# SUPERCRITICAL $CO_2$ POWER CYCLE DEVELOPMENT SUMMARY AT SANDIA NATIONAL LABORATORIES

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## ABSTRACT

Supercritical $CO_2$ power plants offer the potential for superior economics due to their small size, use of standard materials, and improved electrical-power-conversion efficiency at temperatures from 400-750 °C. [1,2] Sandia National Labs (SNL or Sandia) and the DOE Office of Nuclear Energy have been operating a supercritical $CO_2$ (S-$CO_2$) research loop (located at Sandia) and a Brayton cycle power system that is currently located at Sandia's contractor Barber Nichols Inc. in Arvada, Colorado.[3] This latter loop is a re-configurable proof-of-principle Brayton cycle loop that is being developed in stages. During 2010 the Brayton cycle loop was configured with a 260 kW heater, a Printed Circuit Heat Exchanger (PCHE™) recuperator, and a PCHE™ [4] water-to-$CO_2$ gas chiller. In this configuration, the simple recuperated Brayton cycle has just enough power to reach break-even conditions. In 2011 upgrades to the Brayton cycle have added heater power upgrades to 520 kW, a second recuperator (to allow operation as a re-compression cycle), and numerous other upgrades to increase the Brayton Cycle operation and performance capability. The loop has also been operated as a Rankine cycle.

The Sandia supercritical program has focused its effort into four areas including: 1) continued hardware development, testing, and upgrading of the two S-$CO_2$ loops and their components, 2) research and testing of advanced strategies with a focus towards further improving cycle efficiency and extending the applicability of S-$CO_2$ systems, 3) S-$CO_2$ model developments to support system testing, component performance modelling, operations and control methods, and lastly 4) commercial development strategies to build a 10 MWe S- $CO_2$ power conversion system.

A brief summary of each of these four areas of research will be provided. More detailed descriptions can be found in papers and presentations presented at the S- $CO_2$ Power Cycle Symposium, Boulder, Colorado May 24-25, 2011.

## REFERENCES

[1] Dostal, V. Driscoll, M.J. and Hejzlar, P. "A Supercritical Carbon Dioxide Cycle for Next Generation Nuclear Reactors", MIT-ANP-TR-100, March 2004.
[2] Angelino, G. "Carbon dioxide condensation cycles for power production" Journal of Engineering for Power-T. ASME, pages 287-295, July 1968.
[3] Barber Nichols Incorporated, www.barber-nichols.com, 2011.
[4] Southall D., Dewson, S.J. "Innovative Compact Heat Exchangers", in Proceedings of ICAPP 2010, San Diego, CA, June 13-17, 2010.