REPAIRING SEVERELY CORRODED W251B11 GAS TURBINE STAGE ONE BLADES FOR WESTMONT POWER (BANGLADESH) in 2006

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SUMMARY

This article briefly describes the processes of repairing severely corroded stage one blades of W251B11 gas turbine, including advanced brazing repair and applying a DVC thermal barrier coating.

KEYWORDS

Gas turbine, superalloy, hot-section components, turbine blades, brazing, repair, thermal barrier coating.

Gas turbine hot-section components are made of superalloy using precision casting technology. These components have extremely complex surface profiles and internal structure and therefore are very difficult to manufacture. As a result gas turbine hot-section components are very expensive; their accumulated prices over a period of the total life of a turbine accounted for up to 2/3-3/4 of the total price of a gas turbine.

When hot-section components are installed in an operating gas turbine, they experience high thermo-mechanical stresses. Under these conditions, hot-section components develop cracks, deformation, corrosion, oxidation and other damage over a certain period of time, thus require expertise and technologies in high temperature materials to carry out welding, brazing, reshaping, heat treatment, re-coating and other repair processes. These processes help restore material properties of hot-section components and extend component life.

TCI Gas Turbine Technologies Shanghai Ltd. (TCI) is a solely owned US company. It is one of the very few specialized companies in Asia that offer full scope of hot-section repair services to owners and users of industrial gas turbines. Located in Shanghai, TCI specializes in most advanced repair technologies such as advanced brazing repair, low-heat TIG welding repair, applying various high temperature coatings including most advanced Directionally Vertically Cracked (DVC) Thermal Barrier Coating for gas turbine blades and vanes, combustion hardware, as well as for compressor blades up to F and G Classes. At the same time, TCI provides a wealth of technical advices and services related to gas turbine overhaul and hot-section component life estimation, and acts as a platform to gather a group of the world's best after-market service providers to provide integrated services to gas turbine power plants. As an example of TCI provided advanced repair technologies, this article briefly describes the repair and recoating of a set of stage one blades of Westinghouse (Siemens) gas turbine model W251B11 for Westmont Power Plant in Bangladesh.

1 INCOMING INSPECTION AND DAMAGE ANALYSIS

A total of 51 blades of stage one of a W251B11 gas turbine arrived in TCI's Shanghai facility in mid-September, 2006. TCI found severe hot corrosion damages on the tip of every blade. Additionally, there were dozens of cracks on each side of the platform edge of every blade. The photos shown in Figure 1 are the typical damages on these blades. According to the operation history provided by Westmont Power Plant, these parts were installed in the turbine burning heavy oil for a quite while, and then the fuel was switched to natural gas without a thorough cleaning of the blades, and that caused residue corrosive vanadium, sulfur compounds and other harmful substances corrode blades at a higher firing temperature when burning natural gas.

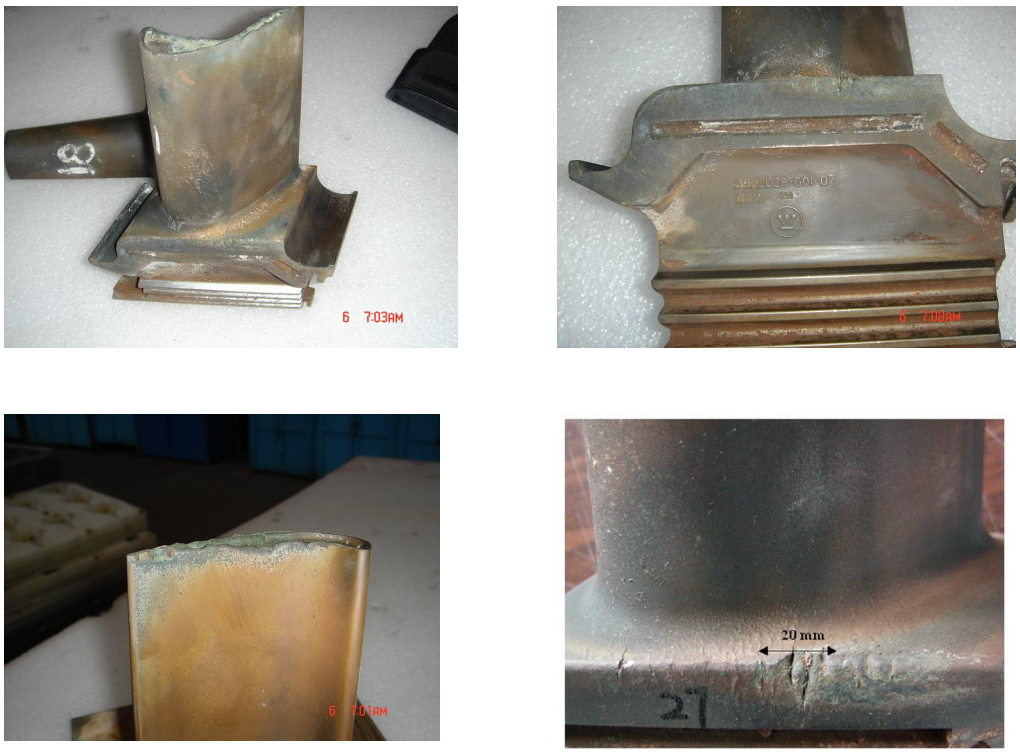


Fig 1. Photos of Damaged W251B11 Stage One Blades after incoming inspection

2 ADVANCED BRAZING REPAIR OF TURBINE BLADES

In order to determine the reparability of these blades, TCI researched design data and reviewed the OEM specifications to find that these blades are repairable, provided various advance technologies and techniques are applied, including the latest advanced brazing repair technology. Although these complex repair techniques need longer turnaround time than conventional repair procedures, in order to deliver timely, TCI arranged tightly fit

production schedule with continuous repair operations on these blades to complete the project in three months.

The advanced brazing repaired parts must meet the design requirements of the rotating blades, especially the high temperature mechanical properties. If the blade base metal materials after brazing repair did not closely match in original composition or microstructure, the repaired blades could fail in operation, resulting in disastrous consequences. Figure 2 shows Bangladesh Westmont Power Plant's W251B11 row one blades after TCI repaired them using the advanced brazing technology.

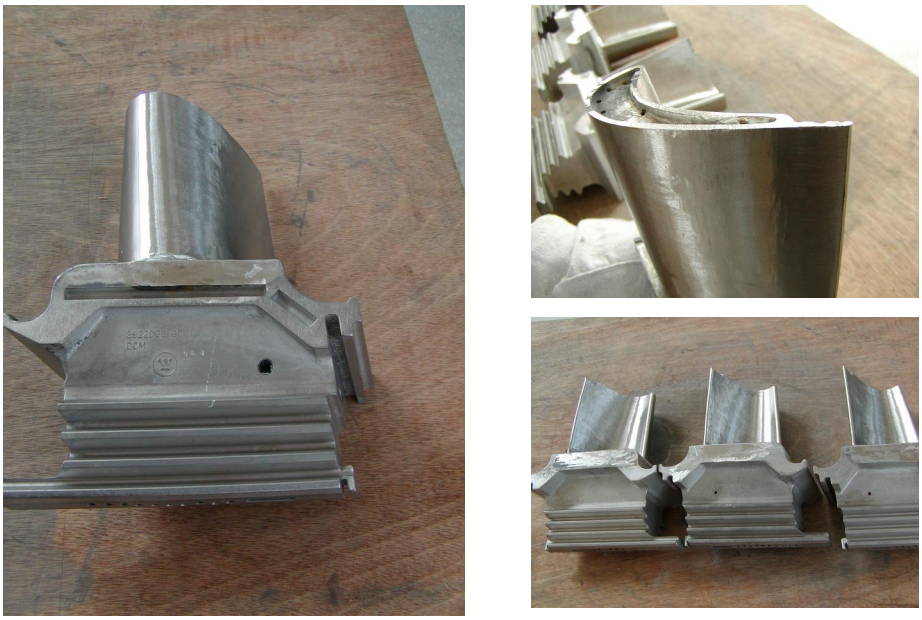


Fig 2, Photos of the W251B11 Stage One Blades After Advanced Brazing Repair

3 APPLICATION OF DVC THERMAL BARRIER COATINGS

Gas turbine hot-section components are often covered with various high temperature coatings. These coatings effectively protect superalloy components from corrosion and oxidation, of which, thermal barrier coating can reduce the operating temperature of superalloy components, thus extend the life of hot-section components.

After repairing corrosion damages and cracks, in order to achieve its original design life of these blades, TCI applied DVC Thermal Barrier Coating (TBC) on the airfoil of these blades. DVC TBC is more capable of resisting thermal shock as compared to the conventional TBC. Applying a layer of TBC could reduce 50-80ºC operating temperature of the blades, thus increase 10,000-20,000 hours of blade life. In fact, in 2009 when Westmont Power Plant had a major overhaul after 24,000 operation hours, they found these TCI repaired blades were

completely intact without any damages. Figure 3 shows these W251B11 stage one blades after TCI applying DVC TBC.

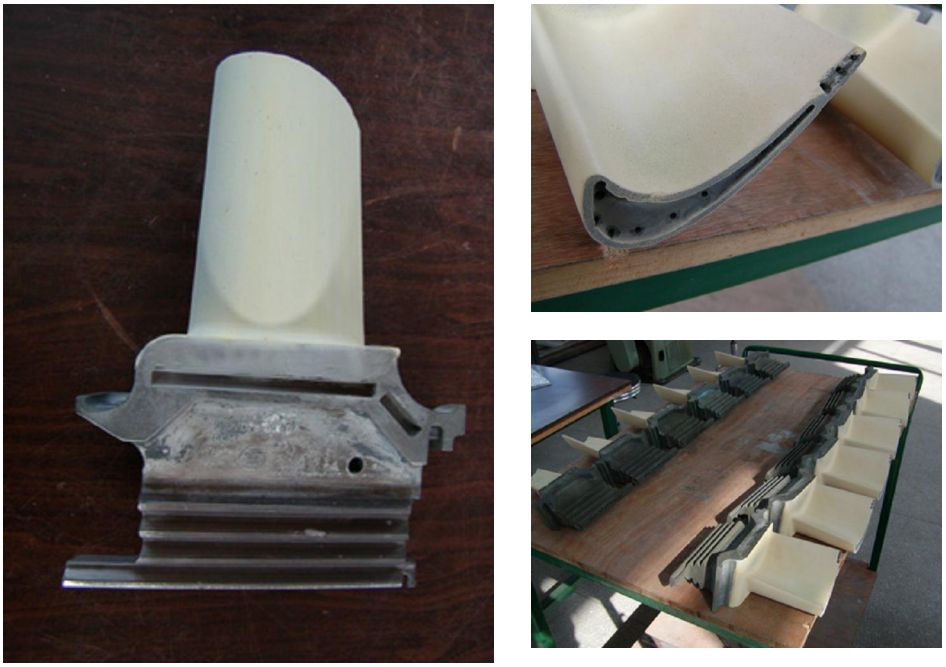


Fig 3, Photos of the W251B11 Stage One Blades After DVC Thermal Barrier Coating Application

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AUTHOR INTRODUCTION

Dr. Maggie Zheng founded TCI Gas Turbine Technologies (Shanghai) in 2004. She obtained M.S. and Ph.D. in Materials Science from University of Wisconsin-Madison, USA. Dr. Zheng was Senior Engineer at GE Power Systems, Schenectady, NY, where she successfully developed several new processes applied on hot-section components of various GE's advanced industrial gas turbines; she is the inventor of three GE patents and author of several GE specifications. Dr. Zheng also worked several years for United Technologies Research Center and Chromalloy, where her responsibilities included developing processes, qualifying and repairing hot-section components for Westinghouse (Siemens), ABB (Alstom), Mitsubishi, and Pratt & Whitney gas turbines. From1999 to 2004, Dr. Zheng managed and completed several projects for US Department of Defense and Department of Energy.