration unit using infrastructure capabilities at Sandia. The expected cost of this demonstration is in the $50 million range and is expected to take 5 years. Cost sharing with the Department of Energy under Multiple Party CRADAs is a possibility. Establishment of Consortia is also being considered.

At the end of the successful demonstration, the expectation is that vendors of commercial power cycle equipment will adopt the technology and place it on the commercial market.

For more information please contact:

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U.S. DEPARTMENT OF ENERGY

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