Protection of Gas Turbine Blades

A PLATINUM BARRIER LAYER FOR NICKEL ALLOYS

The nickel-base alloys developed for use as gas turbine blades have to cope with severe conditions of both stress and corrosive environment at temperatures which are continually being pressed higher and higher in the interests of thermal efficiency and specific output of the engines. Whereas increasing high-temperature strength has progressively been achieved by alloy producers over the last thirty years, it has not always been possible to combine this with adequate corrosion resistance, particularly against the combined attack of sulphur compounds and chlorides, which may arise either from the fuel or in marine environments from the ingested air. Surface coatings have therefore been developed to give added protection against corrosion, and a number of proprietary processes, mainly involving aluminium, silicon or chromium, are in use at the present time.

They are applied by spraying, evaporation or electrodeposition on to the prepared alloy surface and are thermally diffused to key to the basic alloy. While such coatings are effective in controlling corrosion they have a limited life, since at the operating temperature continued diffusion of the protective elements into the underlying alloy takes place; an effective diffusion barrier has therefore been sought.

Günter Lehnert and Helmut Meinhardt of Deutsche Edelstahlwerke (*D.E.W. Tech. Ber.*, 1971, **11**, (4), 236) claim that an electrolytically deposited layer of platinum less than 10 μm thick is effective; it is followed by a pack-aluminising treatment during which the aluminium and platinum interdiffuse. The details of the process are not given, but the properties of the coating when applied to the alloy ATS 290–G are outlined, particularly in comparison with those of a conventional aluminide coating. Oxidation tests in burnt natural gas at 1100°C showed that the duplex coating had a life (measured by the extent of the plateau in the weight change curve) exceeding four times that of the simple coating, and metallographic examination showed that the corrosion proceeded uniformly, whereas deep penetrating attack took place with the simple coating. Cyclic corrosion tests in burnt kerosene with additions of sulphur and sodium chloride and a peak temperature of 1120°C showed an improvement of 230 per cent for the duplex coating.

It is also claimed that by virtue of the high throwing-power of the platinum electrolyte used an effective coating can be applied on the inside of cooling passages in air-cooled blades, even when these involve 10 mm deep holes only 0.4 mm in diameter. A 15 μm coating of LDC–2, involving only 2 to 3 μm thickness of platinum is claimed to give a better performance than a 60 μm coating of the simple aluminide type. An LDC–2 coating degraded by interdiffusion with the base metal can be removed and renewed.

The new coating shows promise of providing a clear advance on the current protective coatings, although it must be noted that all the tests described relate to its application to ATS 290–G, an alloy containing only 12 per cent chromium. Considerable improvement in the inherent corrosion resistance of nickel-base superalloys has been obtained in recent years by increase of the chromium content from the more normal figure of about 20 per cent to 25 per cent or more, without loss of high-temperature creep resistance, and it is perhaps uncertain whether any protective coating will then be necessary. It is nevertheless helpful to engine builders to know that alternative solutions to their problems are available.

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