Study on the influence of Paint-removal Process on the performance of the used parts for remanufacturing

Pin-pin Qin[1], Dai-xiang Jiang[1], Lu-lin Wang[2] ,Xi-qiu Pan[2], Chui-ce CHE[3]

[1]College of Mechanical Engineering, Guangxi University, Nanning, China

[2]Guangxi Liu Gong Machinery Co., Ltd, Liuzhou, China

[3]College of Mechanical Engineering, Guangxi University, Nanning, China

KEYWORDS: Remanufacturing; Cleaning; Paint-removal; High temperature decomposition

ABSTRACT: Cleaning is an important procedure of used parts remanufacturing process and the paint-removal on the surface of used parts is a difficulty during cleaning process. The surface paint of three materials cast iron HT250, cast steel ZG270-500, and carburizing and quenching steel 20CrMnTi were cleaned by high temperature decomposition process in this paper. Before and after cleaning, the dimensional accuracy, microstructure and hardness of the three materials were compared and analyzed. The results showed that high temperature decomposition has no effect on dimensional accuracy, microstructure and hardness of cast iron and cast steel. However, the microstructure of the carburizing and quenching steel has a phase change, and the hardness decreases sharply. Therefore, it is concluded that high temperature decomposition process is an effective method removing paint on the surface of casting iron and cast steel metal used parts, but not for carburizing and quenching steel.

INTRODUCTION

Remanufacturing cleaning, aimed at getting rid of the paint, carbon deposit, grease, rust and so forth on the surface of waste products to meet the requirement of surface cleanliness, is a vital procedures of remanufacturing process and the foundation of testing waste products and components. The effect of cleaning directly affects the surface checking, painting, assembling etc. in the later processes [1].The cleaning process is an energy intensive and seriously polluting procedure in the entire remanufacturing processes [2]. Variety of detergents cause serious pollution to the environment and some of the waste detergents require special handling. As the increasing voices for cleaner production, many industrial cleaning methods have come into being. But those methods are not still used in industrial practice because of very expensive equipment. High temperature decomposition is fit for complex parts without any dead space left, which is also easy for batch cleaning. At present, this cleaning method is becoming a popular method for remanufacturing factories [3].

The important features of remanufacturing is to make used parts return to like-new or better performance, saving costs 50%, energy 60% and materials 70% up [4]. If paint-removal process will affect the performance of the used parts, which will directly take effects on remanufactured product quality. High efficiency, green cleaning technology can make significant meaning for guaranteeing remanufacturing quality and increasing costs.

In this paper, the research will investigate the influence of high temperature decomposition on the performance of the used parts during paint cleaning based on macro and micro analysis. The macro analysis includes parts dimension and micro analysis includes microstructure and hardness.

EFFECTS OF PAINT-REMOVAL PROCESS ON THE PERFORMANCE OF THE USED PARTS

Effects of parts dimension

During the cleaning process, the parts are put into a special cleaning equipment ---furnace, where temperature is up to 420 Celsius. Parts usually prone to deformation at high temperature, so it is necessary to check dimensional accuracy through paint-removal process experiments [5]. If the results showed that high temperature has no effects on parts performance, then the process can be applied in production. If not, another method need to be found.

The cylinder heads and cylinders are the key parts for construction machinery remanufacturing. Comparing experiments of before and after cleaning are carried on between cast iron and cast steel respectively for cylinder heads and cylinders. The results are showed in table 1.

The table 1 demonstrates that, parts dimensional accuracy of before and after cleaning still remain unchanged. There is no direct heat applied to the part surface in the furnace with a closed space, so the parts undertake uniform heating without focus heating. The high temperature decomposition process can be used in cast iron and cast steel parts which have a requirement of dimensional accuracy.

Table 1. The compared results of before and after cleaning for cylinder heads

cylinder heads properties	Number	Before	After
cast iron: HT250 diameter: Φ180mm	NO.1	179.93	179.935
	NO.2	179.93	179.932
	NO.3	179.93	179.933
	NO.4	179.935	179.935
	NO.5	179.94	179.94
	NO.6	179.93	179.93
	NO.7	179.92	179.922
	NO.8	179.93	179.93
	NO.9	179.925	179.93
	NO.10	179.925	179.93
	NO.11	179.925	179.93
	NO.12	179.925	179.93

Table 2. The compared results of before and after cleaning for cylinders

cylinders properties	Number	Before	After
cast steel: ZG270-500 diameter: Φ200mm	NO.1	200.03	200.04
	NO.2	200.035	200.035
	NO.3	200.02	200.02
	NO.4	200.025	200.02
	NO.5	200.065	200.06
	NO.6	200.55	200.06
	NO.7	200.04	200.045
	NO.8	200.04	200.05
	NO.9	200.03	200.04
	NO.10	200.035	200.035
	NO.11	200.01	200.02
	NO.12	200.02	200.02

Effects of microstructure and hardness

Microstructure and hardness are important means of experimental research of metal material, which have an important influence on the mechanical parts performance [6]. These means have been widely applied in testing of raw materials, quality control of production process, product quality testing, failure analysis, etc [7]. In this paper, the surface paint of three materials cast iron HT250, cast steel ZG270-500, and carburizing and quenching steel 20CrMnTi were cleaned by high temperature decomposition process. Before and after cleaning, microstructure and hardness of the three materials were compared and analyzed.

The microstructure and hardness comparing results of before and after cleaning for cast iron HT250 are shown in figure 1, figure 2 and table 3. All the data indicate that the microstructure and hardness of cast iron HT250 has not been affected after cleaning. The same results are achieved for cast steel ZG270-50.

The microstructure and hardness comparing results of before and after cleaning for quenching steel 20CrMnTi are shown in figure 5, figure 6 and table 5. All the data indicate that the microstructure and hardness of quenching steel 20CrMnTi has been affected after cleaning. This because the temperature of 420 Celsius in the furnace is much higher than the tempering temperature of the parts, which empering temperature is about 180 Celsius. The high temperature made microstructure level of martensite and residual austenite change. Before cleaning, the parts texture is compose of martensite and residual austenite, but it has been changed into martensite, residual austenite and troostite after cleaning.At the same time, the hardness of quenching parts drastically reduced. As a result, the quen ching part can not be used in Pyrolysis process for Paint removal, otherwise it will not be able to ke ep the heat treatment performance of the parts.

Figure 1. Microstructure of cast iron HT250 before decomposition

Figure 2. Microstructure of cast iron HT250 after decomposition

Table 3. Comparison of cast iron HT250 specimens before and after high temperature decomposition

Process	Distribution of graphite shape	The length of the graphite	Pearlite quantity （%）	Carbide quantity （%）	Phosphorus eutectic quantity （%）	Hardness
Before cleaning	C-Block sheet	Level 3	98	1	1	HB166
After cleaning	C-Block sheet	Level 3	98	1	1	HB166

Table 4. Comparison of cast steel ZG270-500 specimens before and after high temperature decomposition

Process	Matrix organization	Hardness
Before cleaning	pearlite , widmanst and granular ferrite	HB189
After cleaning	pearlite , widmanst and granular ferrite	HB189

Table 5. Comparison of high temperature decomposition of carburizing and quenching steel 20CrMnTi

Process	carbide	martensite and retained austenite	core ferrite	core hardness	surface hardness
Before cleaning	Level 1	Level 2	Level 6	HRC29	HRC52
After cleaning	Level 1	Level 2	Level 6	HRC30	HRC64

Figure 3. Microstructure of cast steel ZG270-50 before decomposition

Figure 4. Microstructure of cast steel ZG270-50 after decomposition

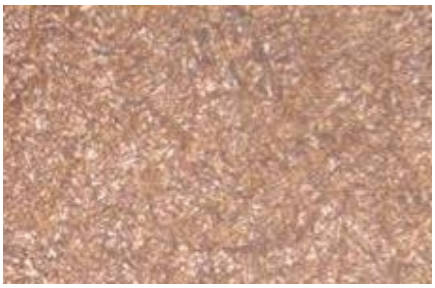

Figure 5. Microstructure of quenching steel 20CrMnTi before decomposition

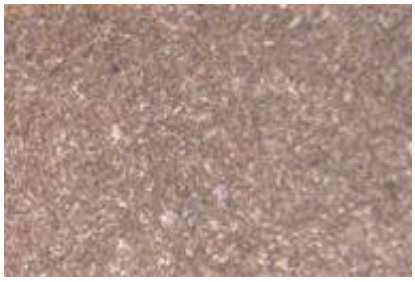

Figure 6. Microstructure of quenching steel 20CrMnTi after decomposition

CONCLUSIONS

In this paper, the impacts of high temperature decomposition and paint-removal process on the performance of the used parts for remanufacturing were studied. Based on analysis of the experimental results, it concluded that high temperature decomposition has no effect on dimensional accuracy, microstructure and hardness of casting iron and cast steel. However, the microstructure of the carburizing and quenching steel has a phase change, and the hardness decreases sharply. Therefore, it is concluded that high temperature decomposition and

paint-removal process is an effective method that removing paint from the surface of casting iron and cast steel used parts.

Considering of most used parts, such as base, member and drive housing are made of cast steel with no heat treatment, the high temperature decomposition and paint-removal process will be applied widely in these parts. For those used parts can't be cleaned by high temperature decomposition should be found other more cleaned method except for traditional manual cleaning method. The new and cleaner methods for remanufacturing clean are also needed to be explored in the future work.

ACKNOWLEDGMENT

The research was supported by Guangxi University Science Research, Project XBZ140447.

REFERENCES

[1]Wei-wei Liu, Bin Zhang, Yan-zeng Li, Yan-ming He, Hong-chao Zhang, February 2014. An environmentally friendly approach for contaminants removal using supercritical CO2 for remanufacturing industry. Applied Surface Science 292(15), 142-148.

[2] Avilon Sebastiao Dias, Hoyeol Kim, Pradeep Kumar Sivakumar, Zhichao Liu, Hong-chao Zhang, Life cycle assessment: A comparison of manufacturing and remanufacturing processes of a diesel engine. Proceedings of the 20th CIRP International Conference on Life Cycle Engineering.

[3] China's industrial cleaning development prospect and investment forecast analysis report from 2013-2017.

[4]Shitong Penga, Tao Lia, Junli Shia, Hongchao Zhang. Simplified Life Cycle Assessment and Analysis of Remanufacturing. Proceedings of the 22nd CIRP International Conference on Life Cycle Engineering. Proc. CIRP 29 (2015) :810 – 815.

[5]Zhu pailong, et al.A new approach remove the sealing plate on the nonnenting surfane of engine with high pressure water-jet. Proneedings of the first conference of mechanical engineering, Shanghai, 2000, 11

[6] XU Binshi. Theory and technology of equipment remanufacture engineering. Beijing : National Defense Industry Press, 2007.

[7]Kohli R,Mittal K L. Developments in surface contamination and cleaning. Oxford .William Andrew, 2011.