Thermodynamic Analysis of Advanced Power Generation Plant

Electrical power generation has undergone a revolution since 1990. The gas-steam combined power plant has come of age and there is the promise of more advanced gas turbine cycles based on aero-derivative machines. During the 1990s, a suite of computer codes were developed at Cambridge to analyse advanced power cycles at a more detailed level than usual. For such calculations it is most important to handle the thermodynamics as rigorously as possible [1998, 2000].

A particularly successful investigation centered on the thermodynamics of gas turbine blade cooling, in particular the prediction of the cooling flowrates and cooling losses for future generations of engines [2002a]. This study made major progress both in establishing the origin of the cooling losses, and in providing the means of estimating their magnitude, topics still remarkably obscure despite thirty years of practical aero-engine cooling technology [2006]. The work has shown that, with improved turbine and compressor efficiency, as well as cooling technology, it may not be beneficial (in terms of improved cycle efficiency) to increase the turbine inlet temperature further, as has been the practice for the last fifty years [2002b, 2005]. This is an important practical finding and the implications are currently being assessed by industry.

Other studies have considered the possibilities of humidified gas turbine cycles with injected water or steam. These cycles (humid air turbines, fog-intercooled machines, etc) will probably be used extensively with future generations of industrial gas turbines. They include novel components such as the 'saturating column' and this has provided the basis for an interesting thermodynamic study [2003]. Papers on the relative merits of the STIG and HAT humidified cycles are currently in preparation.

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