Performance analysis of a venturi flowmeter

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Abstract. The mechanical properties, microstructure and chemical composition of a venturi flowmeter were investigated. The tensile tests were conducted at 23°C and 520°C with different strain rates. The fracture surface of tensile specimens was analyzed by scanning electron microscopy. Microstructure of the venturi flowmeter material was analyzed by optical microscope. The results show that the chemical constituents meet the requirements of relevant standards.

1. Introduction

Venturi flowmeter is widely used in the control and measurement of large diameter fluids in petroleum, chemical, metallurgical, power and other industries. Its unique structure design and data processing method have strict hydrodynamic basis. It has the advantages of wide measuring range and convenient installation. The performance of Venturi flowmeter affects the safety of enterprise operation. Therefore, it is necessary to analyze its performance.

In the past, the mechanical and microstructure properties of different steels were investigated by some researchers. Bouaissi et al. [1] investigated the mechanical and microstructure properties of geopolymer concrete mixed using class F fly ash, ground granulated blast-furnace slag and high-magnesium nickel slag. The results showed that mechanical properties were improved when high-magnesium nickel slag was added in F fly ash-ground granulated blast-furnace slag based geopolymer concrete cured at ambient conditions. Boufala et al. [2] studied the microstructure and mechanical properties of Charonia Lampas Lampas shell. The results showed that both elastic modulus and hardness were load-dependent in each layer in relation to their microstructure. Chong et al. [3] investigated the bi-lamellar microstructure evolution and its significant benefits on various mechanical properties Ti-6Al-4V. The results showed that the yield strength decreased monotonically with the decrease of the cooling rate. Li et al. [4] investigated the fatigue property and microstructure deformation behavior of a medium-carbon bainitic steel obtained under rolling contact condition. The results showed that the multiphase microstructure had a lower stress concentration possibility and higher percentage of high-angle boundaries. Xu et al. [5] studied the hot deformation behavior of 25Cr3Mo3NiNb steel. The results showed that the temperature slightly affected microstructure, but strain rate had strong effects. Chen et al. [6] studied the creep behaviors and characterized the microstructures and precipitations of crept and aged specimens of CNS-2 steel. The results showed that the CNS-2 steels had remarkable creep resistance at 600°C/105MPa.

In this paper, the mechanical and microstructure properties of a venturi flowmeter were investigated. The chemical composition was analyzed.
2. Macroscopic morphology
The macroscopic morphology of the venturi flowmeter is shown in Fig. 1. Venturi tube is about 370 mm in length, 100 mm in outer diameter and 80 mm in inner diameter. The height of the pressure tube is about 80 mm. The distance of equalizing ring is about 130mm. The pressure equalizing rings at both ends are welded to the venturi tube, and the pressure taking pipe and the pressure equalizing ring are also welded to each other.

3. Results and Discussions
3.1. Tensile properties
The stress-strain curves of the venturi flowmeter material tested at room temperature and high temperature with different strain rates are shown in Fig. 3. As shown in Fig. 3(a) and Fig. 3(b), the tensile strength is about 680MPa at the room temperature. The true strain at the time of fracture is about 0.23. It can be seen that the strain rate has little effect on tensile strength. As shown in Fig. 3(c) and Fig. 3(d), the tensile strength is about 500MPa at 520℃.
The SEM morphology of tensile fracture tested at 520°C is shown in Fig. 4. The strain rates are 0.1s$^{-1}$ and 1s$^{-1}$ as shown in Fig. 4(a) and (b), respectively. It can be seen that the dimple distribution of the fracture specimen is more dense when the strain rate is relatively low. The fracture mode of this material is intergranular/transgranular at 520°C. With the increase of strain rate, the area of transgranular fracture increases.

3.2. Microstructure analysis
The microstructure of the venturi flowmeter material is shown in Fig. 5. It can be seen that the microstructures are pearlite and ferrite.
3.3. Chemical composition analysis
The chemical composition of the venturi flowmeter material is shown in Fig. 6. According to the test results, the contents of all elements meet the requirements of 12Cr1MoVG steel in the national standard GB/T 3077-2015 < Alloy structure steels >.

4. Conclusion
The venturi flowmeter material meets the requirements of relevant standards. The fracture mode of this material is intergranular/transgranular at high temperature.

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