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PREVENTIVE AND IMPROVEMENT METHODS TO REDUCE EROSIVE WEAR BY STELLITE COVER PLATE FOR LOW PRESSURE STEAM TURBINE BLADE

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Abstract: During running of power station steam turbines, blades are damaged by droplet impact erosion. In break down time replacement of the damaged blades of steam turbines is a time taken and costlier process. By using stellite plate the life span of the blade is expanded. In order to obtain a high efficiency of a steam turbine plant. The blades must be manufactured more carefully than a steam turbine. The general factors considered for the manufacturing of blade are blade profiling, aerofoil shape, size, material, and coating. It is explained that a decrease of the relative internal efficiency of a steam turbine by 1% decreases the plant efficiency by 1%. In this connection an attempt is made to prevent the erosive wear which decreases substantially the mechanical strength of moving blades and the stage efficiency of steam turbine low pressure blade. The leading edges at the backs of moving blades can be erosion-protected by stellite cover plates soldered by silver solder. Hence the results obtained by using the stellite cover plates for moving blade to decreases the fatigue failure and increases the durability.

Keywords: Steam turbine, High pressure blade, Erosive Wear, Preventive, Improvement

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INTRODUCTION

The moving blades of the last stages of condensing turbines are the turbine elements that are most likely to suffer from impingement wear. In turbine parts where the steam flow of a high wetness fraction has a high velocity, in particular, in high-pressure cylinders of wet-steam turbines of power stations, slit erosion of turbine casings, yokes, diaphragms, fittings and other elements can also take place [1-4]. Erosive wear of moving blades by water droplets impinging against the leading edges of the blades manifests itself list as rough spots, after which recesses, craters, and pits form on the surface and the shape of the blade profile is distorted.

Steam turbine moving blades are designed according to the type of the turbine stage in which they will be arranged. In this respect, turbine stages may be classified as impulse and reaction type and stages with short blades and those with long ones [5-7]. The blades employed here are milled integral with belt which forms the inner end wall of nozzle passages. Blades can be milled or made from shaped rolled strip and are welded to sheet-steel bands. The blade thus formed is welded by thick welds to the body and rim of a diaphragm [8-12]. The diaphragm has a horizontal joint and for that reason the number of nozzle blades in them is always even.

In this work, an effort is made to minimize the fatigue failure for blade can be erosion-protected by stellite cover plates soldered by silver solder. The blades design, as per the inlet and outlet velocity triangle, In addition to this to improve the turbine blade efficiency. In view of the above an attempt in made to explain in details about the improvement of turbine blades materials, coating materials and results obtain of different researchers in their experimental investigations.

II. DEVELOPMENT OF EROSIVE WEAR

The below Table.1 shows three periods are usually distinguished in the development of erosive wear of turbine blades as show in the Fig.1 are:

Table No.1 Fatigue Failures in Periods

Periods	Periodical Results
I	Incubative period during which fatigue failures are accumulated in the surface layer of material (the formation and growth of fatigue cracks).
II	The period of severe erosion.
II	The period of a slower rate of erosion.

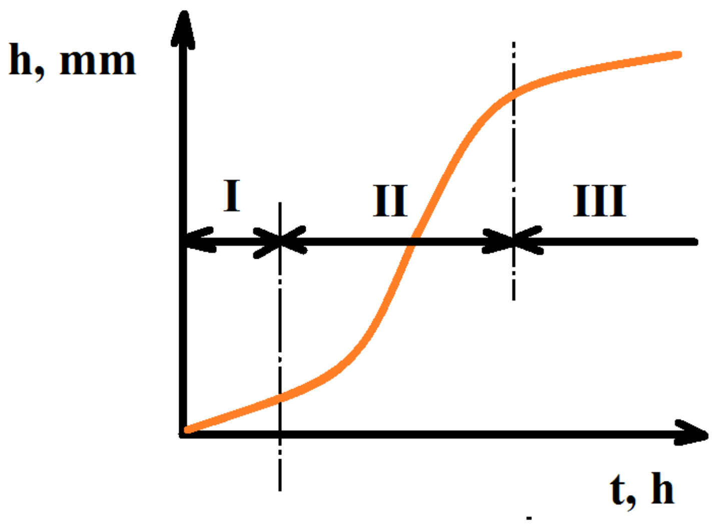

Fig.1 Average depth of erosive wear depending on operating time of blades

The impingement pressure of water droplets may attain 310MPa at the velocity of 300 m/s. This relative velocity of droplets is achieved at circumferential blade velocities slightly above u = 300 m/s. Apart from mechanical stresses, other factors, such as metal corrosion, cavitations, etc. can also influence the process of erosion. The length of these periods depends on the wetness fraction of steam, moisture dispersity, and speed of impingement on blade surfaces. The slower rate of erosion in period III can be explained by the damping effect of moisture accumulated in cavities on the surface. The distribution of moisture in the steam flow in last stages of turbines is substantially non-uniform radially. The highest concentration of moisture is observed at the periphery, so that the tip portions of moving blades, at roughly one-third of their height, are primarily subject to erosive wear.

III. PREVENTIVE METHODS

The following measures are in use to prevent or decrease erosive wear of moving blades:

• Application of erosion-resistant materials, strengthening of blade surface, and use of protective coatings. The leading edges at the backs of moving blades can be erosion-protected by stellite cover plates soldered by silver solder as show in the Fig.3

- The wetness fraction of steam at the turbine exhaust is decreased by increasing the temperature of main stream at the inlet, by steam reheating, by using external steam-water separators in combination with steam reheaters.

- Various moisture-separating devices are employed in the steam path of turbines (inter passage separators, moisture collecting devices at the periphery of turbine stages, steam-separating stages).

- Axial clearances between the nozzle and moving blades are increased which favours disintegration of water droplets and decreases the difference in the velocities of moisture droplets and steam (these clearances may be as wide as 100-300 mm).

- Rejection of banding wires, which promote moisture concentration.

- Provision of longitudinal grooves in the inlet portion of blade backs at their tips; moisture accumulates in the grooves and damps impacts of droplets besides, the grooves enhance moisture separation by the blades.

In steam turbines of thermal power stations operating on steam, cobalt base alloys are in applicable for reasons of durability & safety. The edges of blades of these turbines are surface hardened or hard faced by arc deposition.

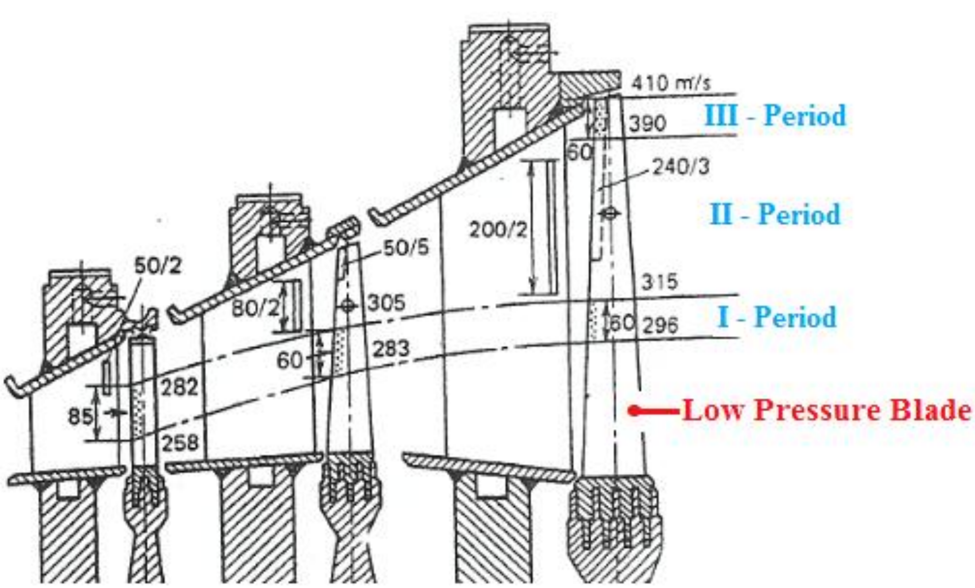

Fig. 2 The steam path of steam turbine with slits in the exit portions of nozzle blades (figures indicate the size of slits, mm, and circumferential velocity of blades, m/s).

As a result of lengthy operation, complete destruction of the top portion of moving blades is possible. Erosive wear decreases substantially the mechanical strength of moving blades and the stage efficiency. The mechanism of erosive wear of moving blades is mainly associated with fatigue failure of the blade material under the action of high mechanical stresses which appear on impingement of water droplets onto the surface of blades.

Stellite plate material is a cobalt-base alloy of great hardness and high wear resistance. Stellite cover plates consist of a number of sections along the blade height in order to minimize shear stresses in the soldered seam between the plates and blade on thermal expansion.

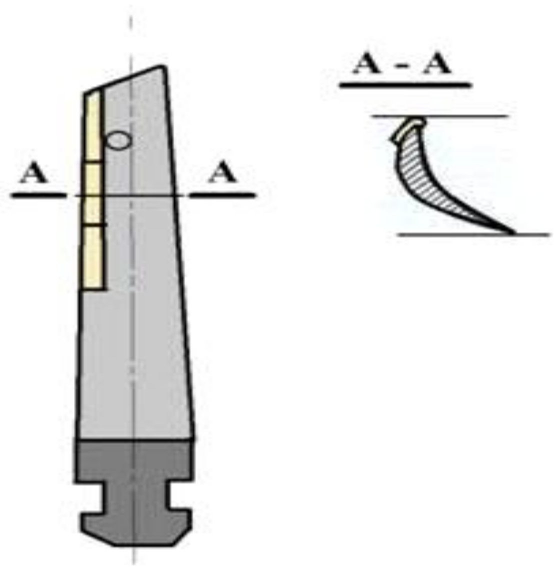

Fig.3 Moving blade with stellite cover plate

IV. CONCLUSIONS

This article is related to research and development of a new technology of protective and strengthening treatment of steam turbine blades, allowing for increasing their erosion resistance. One of the basic ways of protection of the blades by of stellite plates. The use of stellite plates for blades and leads to decrease of their fatigue resistance. The specific feature of these stellite developed technology is decrease of their fatigue resistance and erosion resistant layer on airfoil edge. These measures aimed at preventing erosive wear of turbine blades make it possible to avoid dangerous erosion damage to blades at circumferential velocities for 560-580 m/s and wetness fraction of exhaust steam around 8% or with lower circumferential velocities, around 12-14%.

REFERENCES

1. M. Sampath Kumar, K. Sai Prashanth, C.L.S. Subrahmanyam, M. Naveen, "Determining hysteresis damping in a steam Turbine blade using lazan's law", International Journal of Advanced Engineering Technology, E-ISSN 0976-3945, IJAET/Vol. IV/ Issue II/April-June, 2013, pp:14-16.

2. Kleppe, Robert, "Aircraft Applications for the Controlled Shot Peening Process", SAE Technical Paper Series No. 972625 presented to the SAE International, Airframe/Engine Maintenance and Repair Conference, Vancouver, B.C., Canada, August 5-7, 1997.

3. Ortolano, Ralph J., "An Approach to Improved Steam Turbine Availability Related to Blading Design and Repairs", Presented to The Vibration Institute, Machinery Vibrations Seminar, Cherry Hill, NJ, September 20-22, 1978, and to the ASME, SCAC, Power Division Meeting, Rosemead, CA, November 14, 1978, page 8.

4. Ortolano, Ralph J., "An Approach to Improved Steam Turbine Availability Related to Blading Design and Repairs", Presented to The Vibration Institute, Machinery Vibrations Seminar, Cherry Hill, National Journal, September 20-22, 1978, and to the ASME, SCAC, Power Division Meeting, Rosemead, CA, November 14, 1978, page 8.

5. Ortolano, Ralph J., and Franz, Hilmar L., "A Power Company's Approach to Improved Steam Turbine Availability", Presented to the ASME, Winter Annual Meeting, 78-WA/Pwr-1, San Francisco, CA, December 10-15, 1978, and to The American Power Conference, Chicago, IL, April 24, 1979, page 9.

6. Chetwynd, Russell J., Qashu, Riyad, El Akily, Nabil, and Ortolano, Ralph J., "Arresting Stress Corrosion Cracks in Steam Turbine Rotors", Presented to the EPRI – Steam Turbine Stress Corrosion Workshop, Baltimore, MD, March 19-20, 1997.

7. Ortolano, Ralph J., "Utility Solutions for the Problems of Corrosion, Particle Impact and Vibration in Steam Turbine Blading", Presented to the Electric Power Research Institute, Steam Turbine Blade Reliability Workshop/Seminar, Boston, MA, July 9, 1982, page 15.

8. Ortolano, Ralph J., "Current Industry Blade Modification and Repair Techniques", Presented to the Management Seminar "Managing Turbine Blade Life Extension Problem at Stress Technology, Inc., Rochester, NY, October 12, 1988, page 4.

9. Ortolano, Ralph J., "Repairing Components of Steam Turbines", presented to the Sixth Latin American Turbo machinery Congress, Mexico City, MEXICO, February 18-21, 1997, pp. 2-4.

10. Shot Peening Applications, Eighth Edition, an 84 page handbook by Metal Improvement Company, Inc., a Subsidiary of Curtiss Wright Corporation.

11. Robert A. Miller, Lewis Research Center, Cleveland, Ohio, "Ceramic Thermal Barrier Coatings for Electric Utility Gas Turbine Engines" 3rd Berkeley Conference on Corrosion, Erosion, and Wear of Materials sponsored by the National Association of Corrosion Engineers Berkeley, California.

12. Chenchu Deepa, B. Jayachandraiah, "CFD Analysis for Estimation of Efficiency of Low Pressure Steam Turbine", International Journal of Recent Technology and Engineering (IJRTE), ISSN: 2277-3878, Volume-1, Issue-3, August 2012.

13. Venkata Siva Prasad Chaluvadi, "Blade - Vortex Interactions in High Pressure Steam Turbines", Degree of Doctor of Philosophy, November 2000.

14. Eiichiro Watanabe Yoshinori Tanaka, Takashi Nakano Hiroharu Ohyama, Keizo Tanaka Toshihiro Miyawaki, Masanori Tsutsumi Tanehiro Shinohara, "Improved Technologies of Steam Turbine for Long Term Continuous Operation".

15. Sumio Noda, Satoru Zenitani, Yoshikazu Yamada, Tomoyoshi Sasaki, Mitsubishi Heavy Industries, Ltd., Technical Review, Jun. 2004, Vol. 41 No.3.