Effect of Heat Treatment and Shot Blasting on the Performance of 175 Crankshaft of Automobile Engine

Jikun Yu*
Dalian Ocean University, Dalian, 116300 China
*Corresponding author e-mail: yujikun@dlou.edu.cn

Abstract. After heat treatment, the 175 crankshaft of automobile engine is extremely prone to serious bending phenomenon (the straightness is more than 2um), and the flexure of the crankshaft when the fine rod is bent and cold. This paper has developed the corresponding 175 crankshaft after heat treatment. The reheat is corrected again, and the corrected 175 crankshaft is shot blasting, and the internal stress is further eliminated. The special inspection tool is used to inspect the vertical parting line of the 175 crankshaft in 90 degree range, and the test result is 100% qualified and the deformation amount is controlled within 2um, and the secondary heat treatment is verified. The practicality and effectiveness of shot blasting processing technology.

Keywords: 175 Crankshaft, Secondary Heat Treatment, Shot Blasting

1. Introduction
Automotive engine crankshaft is the core components of automobile engine, the crack of its surface and subsurface and the breakage of its surface is mostly caused by previous improper heat treatment[1]. The early stage result in surface deformation and the internal residual stress cannot be released.

Because of the alternating stress function, firstly, the crack source can be happened in the subsurface, secondly, further fatigue spalling can be happened in the surface, then the crankshaft will happen lose efficacy[2].

Fig. 1 Failure process of surface spalling caused by metal surface fatigue sources
The residual stress of all kind of the part of the equipment was related by the heat-treatment. The residual stress and the heat-treatment relationship can be explained by the professor Creţu Sp research, included roughness, deformation, and the alternating stress[3-5].

Aiming at the large deformation problem of automobile engine 175 crankshaft caused by improper heat treatment in the early stage[6], this paper improved the tooling and processing technology of heat treatment, carried out the second heat treatment and shot peening treatment to eliminate residual stress in the later stage, and reached the expected requirements through testing.

2. Experiment of Implement the Surface Modification Scheme of Engine 175 Crankshaft

2.1. Modification Scheme of Secondary Heat Treatment

The 175 engine crankshafts which have scrapped, by the naked eye, its surface has serious bending phenomenon, its straightness is 3.5 um, so before the 175 engine crankshaft of secondary heat treatment processing, it is easy that happening crankshaft bending deformation problems due to the conditioning., and in the event of happening crankshaft bending, it needs to revise the crankshaft, and relieved stress to the revised crankshaft. Therefore according to the shape characteristic of the 175 crankshaft, this experiment adopts a single independent suspension type heating and cooling method.

According to this process requirement, the test specially designed and made the tooling and heat-resistant steel lifting rings for processing this batch of scrapped crankshaft, as shown in figure 2(a) and (b).

![Image](image1.png)  
(a) 175 crankshaft heat treatment tooling (b) tooling auxiliary heat-resistant steel sling

**Fig.2** shows 175 crankshaft tooling and heat-resistant steel sling.

The crankshaft scrapped due to excessive deformation is placed in the tooling for secondary heat treatment, and the process parameters are newly designed. Due to the crankshaft in the subsequent storage process, the analysis of the excessive amount of deformation of the batch is mainly. It is main reason for the bending deformation that there is more residual stress inside the crankshaft after heat treatment. During the storage process, the stress is gradually released, causing the crankshaft to deform. The stress source to this part can be divided into two aspects. One is that the quenching and tempering is insufficient, and the quenching stress generated during the quenching of the crankshaft is not fully released. Second, after the high temperature tempering of the crankshaft, the air is cooled, the air cooling speed is fast, the shape of the crankshaft get complex and thick, the cooling speed is not uniform, and the secondary stress is generated.

Therefore, the surface modification adopts high temperature tempering heating and increases the holding time, the tempering temperature is set to 520 degrees, the tempering holding time is 6 hours, and the residual stress of the crankshaft caused by the hollow cold cooling rate is increased for the
second condition. The surface heat treatment modification scheme is changed from the original direct air cooling to the cooling of the furnace to 350 degrees or less, and then the air cooling is performed. The secondary heat treatment clamping and processing process can be shown in Figures 3a) and (b).

![Fig.3 175 crankshaft heat treatment process](image)

3. **Shot Blasting Crankshaft Reduces Residual Stress**

This crankshaft 175 shot blasting treatment mainly eliminates the deformation caused by residual stress in cold machining and secondary heat treatment of metal parts, the deformation produced can be divided into elastic deformation and plastic deformation. In ordinary state, both kinds of deformation exist on the work-piece processed at the same time. When the amount of elastic deformation is small, it is not easy to observe, and this batch of crankshafts have primary elastic deformation, the cause of the deformation is related to the applied pressure, the holding time of the applied pressure, and the yield strength of the crankshaft itself. In order to reduce the residual stress, the shot blasting machine is adopted as shown in Fig. 4, after the secondary heat treatment, the crankshaft 175 is treated by shot blasting. Each piece of 175 crankshaft is removed after shot blasting for 5 minutes in the shot blasting machine and tested uniformly after the completion of shot blasting.

![Fig. 4 175 crankshaft shot blasting equipment.](image)
4. Detection and Analysis of Surface Modification

For the 175 crankshaft after the secondary heat treatment and shot blasting treatment, the use of special inspection tools, all 175 crankshaft after processing for 100% detection. First, the bending deformation was detected. According to the main detection position required by the 175 crankshaft itself, the vertical parting line was detected on both sides at 90 degrees as shown in Figure 5.

![Figure 5](image_url)

**Fig.5** 175 crankshaft bending deformation detection.

The actual test results of this part show that in this batch of 175 crankshaft, the qualified rate of bending deformation is 100%, the deformation amount is less than 2um, which meets the requirements and does not need to be adjusted. The hardness of 175 crankshaft after high temperature tempering is measured at 270-285HB, the hardness after shot blasting is 430-450HB, meeting the requirement of national standard 400-500HB, and then the strength of about 930 mp, yield strength is controlled in 790 mp, indicating the second heat treatment and shot blasting process for this batch of scrap 175 crankshaft to carry on the reasonable repair, meet expected requirements, especially surface blasting treatment not only can eliminate the residual stress, reduce the deformation caused by residual stress, and can improve the hardness of the crankshaft.

**Conclusion**

1. Regarding the deformation of the crankshaft in the subsequent storage process, when the crankshaft deformation is repaired, it can be solved by adjusting the tempering air-cooling process and the residual stress reduction method combining shot blasting, which has a good processing effect.

2. For special parts, such as the crankshaft heat treatment of the core parts of the engine in this paper, we can develop special heat treatment tooling and heat-resistant rings to improve the processing efficiency and quality of heat treatment.

3. After shot blasting treatment, the 175 crankshaft not only meets the requirements of its deformation, but also greatly improves its hardness, which fundamentally changes the physical properties of the 175 crankshaft.

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