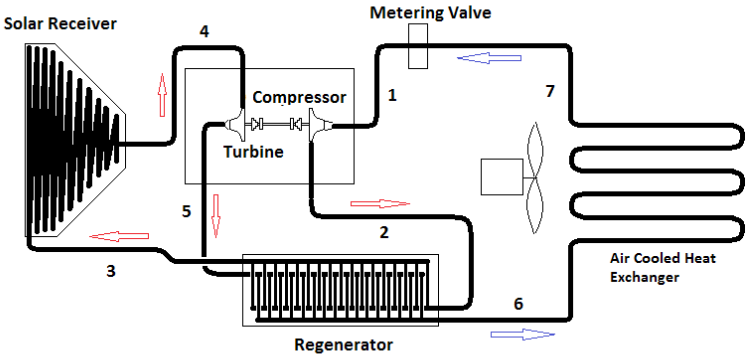
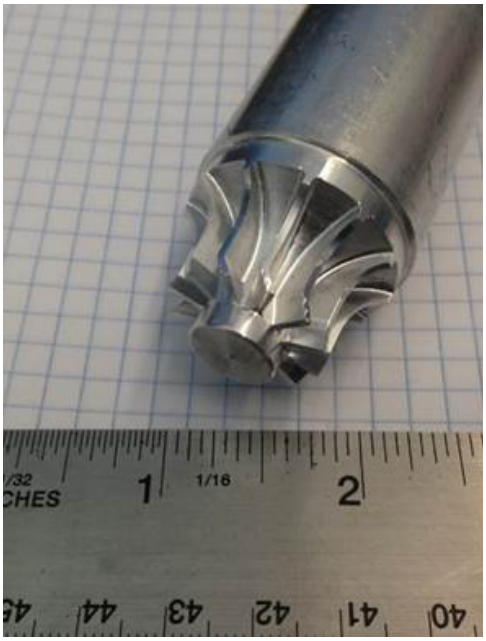
Solar Energy | Water | Environment
Nexus IN NEVADA

Innovative research to achieve water efficient and environmentally friendly solar power

SOLAR ENERGY-WATER-ENVIRONMENT NEXUS PROJECT

SCCO2 Brayton Cycle Diagram





Solar-Driven Supercritical CO_2 Engine Development

Introduction and goal

The goal is to build the first solar-driven supercritical CO2 cycle that can be used for research in advanced high efficiency power cycles. Motivations include moving to higher operating temperatures and thus achieving greater thermal conversion efficiencies, developing advanced equipment concepts including heat exchangers, receivers, turbines and compressors, and understanding how these can be combined to yield high efficiency thermal performance. New approaches include new designs of heat exchangers, advanced turbine/compressor units, and major developments in system integration. Components for the engine configuration have to be designed and manufactured locally because they are not available in the commercial market and operate under more extreme conditions than those of current systems.

Where does this research fit within the NEXUS project?

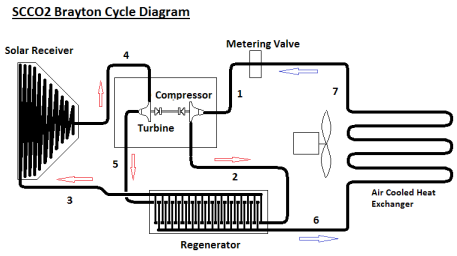
This research will minimize the size, water use, and environmental impacts of new high-performance solar power generation systems and the topics reside under Objective 1, Goal 1. It is a very promising approach to advanced power conversion technologies because it is a pathway to much higher efficiency thermal power generation.

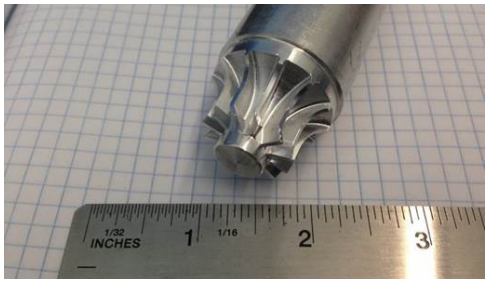
Why is this research important and what knowledge gap does it fill?

Newer, higher performance power cycles are needed to minimize power plant impacts, like water use, in desert areas and will also minimize the potential capital costs per unit of power output. Higher performance comes from, among other factors, using higher operating temperatures, more efficient mechanical components, better approaches to cycle design, and more effective heat transfer components. As higher temperatures are sought for power generation cycles in the coming years, results of this study should have positive impacts on new power generation.

What is the originality of the approach?

No solar-powered engine like this one has been built before that holds promise for a significant list of positive qualities. Only one or two operating systems have been developed according to other theoretical studies, and no solar application has been demonstrated. We are pursuing this approach because it is able to operate at higher pressures and temperatures compared to current cycles and has promise to improve engine performance. The type of heat exchangers we are using are also quite different than are proposed or used in existing systems. All of these approaches are on the path to systems that will prove valuable as higher and higher operating temperatures are sought.





How is the new NEXUS equipment being used now, and in the future?

The equipment, once completed this fall, will be the first solar energy driven engine of this type. It will serve as the base case from which we can understand the performance of several components, most of which involve new design approaches. So the performance of the various components in the engine is of great interest to us as is the overall system performance. As a result of developing the engine system, we have also learned a great deal about advanced system control approaches. Overall, the system is moving us well beyond business as usual, and it should open up a whole new field of development for us.

Key results to date

We have adapted an existing solar dish concentration system to furnish energy to the receiver portion of the new engine. The dish achieves a solar concentration up to about 500X depending upon the size of the receiver. All aspects of the engine system have been defined and designed, and most have been manufactured. An appropriate control system has been developed which has stressed the use of common control devices. When systems are committed to hardware, it tends to be time consuming and expensive to apply major changes to them. For this reason, the simulation computer code to describe the system operation was developed. This will enable us to evaluate a number of variations to the system we have to see how we can improve performance for later designs.

How is the research and/or equipment fostering collaboration now, and in the future?

We have been exploring possible collaborations on a number of fronts. The only system that was built, to our knowledge, was at Sandia Laboratories and was developed primarily for nuclear applications. Discussions with current and former Sandia personnel with knowledge of this system have provided a great deal of insight. We also have been in contact with two international laboratories that are conducting research in this general technical area. We have visited the Thermal Engineering Department at Xi'an Jiaotong University (and they have visited here); possible collaborations have been discussed. The Korea Institute of Machinery & Materials is developing a related engine for lower temperature applications (waste heat from industrial processes). A group from there has visited our laboratory, and we have had discussions about possible collaboration.

Future plans

Our plans are as follows:

- Complete the development of the engine and driving system.
- Modify as may be necessary to improve preliminary performance.
- Perform a variety of evaluations on individual components as well as in the overall system to demonstrate the potential operation of the system.
- Have an operating computer simulation system that can be used for "what if" studies of potential performance improvements.
- Continue to pursue possible beneficial collaborations both in the US as well as internationally.
- Try to secure at least one significant collaboration partner.
- Work diligently to get the word out about our developments to attract potential users.
- Be on the constant lookout for additional funding opportunities to continue our solar engine work.

Contact us

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