Fabricated Turbine Rotors for Advanced Steam Turbines

OBJECTIVES

Steels for advanced steam turbines operating within super-critical steam conditions have been developed within the COST 501 collaborative programmes and are continuing to be developed within the COST 522 programme. The data generated has already been used to develop and design high temperature turbines which are now in operation or at an advanced stage of construction.

New cleaner coal power generation technologies such as air blown gasification combined cycle (ABGC), integral gasification combined cycle (IGCC) and fluidised bed combustion will be looking to utilise these new steels in steam turbines but costs will need to be reduced to improve their competitiveness. The objectives of the project are:

- to reduce the capital and through life cost of steam turbines generating in combined cycles with clean coal technologies
- to develop the materials and welding technology to provide a fabricated steam turbine rotor to operate with supercritical steam temperatures in the high temperature part and long, high strength turbine blades in the low temperature part of the rotor
- to characterise fully the microstructures and properties of such steam turbine rotors to enable the development of lifing methodologies

IP/LP turbine rotor (subcritical steam conditions)

SUMMARY

These combined cycle plants will generate in the region of 350 MW to 400 MW and will utilise steam turbines with an output in the range of 120 MW to 250 MW. The cost of the steam turbine can be reduced considerably if the number of turbine cylinders is reduced. A single cylinder reheat turbine would be adopted for smaller outputs and a two cylinder turbine with an HP turbine and a combined IP/LP turbine for the larger outputs. The requirement for a single rotor forging steel that has good creep properties at temperatures of 570°C and greater combined with high strength and toughness to carry long turbine blades at the low pressure end cannot be met by the COST steels alone.

It is therefore necessary to advance the technology for the welding of the steels developed in the European COST 501 programme to conventional low alloy steels. Using the latest quantitative models developed by the Department of Materials Science and Metallurgy at the University of Cambridge suitable weld metals will be developed and selected. At the same time the university will conduct experimental simulations of the weldment heat affected zones in a range of materials and will characterise their microstructures to determine the influence of heating and tempering cycles. This will be supported by testing their mechanical properties.

A parallel programme of welding technology development will be conducted by Siemens Power Generation Limited. The resulting welds will be tested by Bodycote Materials Testing to determine their mechanical properties, toughness, fatigue properties and creep properties to provide sufficient data to develop lifing methodologies. The testing will be supported by detailed optical and electron microscopy at Siemens Power Generation Ltd and at the University of Cambridge.

COST

The total cost of the project is £379 306 with a contribution of £175 618 from the DTI

DURATION

42 months commencing February 2000

CONTRACTOR

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In collaboration with the Department of Materials Science and Metallurgy, University of Cambridge

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