Osaka University Knowledge Archive

| | |
|---|---|
| Title | Structure optimization of air conditional compressor based on reverse welding deformation model |
| Author(s) | Li, Yongzhi; Lu, Hao; Chen, Junmei et al. |
| Citation | Transactions of JWRI. 39(2) p.71-p.72 |
| Issue Date | 2010-12 |
| oaire:version | VoR |
| URL | https://doi.org/10.18910/12762 |
| rights | |
| Note | |

*Osaka University Knowledge Archive : OUKA*

https://ir.library.osaka-u.ac.jp/

Osaka University

# Structure optimization of air conditional compressor based on reverse welding deformation model†

LI Yongzhi *, LU Hao *, CHEN Junmei * and REN Liping **

**KEY WORDS**: (Air conditioning compressor) (Welding deformation) (Blade groove width) (Three-point welding) (Phase transformation) (Thermal elastic-plastic finite element method)

## 1. Introduction

The FEM simulation of welding residual stresses and distortions can provide valuable instructions for the optimization of welding technology and structures. Under the welding condition, the phase transformation in solid state not only changes the strain-stress, but also affects the life evaluation for the structure. In order to accurately predict the distortion and stress during welding process, the numerical analysis is usually performed using the thermal-mechanic-metallurgical coupling model, and the effects caused by phase transformation are also considered [1,2]. Recently, significant progress has been made by researchers in the modeling of phase transformation behavior of steel [3-5]. Mathematical models are gaining acceptance as powerful tools for residual stresses and distortions prediction and structure optimization.

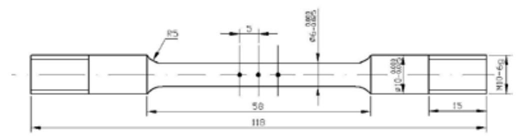
In this paper, a phase transformation model is developed to study the material thermo-mechanical behavior under a typical welding process. A reverse model based on thermal elastic-plastic finite element method is developed to simulate the three-point welding of compressor shell and cylinder.

## 2. Thermo-mechanic-metallurgical model and results

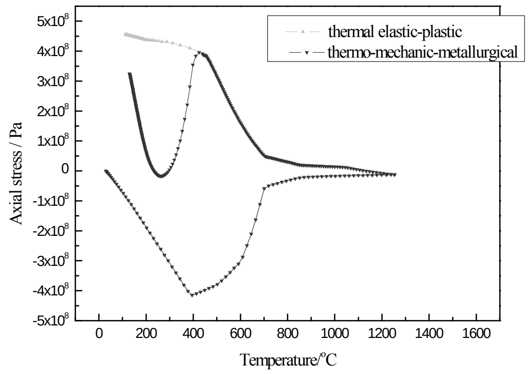
A thermo-mechanic-metallurgical model is developed to study the material thermo-mechanical behavior. The geometric model is shown in **Fig.1**(a), and the result is shown in Fig.1(b), both of the ends are fixed during the simulation. The result shows that, as the temperature increases the axial compressive stress becomes bigger, and during the cooling stage, axial tensile stress appears in the model. Differences between the thermal elastic-plastic model and the thermo-mechanic-metallurgical model appear at the Ms point. In the thermo-mechanic-metallurgical model, the axial tensile stress decreases rapidly because of the transformation strain. But with further cooling, the stress increased again.

## 3. Air conditioning compressor model and results

The FEM model of the air conditioning compressor is shown in **Fig.2**(a), and the contour of temperature distribution is shown in Fig.2(b).

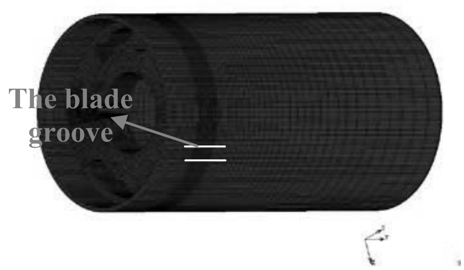


(a) Geometric model

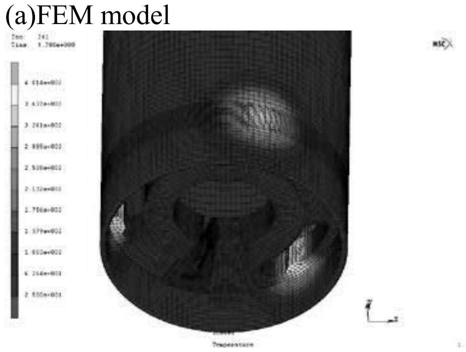



(b) Relation between stress and temperature

**Fig. 1** Thermo-mechanic-metallurgical mode results




(a)FEM model



(b) The contour of temperature distribution

**Fig. 2** Air conditioning compressor model

† Received on 30 September 2010

* Shanghai Jiao Tong University, Shanghai, China
** Engineering Research Center, Gree Electric Appliances, Inc. of Zhuhai, China

Transactions of JWRI is published by Joining and Welding Research Institute, Osaka University, Ibaraki, Osaka 567-0047, Japan

Three parameters are discussed in our simulation, the height of the compressor shell, material properties of the cylinder, and whether the shell is in contact with the cylinder. **Figure 3** shows the width change of the blade groove with different parameters. The results show that, the height of the compressor shell has little effect on the width change of the blade groove. The width change becomes smaller when cast steel is used for the cylinder. In the simulation, the Young's Modulus of the cast steel is smaller than the shell's. And the width change can be decreased by decreasing the material Young's Modulus of the cylinder material. When the shell is in contact with cylinder, the width change is also decreased.

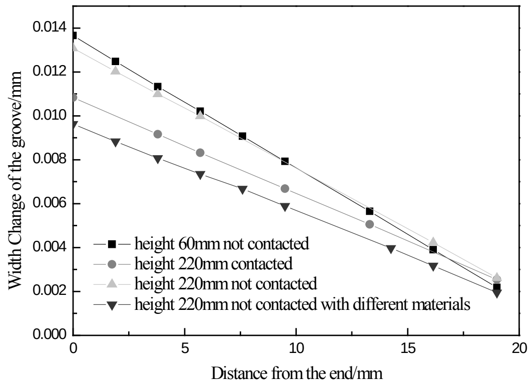



**Fig. 3** The width change of the blade groove with different parameters

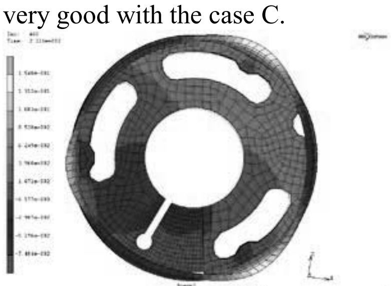
The deformation of the shell with different parameters is shown in **Fig. 4**. Three different cases are discussed:

Case A, the shell and the cylinder are in contact, and using the same material properties.

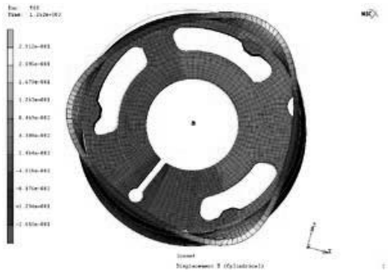
Case B, the shell and the cylinder are not in contact, using the same material properties.

Case C, the shell and the cylinder are not in contact, the cylinder using different material properties.

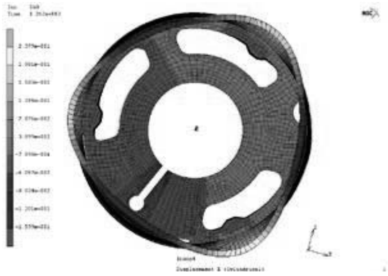
The results show that, the deformation of the compressor shell seems like a "flower". When the shell and the cylinder are in contact, the deformation of the shell is much smaller. The cylinder roundness of these three cases are 229μm、416.2μm and 397.8μm. And in the experiment, the measured cylinder roundness is 377.41μm, which is in very good with the case C.



(a) Case A (×40)



(b) Case B (×30)



(c) Case C (×30)

**Fig. 4** Contours of radial deformation under different conditions

## 4. Conclusions

According to the simulation results, the following conclusions can be obtained:

(1) The height of the compressor shell has little effect on the width change of the blade groove. The width change becomes smaller when cast steel is used for the cylinder.

(2) When the shell and the cylinder are in contacted, the deformation of the shell is much smaller. And in the experiment, the measured cylinder roundness is 377.41μm, which is in very good with the case C.

**Acknowledgement**

This project is support by the National Natural Science Foundation of China (Grant No. 50975176)

## References

[1] Jun-yan LIU, Hao LU, Jun-mei CHEN, Jinyang LIU. Finite element simulation of Satoh test taking into account transformation induced plasticity. Transactions of the China Welding Institution, 2008, 29(3):105-109.

[2] Jun-yan LIU,Hao LU, Jun-mei CHEN. Experimental analysis of transformation induced plasticity in 9Cr1Mo steel. Front. Mater. Sci. China 2009, 3(1):61-66.

[3] Caner Simsir, Cemil Hakan Gür. 3D FEM simulation of steel quenching and investigation of the effect of asymmetric geometry on residual stress distribution. Journal of materials processing technology, 2008, 2007:211-221.

[4] Caner Simsir, Cemil Hakan Gür. A FEM based framework for simulation Application to steel quenching. Computational Materials Science, 2008, 44:588-600.

[5] Moumni, Z., et al. Theoretical and numerical modeling of the thermo mechanical and metallurgical behavior of steel. Int. J. Plasticity (2010), doi:10.1016/j.ijplas.2010.07.002.