Benefit analysis and contribution prediction of engine remanufacturing to cycle economy*

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Abstract: The first automobile engine remanufacture company in China, Jinan Fuqiang Power Co., LTD., was introduced. The engine remanufacturing technological process of this company was described. The benefit statistic of remanufacturing 10000 Styer engines were analyzed, and the contribution of engine remanufacturing to cycle economy was predicted. The results show that remanufacturing engineering could use the maximal additional values of obsolete engines, and make contributions to materials conservation, capital saving, energy conservation and environment protection. 10000 engines are supposed to be remanufactured per year, the following benefits would be obtained: reclaiming additional values of ￥3.23 hundreds millions, saving metallic materials about 7.65 thousands tons, creating profits and taxes of ￥0.29 hundreds millions, saving energy of 14.5 millions kilowatt-hours, reducing emission of CO_2 about 11.3~15.3 thousands tons, and providing employment for 500 persons. According to the survey and analysis, tremendous benefits will be gained by the year of 2020. For example, reclaiming additional values per year of 1424~2236 hundreds millions RMB, saving energy per year of 60~90 hundreds millions kilowatt-hours, reducing emission of CO_2 about 6.67~9.69 millions tons. It can be deduced that developing remanufacturing will play an important role in enriching the cycle economy and accelerating the development of national economy.

Key Words: engine remanufacturing, cycle economy, benefit analysis, contribution prediction

1 Introduction

With the automobile industry developing rapidly in the 21 century, the automobile fleet in China increased at a startling speed per year. The volume of in-use automobiles in China is more than 35 millions and the volume of end-of-life automobiles was up to 2.1 millions by the end of 2005[1, 2]. Large quantity discarded automobiles lead to resource waste and environment pollution.

One of the important approaches to solve the contradiction between the economy development and shortage of resources is to actively carry out remanufacturing engineering and greatly develop remanufacturing industry and to look upon waste engines as the second resource relative to natural resource and perform resource recover of waste engines in order to exploit raw material and energy from waste engines[3~5]. Therefore, developing remanufacturing will play an important role in enriching the cycle economy and accelerating the development of national economy.

2 Introduction the engine remanufacturing company

Jinan Fuqiang Power Co., LTD. is the first genuine automobile engine remanufacturing within China. It is a sino-British joint venture company, set up by China National Heavy Duty Truck Corporation Limited

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and Sandwell Holding Limited. The Ministry of Foreign Trade & Economic Cooperation, Ministry of Machinery Industry and Customs of China have jointly approved and acknowledged its establishment[6].

Jinan Fuqiang Power Co., Ltd, with its machines imported from Europe and the United States and its key employees undergone extensive training in UK, has set up its technical, production, supplying and marketing systems based on European style and standard. The company has also secured implementation of ISO9002 quality standard ever since its start-up and is now a professional operator of engine remanufacturing that has state of art technology up to the internationally recognized high standard. Now, Jinan Fuqiang Power Co., Ltd is remanufacturing Steyr, Santana, Cummins, Jetta, Cherokee and Ford engines, with its annual production capacity 10 thousands remanufacturing engines and sales revenue RMB 30 millions. Fig.1 gives processing workshop equipped with modern machines of Jinan Fuqiang Power Co., Ltd.

Fig.1 Processing workshop equipped with modern machines

3 Meaning and characteristics of engine remanufacturing

3.1 Meaning of engine remanufacturing

Automobile engine remanufacturing is a pioneer industrialization within remanufacturing engineering for 50 years in foreign countries[7]. For example, the total amounts of engine remanufacturing companies in America exceed 50,538, the sales value reach 365 hundred million dollars, and the total employees are 337,571. The meaning of engine remanufacturing is making comprehensive consideration of environmental and resource benefits, using waste engine and components as raw materials, adopting the advanced technique and industrialization ideas, basing on the disassembly and identification, then employing professional and mass production mode, implementing strict quality standard and market control pattern, then reach the new engine performance and standard[8~10]. Compared with manufacture new engine, about the value of 90.1% could be reused and the cost of 50~60% be saved by engine remanufacturing.

3.2 Technological process of engine remanufacturing

Fig.2 gives the remanufacturing process of engine. Firstly, old or discard engine are disassembled and classification; secondly, some basic parts cylinder body, crankshaft, connecting rod (cylinder body, crankshaft and connecting rod, etc) are washed and decomposed by physics or chemical methods at high temperature, after cleaning, the engine parts are renewed, with every parts fully cleaned and with the remained incrustation and oil completely ridded. Thirdly,

overall identification are carried out, some damage parts are replaced or repaired. Then, according the standard of new engine to remanufacturing. After assembly, overall testing and packing, the new remanufactured engines are produced. Fig.3 and Fig.4 show some reusable and replacement parts of engine.

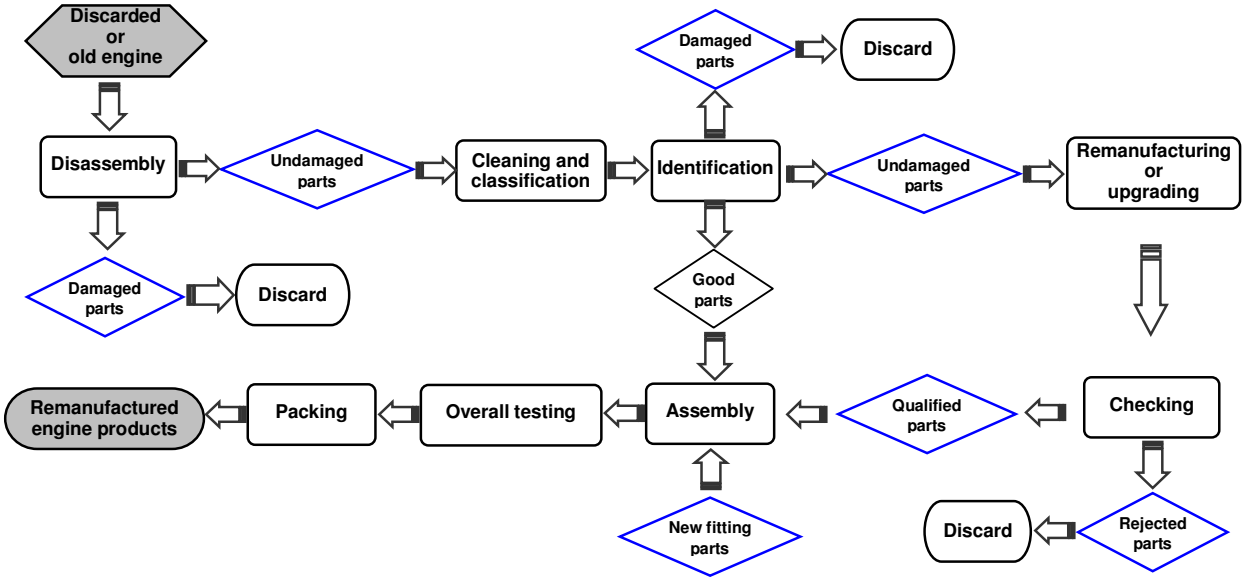

Fig.2 Technological process chart of engine remanufacturing

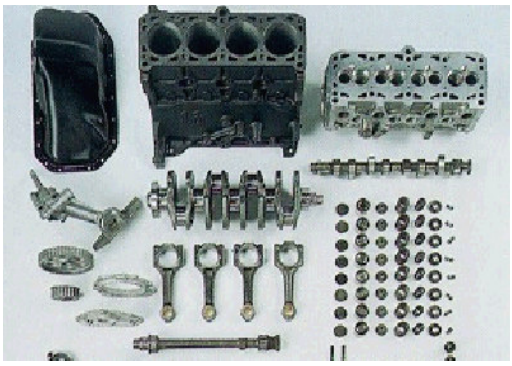

Fig.3 Some main reusable engine parts

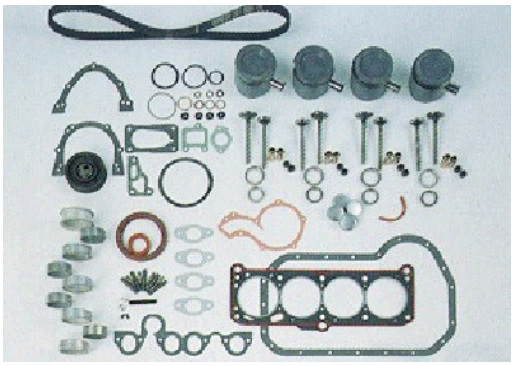

Fig.4 Some replacement engine parts

4 Benefit analysis and contribution predict of engine remanufacturing

4.1 Benefit analysis

Fig.5 gives the proportion of engine resource ratio by different treatment mode based on the statistic of 10000 Styer remanufacturing engines. It can be seen that among the engines parts, about 23.7% in quantity, 14.4% in weight and 12.3% in value could be directly reused. After remanufacturing about 62% in quantity, 80.1% in weight and 77.8%

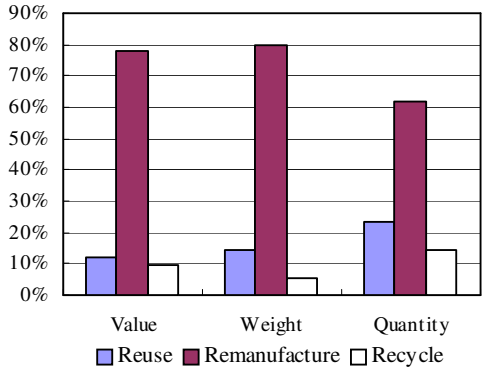

Fig.5 The proportion of engine resource ratio by different treatment mode

in value could be reused[11]. All these data indicate that remanufacturing old engines has significant economic benefits.

Table 1 shows comparison of production period between manufacture and remanufacture engine. Although the disassemble time, wash time and assemble time of remanufacturing are longer than manufacturing, the processing time of remanufacturing is remarkable shorter than manufacturing. Therefore, the total production periods of manufacturing and remanufacturing are 15 days and 7 days respectively. This indicates that remanufacturing could save much time and has higher production efficient.

Table 1 Comparison of production period between manufacture and remanufacture engine (days)

	Total production period	Disassemble time	Wash time	Processing time	Assemble time
Remanufacture	7	0.5	1	4	1.5
Manufacture	15	0	0.5	14	0.5

The compared conclusions of basic cost between manufacture and remanufacture engine were shown in Table 2. Compared with manufacturing engine, remanufacturing engine could save the total cost by 61%.

Table 2 Comparison of basic cost between manufacture and remanufacture engine (RMB/ hundred yuan)

	Equipment cost	Materials cost	Energy cost	New parts cost	Pay for tax	Pay for wage	Administration cost	Amount
Remanufacture	4	3	3	100	34	16	4	164
Manufacture	10	180	15	120	47	30	20	422

Table 3 gives the benefit analysis to cycle economy based on 10 thousands Steyr engines be remanufactured per year. It can be seen that carrying out engine remanufacturing engineering could reclaim additional values of ￥3.59 hundreds millions, create profits and taxes of ￥29 millions, save energy of 16 millions kilowatt-hours, reduce emission of CO_2 about 11.3~15.3 thousands tons, and providing employment for 500 persons[12]. All these conclusions indicate that remanufacturing engineering could use the maximal additional values of obsolete engines, and make contributions to materials conservation, capital saving, energy conservation and environment protection.

Table 3 Benefit analysis to cycle economy of remanufacturing 10 thousands Steyr engines per year

	Investment-saving /million	Additional value/million	Employment /person	Taxes/ million	Energy conservation/ kilowatt-hour	CO_2 emission reduction/ kt
Remanufacture	290	359	500	29	1.6×10^7	11.3～15.3

4.2 Contribution prediction of engine remanufacturing

According to the survey and analysis, suppose the average price of different engine is ￥10 thousands, provide employment 500 person, reduce energy wastage 1800 kilowatt-hours, reduce emission of CO_2 20 kt. Then, tremendous benefits will be gained by the year of 2020. For example, reclaiming additional values per year of 1424~2236 hundreds millions RMB, saving energy per year of 60~94 hundreds millions kilowatt-hours, reducing emission of CO_2 about 6.67~10.47 millions tons. It can be deduced that developing remanufacturing will play an important role in enriching the cycle economy and accelerating the development of national economy.

Table 4 Synthesizing benefit prediction to the remanufacturing engines

	2006~2010	2011~2015	2016~2020
Remanufacturing engine / piece	2.25×10^6～3.6×10^6	7.50×10^6～12×10^6	2.16×10^7～3.36×10^7
Sales value / million	2.25×10^4～3.6×10^4	7.5×10^4～12×10^4	2.16×10^5～3.36×10^5
Employment / person	1.13×10^5～1.8×10^5	3.75×10^5～6.0×10^5	1.08×10^6～1.68×10^6

Energy conservation / kilowatt-hour	$1.3\times10^{10}\sim2.1\times10^{10}$	$4.3\times10^{10}\sim6.9\times10^{10}$	$1.24\times10^{11}\sim1.93\times10^{11}$
Additional value / million	$3.07\times10^{4}\sim4.9\times10^{4}$	$1.02\times10^{5}\sim1.6\times10^{5}$	$2.9\times10^{6}\sim4.6\times10^{6}$
CO_2 emission reduction / kt	$1.44\times10^{3}\sim2.3\times10^{3}$	$4.79\times10^{3}\sim7.66\times10^{3}$	$1.38\times10^{3}\sim2.15\times10^{3}$

5 Conclusions

(1) Engine remanufacturing is a new and promising industry, Comparing with manufacturing and recycling, remanufacturing could reuse more value contained in the products. Remanufacturing possesses the characteristics such as high quality, high efficiency, beneficial for the environment, energy and materials conservation.

(2) Carrying out engine remanufacturing could reclaim additional values of ￥3.23 hundreds millions, save metallic materials about 7.65 thousands tons, create profits and taxes of ￥0.29 hundreds millions, save energy of 14.5 millions kilowatt-hours, reduce emission of CO_2 about 11.3~15.3 thousands tons, and provide employment for 500 persons based on 10000 engines were remanufactured per year.

(3) By the year of 2020. Engine remanufacturing industry could reclaim additional values of ￥1424~2236 hundreds millions, save energy of 60~90 hundreds millions kilowatt-hours, reduce emission of CO_2 about 6.67~9.69 millions tons per year according to above mentioned survey and analysis.

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