Optical Blade-Tip Clearance Sensor for Non-Metal Gas Turbine Blade

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1. Introduction

Because of its measurement principle, the conventional blade tip clearance sensor cannot be applied for non-metallic rotor blade (ex. Ceramics). We produced an optical blade tip clearance sensor that does not require any special devices or experimental process, only using the reflection of the light. This paper describes the details of the optical tip clearance sensor and the results of its performance proof experiments.

2. Schematic of Blade Tip Clearance Sensor

The tip clearance measurement system is composed of sensor head, CCD, signal processor, and PC. The cross section of the sensor head is shown in Fig. 1.

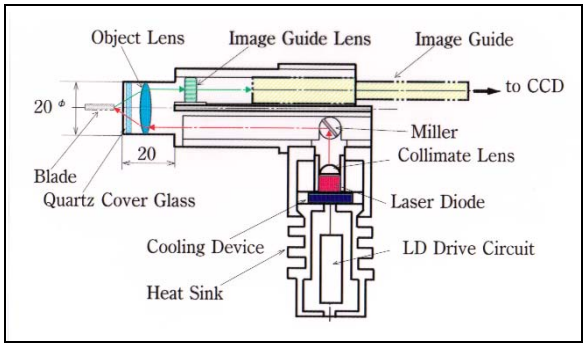

Fig.1 Cross section of sensor head

First, light from laser diode (LD) is squarely bent by the miller, then is projected to the blade tip through object lens, and finally the reflected light makes a spot on an optical incidence side of the image guide through the same object lens and a image guide lens. This spot position is detected by CCD electrically.

The resolution of this tip clearance sensor is determined by characteristic of the CCD, which becomes approximately 6.5μm, and the measurable distance is 1.664mm. The output of LD is 10.0mW, and is attenuated to 4.0mW by the converging lens, object lens, and the heatproof protection glass.

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3. Tip Clearance Measurement Examination

As a result of static characteristic examination, accuracy became ±20μm, with 1.4mm for measurement range. The tip clearance measurement experiment was done with the high-speed rotational disk, which could rotate up to 24,000rpm at maximum (350m/s at its surrounding). The disk has imitational blades, which are 3mm in height, 2.44mm in length and 5mm in width. The test results are shown in Fig.2. According to the figure, the tip clearance is constants until 15,000 rpm, and gradually decreases as revolution increases. The maximum clearance change is approximately 90μm.

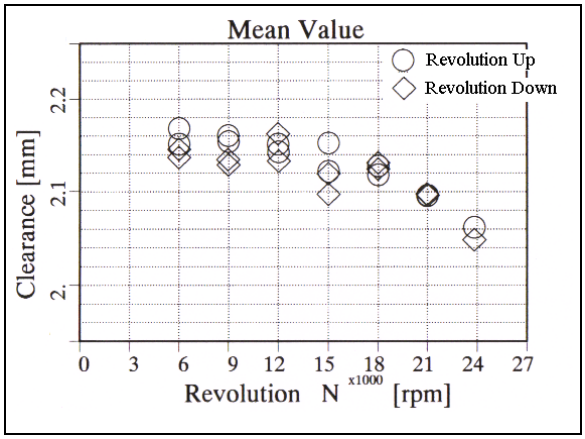

Fig.2 Tip clearance measuring test results

4. Conclusion

It was confirmed that applying optically light reflected method to tip clearance sensor was successfully. The sensor is proved to have enough accuracy for the measurement tip clearance.

Reference

(1) Matsuda Y. and Tagashira T., GTSJ Vol.29, No.6, 2001.11, in Japanese