

Study status of engine crankshaft remanufacturing

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Abstract: Remanufacture is high technique repair and transformation industrialization of old and discarded parts. The engine crankshaft remanufacturing is similar with other electromechanical parts remanufacturing, including detaching, cleaning, life evaluation, property recovery, quality checking and others processes. Nowadays, reducing dimension technologies usually are used in abroad, while addition dimension technologies often are studied in China. This paper introduces techniques usually used in engine crankshaft repairing, which are useful for determining remanufacturing crankshaft technology by addition dimension technologies. Materials for spheroidal graphite crankshaft remanufacturing by thermal spraying technology are also presented. According to the character of thermal spraying technique, the development tendency of thermal spraying technique and thermal spraying materials for engine crankshaft remanufacturing are stated.

Keywords: Crankshaft, Remanufacturing, Thermal spraying, Engine

Introduction

Remanufacturing is different from manufacturing. Manufacturing is a process that raw material was treated to some products, while remanufacturing is a machining process that products reaching service life were repaired or technique transformed to new products, and the properties of the new products was not worse than the original products. The rich connotative meaning of remanufacturing engineering takes electromechanical products full-life designing and managing as policy, improving waste and scrap electromechanical products property as aim, high quality, high efficiency, energy-saving, material-saving and environment protection as criterion, advanced technologies and industrial production as means, and it is a generic terms including a series of technologies that repairing and transforming waste and scrap electromechanical products and related engineering activities^[1-2]. During the process of carrying out the scientific development concept and community sustainable development, the importance of remanufacturing for energy-saving, material-saving and environment protection is more prominent, and its status and function were continuously upgrade^[3-7].

Although remanufacturing engineering

appeared at 50 years ago in abroad, it developed very fast and it has become an important component of manufacturing and service industries as a new industry. In abroad, a lot of automobile parts could be used to remanufactured, such as engine, internal combustion engine, driving device, clutch, steering device, pump, air condition compressor, screen wiper motor, oil pump, dynamic control and shock absorber et al^[8-10]. In China, the remanufacturing industry just began in a few years ago, and there are a lot of efforts should be paid to catch up with developed countries. In late 1990s, with government confirming sustainable development as strategic object, remanufacturing engineering has been greatly attended by China government and academia^[11-12], and also recognized and supported by some many companies^[13].

Engine is one of the most important parts in automobile parts. Crankshaft bears complex periodic gas pressure, reciprocating mass force and moment, which led crankshaft bending and warping. Frictional wear during motion leads bearing location non-circularity and non-cylindricity increasing. When the deforming volume exceeds some value, bearing location will be damaged or crankshaft will break for fatigue at

some serious time. Faulty lubrication, bearing bush failure, body bending, overloading and other ways will lead bearing location scratching or burning loss. At some serious condition, not only bearing location will heavily partial wearing, crankshaft bending and deforming, but also cross direction crack will appear in crankshaft, for fast cooling rate of speed^[14]. This paper introduces thermal spraying technology which is one of the key remanufacturing technologies. The technologies usually used in repairing crankshaft and the status of spheroidal graphite crankshaft remanufacturing thermal spraying material used in China is also presented.

1 Thermal spraying technology theory

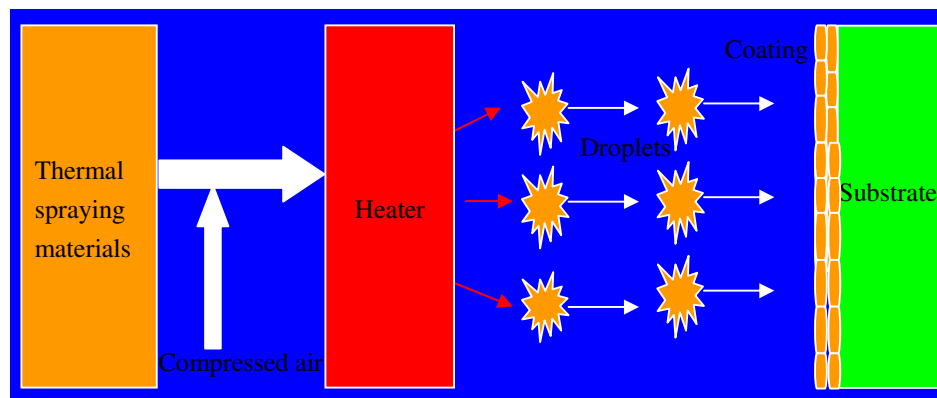


Fig.1 Schematic diagram thermal spraying technology

Nowadays, thermal spraying technologies have been applied in industrial production process, and the advantages of thermal spraying technologies have been recognized by more and more product designers. Thermal spraying coatings have been used in the processes from products designing, machining to quality controlling for some key components assembly, and the technologies have become an important new products machining technologies process in manufacturing field from traditional waste and scrap components assembly repairing.

2 Engine crankshaft remanufacturing technology

Nowadays, there are a few companies researching in crankshaft remanufacturing in China, while there are a lot of companies

engaging in crankshaft repairing. The difference between repairing and remanufacturing is that the remanufacturing suit for industrial producing and more strict demand for remanufacturing product property. Repairing technologies are the basic of remanufacturing technologies, and remanufacturing technologies are upgraded from repairing technologies. There are some technologies have been used in crankshaft repairing field, such as repairing dimension technology, building-up weld^[16], laser fusion cast^[17], brush-plating^[18], thermal spraying technology^[19-21] and other surface engineering technologies^[22-27].

Thermal spraying technology is one of the most effective surface modification technologies in surface engineering field, and it also one key remanufacturing technology. Thermal spraying technology is a method that thermal spraying materials are preheated to melting state or semi-melting state by some heat source, then the metallic droplets are ejected on the surface of pretreated substrate by high velocity, and thermal spraying coatings are formed, which endow substrate surface with special property^[15]. The thermal spraying coatings forming fundamentals is shown in Fig.1. With the development of thermal spraying technology, a lot of thermal spraying coatings have been exploited.

The repairing dimension technology is usually used in repairing worn mating accessory surface. One of the mating accessories is

machined to right shape and gains a new repairing dimension, then choosing another accessory with corresponding dimension matched with the accessory, and matching characteristic is resumed. For the crankshaft with smaller wearing dimension, grinding method can be used to repair them. In remanufacturing field, the technology is usually used to upgrading waste and scrap products.

The build-up weld is a technique that wearing coating, anti-corrosive coating and other special alloy coatings are fused on the surface of metal substrate or components assembly. When the wear extent of crankshaft bearing location is overrun and it can not be grinding repaired by the last repairing dimension, the wearing surface could be firstly repaired by vibratory build-up weld technology, then grinded to required dimension. However, pretreatment quality requirement is high for build-up weld. If the pretreatment quality is not satisfied, crack and gas porosity which lead to crankshaft discarding will appear. Laser weld technology is also used for repairing crankshaft, although the technology reduces the volume of crack and gas porosity, cost will increase.

The advantage of wearing bearing parts repairing by the laser fusion cast technology have high adhesion, non machining distortion, high surface hardness and better wearing resistant property et al. However, during the process of fusion cast, laser working time is so short and the residual stress will appear in crankshaft. In order to reduce the residual stress, special alloy powder and functionally gradient material usually are used which limit the choosing category of fusion cast material.

The brush-plating technology is often used in crankshaft repairing. The adhesion strength between claddings and substrate usually is high, and the claddings need not grinding polishing treatment. However, there are usually cracks in cladding. In addition to, the cladding has high hardness, which decreases the cladding general

application property and also do not assure the engine whole application property.

Thermal spraying technology is a surface engineering technology that widely applied in mechanical manufacturing and equipment repairing in recent years. Nowadays, the technology has widely used in lots of functional coatings manufacturing and mechanical parts repairing. Such as anti-attribution wearing coating, anti-corrosive coating, anti-high temperature oxidation coating, thermal barrier coating, catalysis coating, electromagnetism mask attenuating coating, conducting insulation coating, far infrared radiation coating et al. Industrial production line can come into being combining thermal spraying devices with robot. Engine crankshaft remanufacturing can be realized by researching new thermal spraying materials and optimizing thermal spraying technology.

3 Materials for engine crankshaft remanufacturing

As a matched parts, whether the property of coatings on the surface of remanufacturing crankshaft is higher or lower than new crankshaft, the engine whole application property will be influenced largely, which decides the property of thermal spraying coating should be strictly controlled when choosing thermal spraying materials and optimizing thermal spraying technology.

When repairing or remanufacturing spheroidal graphite crankshaft by thermal spraying technology, two processes are usually used. The one process is that stainless steel wire or carbon steel wire is directly sprayed on the surface of crankshaft, and the other process is that NiAl alloy wire or NiAl alloy powder is sprayed firstly, and then stainless steel wire or carbon steel wire is sprayed on the surface of crankshaft. After stainless steel wire or carbon steel wire is directly sprayed, the coatings adhesion strength will be influenced by stress in the coatings, which lead to coating spall during remanufacturing crankshaft working. In the traditional repairing process, if the

coating on the surface of repaired crankshaft spalls, the repaired coating will be removed and new coating will be sprayed. Coating quality stability can not be assured after repairing using traditional materials, so the materials could not used in engine crankshaft remanufacturing process.

In order to improving coatings adhesion strength, the coating is usually prepared in two steps in repairing field. The NiAl alloy wire or NiAl alloy powder is sprayed firstly forming bottom layer, then stainless steel wire or carbon steel wire is sprayed forming working coating. Exothermal reaction appears during NiAl alloy spraying process, which improves the coating adhesion, and the surface of NiAl coating is rough which improves the adhesion of working coating. The problems that coating forming by directly spraying stainless steel wire or carbon steel wire has lower adhesion strength and liable to spall are settled by the method. However, the process will decrease production efficiency and increase cost in industrial production process.

The characteristic of remanufacturing decides that the property of thermal spraying materials using in remanufacturing field is not only meet coating property demand, but also let coating preparing in one step. Many universities and institutes have researched technology and materials for engine crankshaft remanufacturing in China. At present, National Key Laboratory for Remanufacturing, Jinan Fuqiang Power Co., Ltd. and Shanghai Dazhong Allied Developing Co., Ltd. had made some progress.

4 Conclusions

The appearance of remanufacturing technology has advancing and necessity of the times. The development pace of automobile parts remanufacturing increases quickly under supporting by related state departments. Crankshaft remanufacturing is an important part in automobile parts remanufacturing. Materials and technology using in the crankshaft remanufacturing will continuously improve.

Thermal spraying technology is suit for remanufacturing for its own advantage and it will became an automated, high efficiency and portable technology. Although there are some disadvantages in thermals spraying material used nowadays, they will change into high property and multi-function materials.

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