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Influence of carbon content on erosive wear behavior of multi-component cast steel

Kimitoshi Nakamura, Kazumichi Shimizu, Kenta Kusumoto
Muroran Institute of Technology
27-1 Mizumoto-cho, Muroran city, Hokkaido, 050-8585, Japan

This study investigated the influence of carbon content on erosive wear behavior of multi-component cast steel. The multi-component cast steel with Cr, Mo, W and V of about 5 mass % with 1.0, 1.5 and 2.0 mass % C were prepared as the test material. The test specimens for erosive wear test were mechanically machined to be sized 50×50×10mm. Specimens were tested using a blast machine.

According to the results of erosion test, the erosion rate of specimen decreased with the increase of C content. The specimens of 2.0 mass % C showed excellent erosive wear resistance. The reasons of decreasing of erosion rate with increasing of C contents were determined by microstructure analysis and EDS analysis diffraction. According to the results, the matrix has changed from austenite to martensite with the increasing of carbon contents. Therefore, multi-component cast steel with 2.0 mass % C showed superior erosive wear resistance. It's considered that area ratio of carbide and matrix are important factors of erosive wear resistance.

Keywords: *Erosive wear, Erosion rate, Room temperature, Multi-component cast steel, Area ratio of carbide*

1. Introduction

The phenomenon becomes a serious problem for bended section of pneumatic transportation pipe, valve, turbine blade fan, and so on. Erosive wear in pipe line occurs in the inner wall of pipe and could not be judged from the exterior of pipe, so periodical exchange of parts and the inner wall of the pipe to be thinned down was built up through welding in order to avoid causing accidents. In order to reach an aim of high safety and low cost, it is important to develop wear resistant material and to estimate of life service during erosion. What's more, the influence of rodent is inevitable to life service estimation procedure [1-3]. Recently, many researchers have studied on the variety of alloys, and tempted to develop wear resistant materials [4-6].

This study investigated the influence of carbon content on erosive wear behavior of multi-component cast steel.

2. Experimental procedure

2.1 Materials

The chemical compositions of specimens are as shown in Table 1. The multi-component cast steel with Cr, Mo, W and V of about 5 mass % with 1.0, 1.5 and 2.0 mass % C were prepared as the test material. 50 kg raw materials were melted in high frequency induction furnace at 1908 K and then poured into a sand mold with a Y-shape of 53×113×125 mm after the process of spheroidzing by 95 mass % Ni - 5 mass % Mg. The specimens used in the erosion test were mechanically machined into flat plate with diameter of 50×50×10 mm. The heat treatment was performed for the purpose of secondary hardening, and the processing conditions are 4 hours keeping at 1223K for annealing, 2 hour at 1323K hardening, and 6 hours keeping at 798K for tempering.

Table 1 Chemical composition of specimens.

(mass%)

	C	Cr	V	Mo	W	Fe
1	1.0	5.0	5.0	5.0	5.0	Bal.
2	1.5	5.0	5.0	5.0	5.0	Bal.
3	2.0	5.0	5.0	5.0	5.0	Bal.

Si, Mn = 0.50 %, P, S = 0.020 %

2.2 Experimental method

A shot blasting machine was used to test the erosive wear property of target materials in the present study. Irregularly shaped erodent particles were in this experiment. They are irregularly shaped steel grits with average diameter 770μm and Vickers hardness of 810HV. Steel grits was used for very hard. The erodent particles were changed after each test because

that the particles themselves also were eroded to be smaller during the experiment. The examined air speed was 100m/s, and the particle feed rate was measured with about 20g/s with changing their impingement angles 30, 60 and 90deg., respectively. All the erosion tests were conducted at room temperature in 3600sec.. Before and after the test, the mass amounts of specimens were weighed with an electronic scale and then calculated the volumetric loss. The erosion rate was introduced because it's more accurate to evaluate material removal by volumetric loss than by mass loss for specimens with different densities. The results of the wear test was discussed by Vickers hardness measurement and scanning electron microscope (SEM).

3. Experimental results and discussion

Fig. 1 showed the microstructure and area ratio of carbide measurement result of specimens. Matrix of material 1.0 mass % C was pearlite. Matrix of other specimens was martensite. Area ratio of carbide was calculated by the average of 5 photos in 400 times taking by SEM. Among all specimens, material with 2 mass % C showed the most area ratio of carbide.

Result of erosive wear test of 30deg. and Vickers hardness measurement are as shown in Fig. 2. According to the results, erosion rate decreased with C content increased, and material with 2 mass % C showed the best erosive wear property. The similar results can be get in other impact angles. Also hardness of the experimental materials increased with the C content increased.

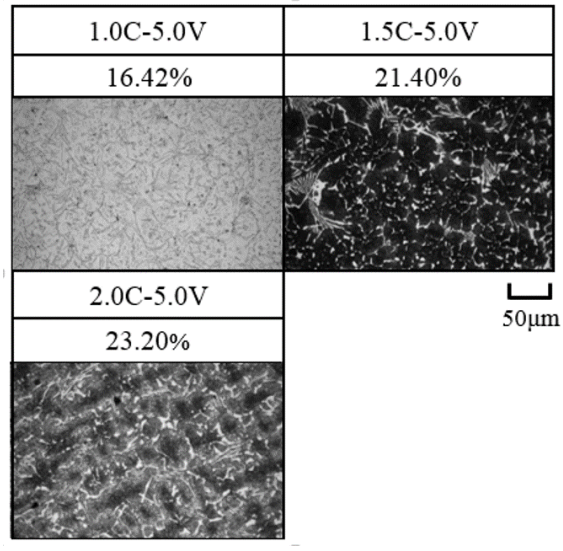

Fig. 1 Microstructure and area ratio of carbide measurement of specimens.

Therefore, multi-component cast steel with 2.0 % C showed superior erosive wear resistance. It can be considered that area ratio of carbide and matrix are important factors of erosive wear resistance.

4. Conclusions

This study investigated the influence of carbon content on erosive wear behavior of multi-component cast steel. And the following conclusions were obtained.

(1) Erosion rate decreased with C content increased. Especially, erosion rate of material with 2 mass % C showed the best erosive wear property. It is because that material with 2 mass% C has the highest hardness and the most area ratio of carbide compared with other specimens.

(2) It can be considered that area ratio of carbide and matrix are important factors of erosive wear resistance.

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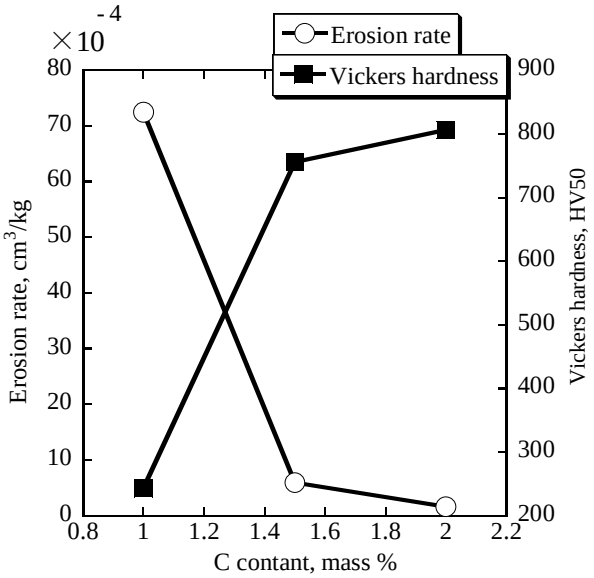

Fig. 2 Erosive wear test of 30deg. and hardness measurement.