

## **Research of Turbine Flowmeter Performance under the condition of Low Temperature**

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**Abstract:** This paper mainly studied the impeller affecting the performance of turbine flowmeter measurement under the condition of low temperature -25°C, through the test method, analyzing the impeller affecting the performance of turbine flowmeter measurement under the conditions of different temperature.

**Keyword:** impeller, low temperature, turbine flowmeter, experiment

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### **I. INTRODUCTION**

Turbine flowmeter is a kind of speed impeller flow measuring instrument, it uses the proportion relationship of the impeller rotating angular velocity and the fluid velocity, the flow rate of the fluid is obtained by measuring impeller speed, in order to obtain the pipe flow<sup>[1]</sup>. Turbine Flowmeter with its simple structure, small pressure loss, high accuracy and wide flow range, good anti-vibration and anti-pulsating flow performance has been a large number of applications in the field of energy and industrial power and gas metering, etc<sup>[2]</sup>.

At present, at home and abroad, the turbine flowmeter was studied with the method of computer simulation, in improving the performance of turbine flowmeter has made significant progress[3]. But, comparing domestic and international standards can be found. There is a big gap between domestic and foreign for the performance of turbine flowmeter especially in terms of accuracy. At present, the study of the turbine flowmeter performance under high pressure, low temperature and other conditions, however, at low temperature, the relevant literature is seldom.

This paper mainly studied the impeller affecting the performance of turbine flowmeter measurement under the condition of low temperature.

### **II. The theoretical model and structure of turbine**

#### **2.1 Theoretical model**

Turbine flowmeter is a kind of flow measurement device, the flow of fluid power drives the impeller rotation, its rotational speed is approximately proportional to the volume flow rate. By fluid volume flow meter is based on the number of revolutions of the impeller. Within a flow range and a certain viscosity range, turbine flowmeter output signal pulse frequency  $f$  is proportional to the volume  $q$  flow through the meter, for example:

$$q = \frac{f}{K} \tag{2-1}$$

In the formula:  $f$ —signal pulse frequency;  $q$ —volume flow;  $K$ —meter factor.

## 2.2 Basic structure

The structure diagram of turbine flowmeter as shown in Fig.1, main components including rectifier, impeller, magnetic coupling, mechanical counter, gear transmission, etc.

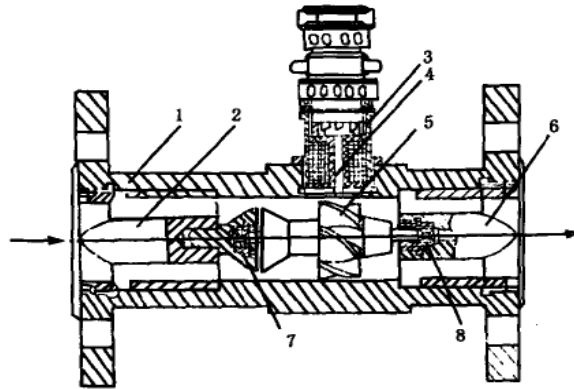


Fig.1 The structure diagram of turbine flowmeter

1-shell; 2-guidedvane; 3-pre-amplifier; 4-magnetolectric transducer;  
5-impeller; 6-guidedvane; 7-bearing; 8-bearing

## III. The introduction of the impeller

Turbine impeller also called impeller, testing gas general uses engineering plastic, steel or aluminum alloy material, its role is to convert the kinetic energy of a fluid into mechanical energy. In accordance with the design requirement of the impeller blade number  $Z=12\sim 20$ , tilt angle of the blade  $\theta=30^\circ\sim 45^\circ$ , overlapping degree for  $1\sim 1.2$ , blade and casing clearance for  $0.5\text{mm}\sim 1\text{mm}$ . In order to improve the measurement performance of turbine flowmeter can make use of adjusting the angle or appropriately increasing the number of the leaf. The basic structure of the impeller is shown in Fig.2.

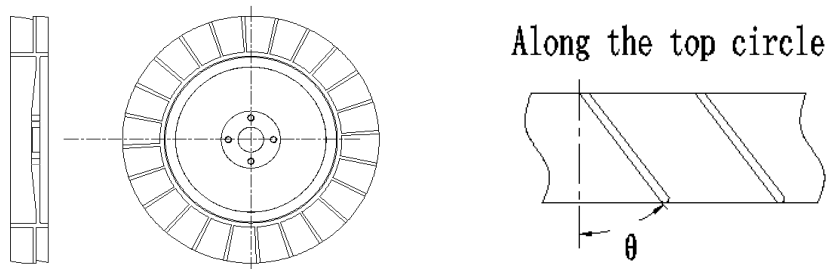


Fig.2 The structure diagram of impeller

## IV. Test data and processing

This test selects a grade 1 standard of TGM/G250/DN80/PN16 gas turbine flowmeter, in order to research performance of turbine flowmeter under different temperature conditions, as shown in Table 1.

Table 1 Temperature contrast

Impeller	Angle/ $\theta$	Blade	Temperature
A	$60^\circ$	14	$20^\circ\text{C}$

A	60°	14	-25°C
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Before the test, turbine flowmeter is respectively spin time under different temperature conditions, as shown in Table 2.

Table 2 Spin time

Impeller	Temperature	Spin time
A	20°C	2'37"
A	-25°C	1'15"

At 20°C, the turbine flowmeter test data as shown in Table 3.

Table 3 20°C Test data

Flow point	250	160	112	64	40	25	12	8
Instantaneous flow	241.5491	164.6941	117.4123	61.8788	40.2654	25.7887	12.1234	8.5989
Error coefficient	-0.7233	-0.6543	-0.3751	-1.0672	-0.9142	-0.7013	-1.6080	-3.5667

According to Table 3 draws the Fig.3.

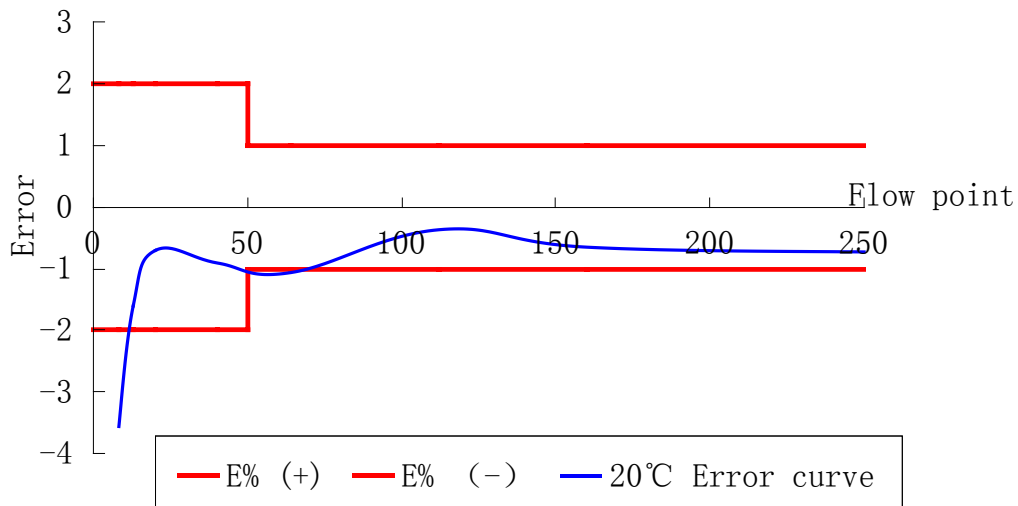


Fig.3 20°C Error curve

At -25°C, the turbine flowmeter test data as shown in Table 4.

Table 4 -25°C Test data

Flow point	250	160	112	64	40	25	12	8
Instantaneous flow	247.5491	158.4543	112.8484	64.8576	40.0554	24.9743	12.4243	8.4033

Error coefficient	-0.3021	-0.2777	-0.2370	0.0965	0.2013	0.4430	-0.8023	-3.7612
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According to Table 4 draws the Fig.4.

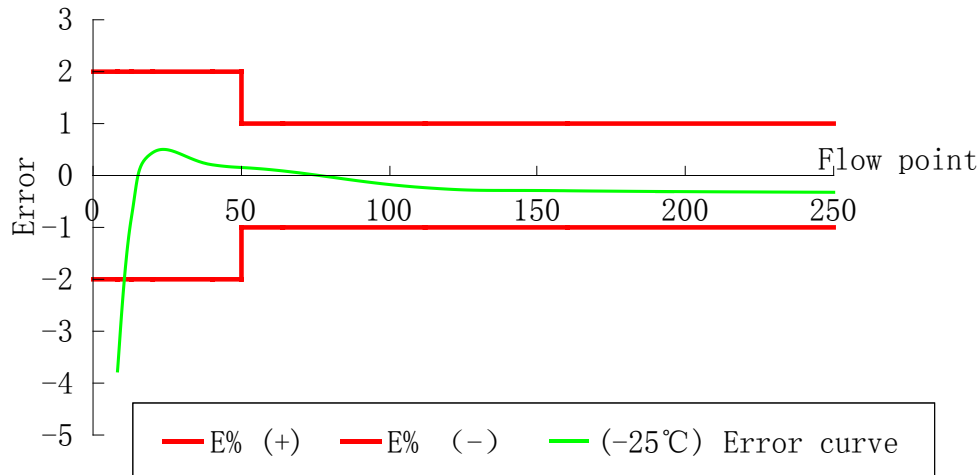


Fig.4 -25<sup>0</sup>C Error curve

According to Table 3 and Table 4 draw the Fig.5.

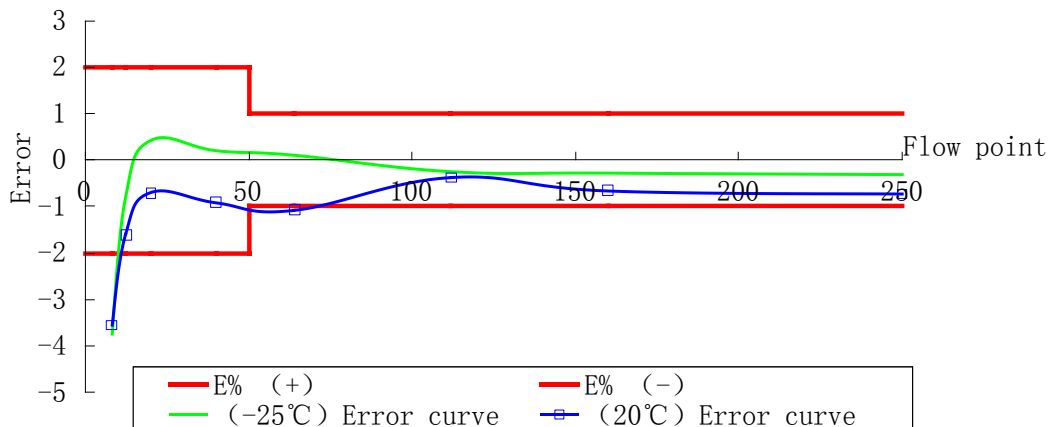


Fig.5 Error curve

### V. Conclusion

The study found that the performance of turbine flowmeter will be affected as the change of temperature, especially in traffic near 25m<sup>3</sup>/h, the error range is bigger, about 1%, so it brings the unfair trade measurement. Within the scope of other, error curve is similar. In the later research work, we will study the error in a small flow point.

### References

- [1] Liu Xinrong. Flowmeter [M]. Beijing: Water Resource and Electric Power Press, 1990,23-25.
- [2] Cai Wuchang, Ying Qijia. The flow measurement technology and instruments [M].Beijing: Chemical Industry Press,2003,67-69.
- [3] Lin Qi, Jiang Yingping, Zhang Tao, etal. The research on wide range gas turbine flowmeter [J]. Oil and Gas Transport, 2009,19(1): 39-43.

- [4] Yang Youtao, Xu Yinghua, Wang Zigang, Gas turbine meter [M].Beijing: China metrology press, 2007, 45-60.
- [5] EN 12261, Gas meters-Turbine gas meters [S]. CEN, 2002.
- [6] GB/T 21391, Gas flow rate is measured with a gas turbine flowmeter, China national standardization management committee, 2008.