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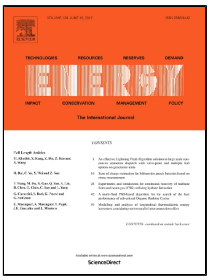

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Experimental Investigation on Overall Performance of a Millimeter-Scale Radial Turbine for Micro Gas Turbine

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Abstract: As a major component and work unit of micro gas turbine, the performance of micro turbine directly determines the realizability of micro gas turbine. In order to explore the feasibility, to obtain the performance, and to verify the design results of a micro radial turbine, this paper mainly presents the investigation on overall performance of a micro radial turbine with 10 mm diameter for 50W-class micro gas turbine by the cold model test. Firstly, the aerodynamic performance test platform for high speed micro radial turbine was exhibited. Then, the feasibility and overall performance test of micro radial turbine was carried out. At present, the rotational speed of micro radial turbine has achieved at 359,900 rpm by using hydrostatic gas bearing, which is approximately 80% rotational speed of the design point in cold model test. Thirdly, based on the experimental data and numerical simulation, the operating performance and overall performance of the micro gas turbine were analyzed and discussed in details. The final results indicate that the feasibility of the millimeter-scale micro radial turbine with 10mm diameter has partly been proven at present level and the micro radial turbine system need to be further improved. These works not only obtain the some valuable experimental data, but also accumulate experience of micro radial turbine design. And this paper not only exhibits the test and design results as engineering reference, but also presents the operation problems and its potential solutions of ultra-high rotational speed experiment and performance test of a micro radial turbine.

Key words: micro radial turbine; cold model test; experimental verification; overall performance

1. Introdutuion

Since the high energy density portable power devices and micro compact power sources have become a concept, the millimeter-scale turbomachinery and miniaturization of gas turbines have been selected as an excellent candidate for the power source of mobile machines and portable electronics [1-3], and micro gas turbines have the higher power density and energy density which cannot be delivered by batteries. Because the increasing need of energy supplies for portable machines such as computers, tablet computer, digital assistants, cell phones, unmanned aerial vehicles, and micro robots etc., it has led to intense research and development efforts on millimeter-scale gas turbines with power outputs up to hundreds watts [1].

The micro gas turbine is an effective device of converting the fuel energy into electrical energy. Accordingly, many international research groups in universities and research organizations had downscaling traditional gas turbines and designing the original micro gas turbines. The overview of basic parameters of some micro turbines is shown in Table 1.

Table 1 The overview of some micro turbines[4, 5, 7, 8, 10, 14-16, 18-21, 25]

Region	Organization	Type	Diameter /mm	Rotational speed /rpm	Output /W
US	MIT	radial	4	2,400,000	60
	MIT	radial	6	1,200,000	52
	Stanford	axial-radial	12	800,000	-
Asia	UTokyo	axial-radial	8	1,170,000	300
	Tohoku Univ.	axial-radial	10	870,000	475
	XJTU	radial	10	930,000	485
	SIMTech	radial	8.4	-	-
	KIMM	radial	-	400,000	500
Europe	KUL	axial	10	250,000	44
	AIT	radial	10	35,000	10
	ICL	axial	12	140,000	10
	ETH Zurich	radial	16	500,000	100
	WUT	disk	30	176,500	800