論文 / 著書情報
Article / Book Information

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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	材料工学	専攻	
学生氏名： Student's Name	Lyta		

申請学位（専攻分野）： Academic Degree Requested	博士 (工学) Doctor of
指導教員（主）： Academic Advisor(main)	丸山 俊夫
指導教員（副）： Academic Advisor(sub)	

要旨（英文 800 語程度）
Thesis Summary (approx.800 English Words)

In A-USC power plants, piping materials must meet requirements of creep rupture strength and steam oxidation resistance. Newly developed Fe-20Cr-30Ni-2Nb (at.%) austenitic steel is one of the candidates because of its superior creep rupture strength provided by formation of Fe2Nb Laves. In this study, steam oxidation of these steels was conducted in Ar-15%H_2O at 1073 K for up to 1209.6 ks. Duplex scale consisted of outer scale of magnetite and inner scale of spinel formed in the initial stage in which oxidation rate was high. The longer exposure offered the protective Cr_2O_3 scale at the steel/scale interface, which suppressed the growth of oxide scale. Steam oxidation mechanism of the developed steels at 1073 K was proposed. The in-situ measurement of the oxygen potential at the surface of the scale clarified the steam oxidation mechanism. Boron doped steel with higher creep resistance exhibited better resistance to steam oxidation. The results obtained the estimated scale thickness after 10^5 hours exposure at 1073 K to be less than 100 μm. In conclusion, these steels are expected to be applicable in power plants operated at 1073 K.

In this thesis, the high temperature steam oxidation of Fe-Cr-Ni-Nb austenitic steels at 1073 K was investigated systematically. The structure of the thesis is summarized below:

Chapter 1: "Introduction"

The background of this thesis is explained in relation to the global energy problem and the issue to be solved in fossil fuel power plants. The improvement of efficiency in power plants is going on progress by operation at higher temperature in which the steam oxidation of steels is an issue to overcome. The objective of this thesis is to evaluate the availability of newly developed Fe-Cr-Ni-Nb austenitic steels to A-USC power plants operated at 1073 K in the view point of high temperature steam oxidation.

Chapter 2: "Steam Oxidation Behavior of Fe-20Cr-30Ni-2Nb (at.%) at 1073 K"

Steam oxidation of Fe-20Cr-30Ni-2Nb (at. %) austenitic steel with various heat treatments and polishing treatments was conducted. Both internal and external oxidation occurred in the initial stage of steam oxidation. Precipitates of Ni-Fe nodules of alloy were formed in the IOZ. During the steam oxidation, the nodule was oxidized to form magnetite as the outer scale and remaining Ni-Fe alloy was located at the interface of the duplex scale. Discontinuous Cr_2O_3 layer was formed. In the initial stage, the scale growth rate of this steel was almost same as that of 316 steel because of the typical duplex scale. When the transition from internal to external oxidation occurred and continuous layer of Cr_2O_3 was covered at the scale/steel interface, internal oxidation zone which was formed in the initial stage became inner scale. The inner scale consists of $(Fe,Cr)_3O_4$ and Ni-Fe metallic alloy. The longer exposure offered the protective Cr_2O_3 scale at the steel/scale interface, which suppressed the growth of oxide scale. Mechanical polishing provided the surface layer with micro-strain which was the high energy sites beneficial for nucleation and growth of Cr_2O_3. Electrolytic polishing removed the surface strained layer. For long term exposure, this steel is expected to be safe from exfoliation. Therefore this steel is expected to be applicable in A-USC power plant operated at 1073 K.

Chapter 3: "Surface Oxygen Potential Measurement in Steam Oxidation of Fe-20Cr-30Ni-2Nb (at. %) at 1073 K"

In-situ monitoring of the surface oxygen chemical potential was conducted using an oxygen concentration cell CaO stabilized ZrO_2 (CSZ). Drop of the surface potential in surface potential measurement was detected at

the initial stage, which was correspondent to formation of the duplex scale. Cr_2O_3 formation was detected by the increasing of the oxygen chemical potential at the surface of specimen. Continuous monitoring of surface oxygen potential was applied to clarify steam oxidation mechanism.

Chapter 4: "Effect of Addition of Boron on Oxidation Behavior of Fe-20Cr-30Ni-2Nb (at. %) at 1073 K"

Steam oxidation of Fe-20Cr-30Ni-2Nb-0.03B (at.%) austenitic steel with various heat treatments has been conducted. The oxidation behavior was basically as same as that of the steel without boron. However the addition of boron decreased slightly the growth rate of the oxide scale but the mechanism has not been clarified yet. This boron-added steel is potentially applicable in A-USC power plant operated at 1073 K.

Chapter 5: "Conclusion"

The results obtained in the present study are summarized as conclusion.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).