

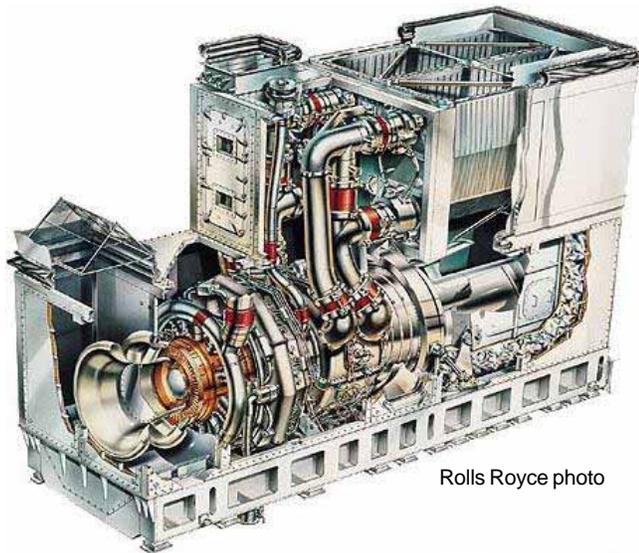
Turbo Expo Shows Off Latest In Gas Turbines

By Ben Wiens

Birmingham, England was the site of Turbo Expo '96, an annual conference and exposition for the exchange of gas turbine science and technology. It is put on by ASME, the 125,000 member engineering organization.

Patented by John Barber in 1791, the gas turbine development and evolution has been slow and tedious. Centuries of research have paid off though, and now large gas turbines are the most efficient heat engine available.

At this year's conference it was apparent that gas turbine powerplants burning natural gas for generating electricity have increased dramatically in popularity, mainly because of concerns with nuclear power, and pollution problems with coal fired steam powerplants. Presently the combined-gas-steam turbine cycle is the favorite of electric utilities. Siemens' latest engine, available next year, is the most efficient at 57.9%. Most major manufacturers are seriously working on engines running at up to 1500°C. Radical air or steam cooling, along with extensive use of ceramic engine coatings (an all-ceramic engine does not appear to be imminent), will produce efficiencies of 60% or more.



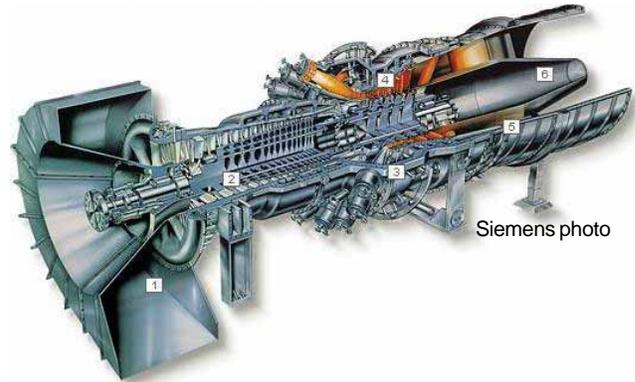
Rolls Royce photo

Intercooled, recuperated WR-21 engine from Rolls Royce is an efficient, compact package

Rolls Royce engineers discussed the company's new WR-21, a 33,000 hp intercooled, heat exchanged gas turbine under development primarily for naval propulsion. Today simple cycle gas turbines are commonly used in many fast passenger as well as fighting ships, but these suffer in efficiency at the lower power levels used much of the time. Intercooling and heat exchange has been known to increase the part load efficiency, but no production naval ship uses it. The efficiency of the WR-21 has turned out to be excellent—46% at 60% power—largely thanks to it being based on the RB211 high temperature and efficient aeroderivative engine. The heat exchanger is a very compact plate and fin design. This type of heat exchanger has been looked down on in the past decades as being prone to cracking and being very unreliable. Allied Signal, who supply the heat exchanger, say their design has a lifetime of over 100,000 hr.

This engine is also intended for use as a cogeneration powerplant. Though I believe a higher efficiency would have been possible had the size constraints in the naval design not been so tight, an electrical efficiency of 40 to 46% is considerable higher than the 36% of the simple

cycle and only slightly less than the 48% of the combined-cycle in this size class. It does not require hours to warm up as the combined-cycle does and will likely be cheaper, smaller, and inherently simpler. When the power demand varies, its average efficiency may be higher than the combined-cycle. There is considerable waste heat left in the exhaust, but if more is required the recuperator and intercooler can be bypassed.



Siemens photo

Siemens V64.3A gas turbine can produce 254 MW and is 57.9% efficient in combined cycle form. It is also available at 103 MW, 54.8% efficiency. The engine has a large hollow single shaft which forms the cooling passageways to 3 pressure level turbine blade cooling. The outer can delivers air to the annular combustion chamber and for cooling the stators of the turbine. Single crystal turbine blades are used for high material temperatures.

Solar Turbines is also developing high efficiency recuperated gas turbines but in the smaller 5 to 15 MW range with hopes for 40+% efficiency.

Much money has been spent to date on research into very small, low pressure, heat exchanged gas turbines for both vehicles and small electrical generation. Most of this money was spent on gas turbines with rotating heat exchangers. These rotary regenerators have been difficult to perfect, and so none have made it to production. At the show, Volvo had a prototype of just such a small gas turbine for use in hybrid electric automobiles and buses, but again there was no commitment to production. Capstone Turbine Corp. plans to change this situation by introducing a small low pressure gas turbine, but using the proven plate and fin heat exchanger. The 24 kW, 72 kg, 31.5% efficient unit is ideally suited to provide the electricity and hot water needs of small industry, but use in hybrid electric vehicles is also being considered. Plans are to have first sales within 12 months. It is clear that there is renewed interest in heat exchanged gas turbines and we will likely be seeing more in the future.

Fuel cells are still in the picture for generating electrical power, especially below 1 MW. For example, a high temperature solid oxide fuel cell combined with a gas turbine, could achieve 60+% electrical efficiency.

Environmental issues were also a hot topic at the conference. Electric utilities in the U.S. and Europe often are faced with emitting less than 3 ppm NOx with new powerplants. Global standards have been tightened to around 50 ppm. Helping to meet these standards are the new dry low NOx gas turbine combustors that can achieve less than 10 ppm NOx.

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