

MORE ON NEW APPLICATIONS AND GAS TURBINES

Over the last two decades, specific government-industrial programs have increased the performance of gas turbines. Programs such as the Department of Defence's IHPTET program have been critical in both advancing technology and maintaining the United States industrial competitiveness in this field. Much of this improvement has come from improvements in the understanding of the basic fluid mechanics involved in these devices, materials, or manufacturing processes. These improvements were the results of detailed research using specialized facilities. However, most work did not focus on operability of gas turbines, and has focused on producing conditions that replicate the average operational condition of gas turbines. There is considerable evidence that dramatic improvement in overall system performance for a wide range of applications, involving gas turbines, can be achieved by focusing on the natural variation that occurs in the operating conditions of these gas turbine systems. Innovations in instrumentation, data analysis techniques, and fundamental understanding of the flow physics, allows a wide range of problems to be addressed and commercialized through new common facilities, which deal specifically with gas turbine operations. Some opportunities are further advanced in commercialization than others, but they all share a common thread of dealing with the overall system in which the gas turbines operate

One of the key technologies already demonstrated is the fuel energy system in a heavy truck fleet in 2008. This system, which operates on improving the combustion process by decreasing the droplet size in the fuel air mixture in a diesel engine by passing the mixture through a magnetic field, resulted in a 25-35% reduction in fuel usage from the same vehicle without the treatment.

While this is impressive in its own right, there are more benefits to replacing the diesel engine and transmission of a typical truck with a higher performance gas turbine operating with a coupled electrical generator, essentially turning trucks into electrical vehicles with their own electricity sources. The same technology used to improve the diesel operation can be used with gas turbines. However there is an added source of energy in gas turbines, which comes from controlling the variation in pressure waves that occur in the engines. This could lead to another 20-30% improvement over the currently proven diesel improvements

However, the same improvements possible in a gas turbine/electrical generator to power a truck are also possible with stationary power plants. The ultimate goal of boosting overall system performance of smaller 1 MW range distributed power systems also is completely viable. Finally the same performance gains are also possible in flight vehicles as well, either with or without electrical generators.

What is needed is a new generation of research and commercialization facilities, which are designed to examine the overall operation of the system, with both the gas turbines and the electrical drive motors connected. What is different from past rigs is that these rigs must be designed to operate at a range of operating temperatures and or operating loads under changing conditions.



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Problems that have been most readily seen on flight test engines for planes but are not seen in ground operations are due to energy shifts in the air moving through the engine that change as a function of speed and inlet temperature. These can be controlled, which will reduce stall margins, and which will directly improve efficiency, but can also be harnessed to recover more of the energy in the working fluid. The magnetic system used to improve combustion in the diesels, is another example of this same phenomenon. For turbines coupled to electric generators, the source of instability comes from dynamically varying the loads, which is similar to changing the inlet temperature on a flight engine.

These same rigs can be used for commercial demonstration of distributed power systems, and can be coupled with research facilities that specialize in diesel engines. However, these same rigs can also be used for a wide range of other related research interests including bio fuel/synthetic fuel testing and operability of engines, in areas with a high concentration of volcanic ash in the air.

This brief highlights many commercial opportunities that exist to dramatically reduce fuel consumption and emissions from using this type of technology. While the applications differ, they are all connected through the improved combustion process, and through improved control of the working fluid. In addition to improving fuel consumption efficiency, investment into the pertinent research facilities, will help create a wide range of jobs throughout the industry and will help the United States maintain its competitive stance in the many industries and particularly those related to gas turbines.