Decarburized Simulation Analysis of the Crankshaft of JB36-400 Press

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***Abstract*—The thickness of decarburization layer of crankshaft of JB36-400 press was simulated by the DEFORM-3D software. The results indicated that the minimum decarburization layer was obtained at 830°C and holding for 120min and the mechanical properties and performance can be met the requirements. The experiment and theoretical simulation were consistent, the main causes of the error were temperature uniformity of furnace and the surface conditions of crankshaft.**

Keywords-DEFORM-3D；decarburized simulation；heat treatment

I. INTRODUCTION

Decarburization is one of the common problems when they were heated during the heating process[1-3]. The strength and wear resistance of carbon steel with decarburization are decreased [4-8]. DEFORM-3D is a finite element simulation software of metal forming, designed for forging, rolling, extrusion, heat treatment and metal forming process, and helps to provide an extremely valuable data during the process analytical[9,10]. The decarburized layer of the crankshaft of JB36-400 press during heat treatment process is simulated by the DEFORM-3D software in this paper, and the results of experiment was consistent with the simulation, the quality of crankshafts was improved a lot.

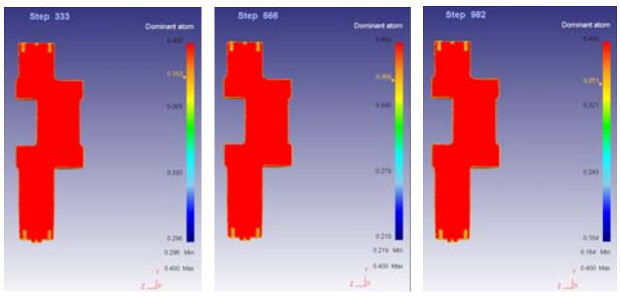
II. EXPERIMENTAL PROGRAM AND PROCESS

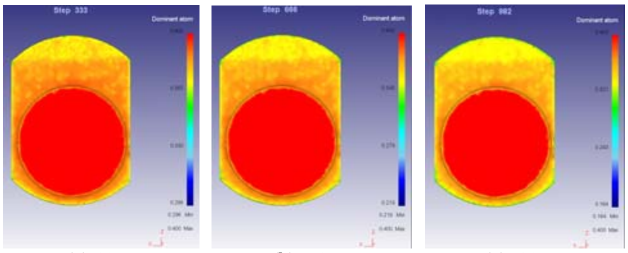
The decarburization of crankshaft during heat treatment was simulated by the DEFORM-3D software. The crankshafts were experimented by the heat treatment, and the results of decarburization were measured by the metallographic microscope XJP-200. The analysis was made between the results of experimental and simulation.

III. RESULTS AND DISCUSSION

A. Simulation results of crankshaft

The depths of decarburized layer at temperature of 800°C for holding time were respectively 60min, 120min, 180min were shown in Fig.1, and the results of 830°C, 860°C were displayed in Fig.2 and Fig.3. The decarburized layer can be seen from axial and radial cross-section of the crankshaft. It was obvious that the depth of decarburization layer gradually increased with the longer time and the higher temperature. The carburization depths of different quenching temperature and holding time were shown in table.1. From the data, one can be seen that decarburization layer is 0.055mm at the temperature of 800°C and holding time of 60min. 0.185mm was correspond to 860°C and 180min. By comparative analysis, the conclusion was that at 830°C and holding for 120min, the crankshaft was fully austenitized and the minimum decarburization layer was obtained. The mechanical properties and performance can be met the requirements.

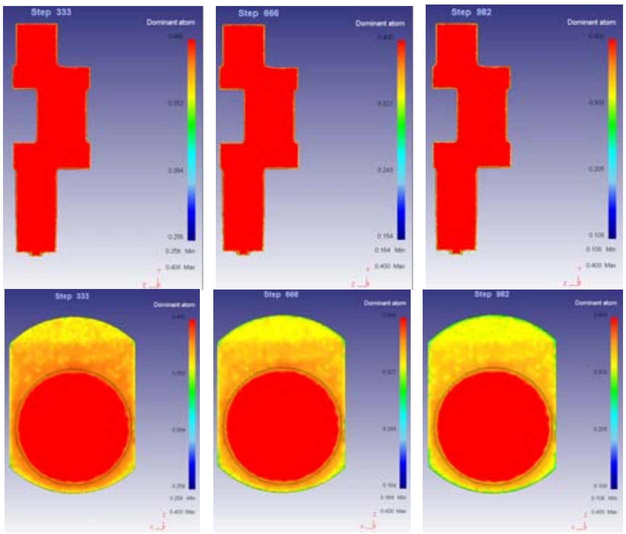




(a) 60min (b)120min (c)180min

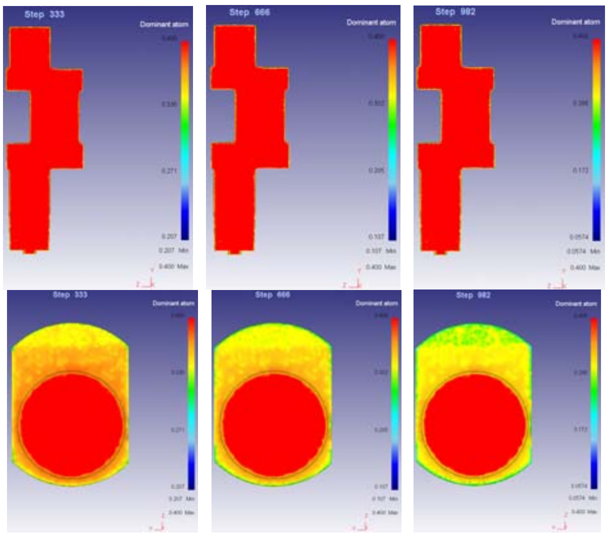
(Cross-section of the crankshaft)

Fig.1 The simulated decarburization of crankshaft at different holding time at 800℃



(a) 60min (b)120min (c)180min

Fig.2 The simulated decarburization of crankshaft at different holding time at 830℃



(a) 60min (b)120min (c)180min

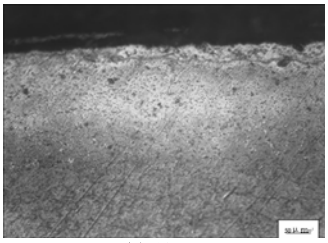
Fig.3 The simulated decarburization of crankshaft at different holding time at 860℃

TABLE Ⅰ. THE EXPERIMENTAL RESULTS OF THICKNESS OF DECARBURIZED LAYER

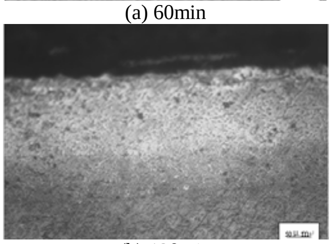
Quenching temperature/ °C	**Holding time/min**	**Average decarburized thickness /mm**	**Rectified values/mm**
800	60	0.52	0.052
	120	1.20	0.120
	180	1.53	0.153
830	60	0.55	0.055
	120	1.38	0.138
	180	1.70	0.170
860	60	0.58	0.058
	120	1.43	0.143
	180	1.85	0.185

B. The analysis of experimental results

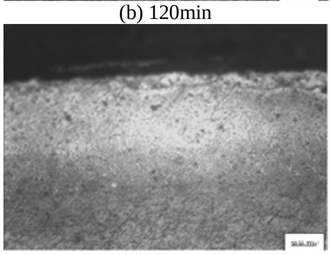
The samples of the crankshaft were heated to 830°C, with holding respectively 60min, 120min, 180min, and quenched in oil. The thicknesses of the decarburized layer were shown in Fig. 4.



(a) 60min



(b) 120min



(c) 180min

Fig.4 The decarburized layer of crankshaft for different holding time at 830℃

The decarburized layer was about 0.05mm, 0.12mm and 0.16mm with holding 60min, 120min and 180min. The errors were respectively 0.005mm, 0.018mm and 0.010mm compare to the simulation. The mechanical properties of the material was decreased after the decarburization, can not satisfy the requirement, hardness and wear resistance have been seriously affected.

IV. THE ERROR ANALYSIS

The thickness of decarburization layer is a little error between simulation and experiment. The results were shown in Fig.10.

In the actual process of heat treatment, 40Cr steel samples were heated to 830°C and kept in this temperature with 60min, 120min and 180min. the thickness of decarburization layer and the corresponding depth are 0.05mm, 0.12mm, 0.16mm, the simulated results were 0.055mm, 0.138mm, 0.170mm. The temperature of heating furnace and air flow were existed during the experiment. So the results of actual depth of decarburized layer were smaller than the simulated results.

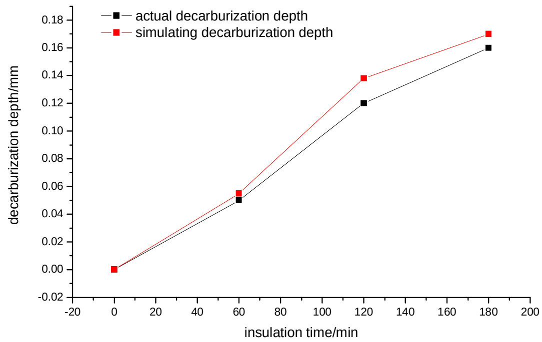


Fig.5 The graph of the depth of decarburization layer about the actual and the simulated

V. CONCLUSION

Decarburization of the crankshaft was simulated at 800°C, 830°C, 860°C by DEFORM-3D and the experiments were practiced with heat treatment. The results indicated that quenching temperature at 830°C was the appropriate.

The depth of decarburization layer on the surface of crankshaft was increased with longer time and higher temperature.

The results of simulation and heat treatment experiments of the depth of decarburization layer are same basically, and the error was from 0.010mm to 0.017mm. The experimental results show that DEFORM-3D software simulation is important for 40Cr steel to simulate the process of decarburization before the experiment.

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