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RECONDITIONING AN ECCENTRIC SHAFT FROM A SEMI-HERMETIC COMPRESSOR

Alpar BELENYI, Gheorghe ACHIMAŞ

Abstract: *Refrigerating compressors play an important role in the functioning of cooling units. It can be said that the compressor is the heart of the equipment because it keeps the used freezing agent in circulation. If the compressor fails then the freezing equipment to which it is attached also malfunctions. Many types of industrial compressors are in use, the best known of these being the semi-hermetic compressor. Problems like greasing, hydraulic slugging, overheating, and contamination lead to physical wearing of the compressor, as well as to the failure and deterioration of the compressor elements.*

Key words: *semi-hermetic compressors, metallization, reconditioning, eccentric shaft, greasing problems.*

1. INTRODUCTION

Refrigerating compressors play an important role in the functioning of cooling units. It can be said that compressor is the heart of such an equipment because it keeps the used freezing agent in continuous circulation. Many types of industrial compressors are currently in use, the best known of them being the semi-hermetic compressors.

Semi-hermetic compressors are specific to the refrigerating applications, because refrigerants protect the electric coverings and allow the introduction of an engine in the flux of refrigerant circulated by the compressor. The main advantage of these compressors is that on the same axis we can find the electric engine and the crank of the compressor. The maximum power of such a semi-hermetic compressor is in the range 4 ÷ 100 kW and they are used for average functional conditions in the cooling industry.

Semi-hermetic compressors can be of two types [1]:

- Volumetric – with 2, 4 or 6 pistons;
- Rotational – with screw, spiral or centrifuge.

2. LOSS OF LUBRICATION AND GREASING PROBLEMS

The most common greasing problem of freezing compressors are the followings [2, 3]:

- Oil dilution by the refrigerant;
- Decreasing of the oil level;
- Reduction of the oil viscosity by excessive heating.

Oil dilution is one of the most common lubrication problem of the refrigeration units. While the oil is showing a greater affinity to the refrigerant, being miscible with this, in the case of a prolonged stopping it is possible of becoming diluted enough with the refrigerant as to lose its lubing properties. *Figure1* shoes an eccentric shaft from a semi-hermetic compressor which was exposed to the oil dilution by the refrigerant. The abrasion effects can be observed on the surface of the crankpin chamber, without this showing even the slightest lose of color produced by heating, the deterioration causing itself practically instantly, and the biggest part of the heat caused by scrubbing was absorbed by the vaporization of the refrigerant.

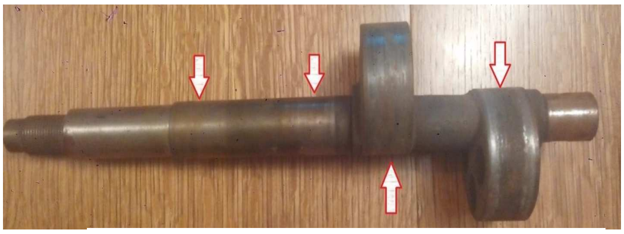

Fig. 1. Wearing effects observed at crankpins and shaft

The same specific particularity of the surface deterioration is noticeable at the aluminum connecting rod of the same compressor, as shown in *Figure 2.*

Fig. 2. Connecting rod worn due to improper lubrication

3. RECONDITIONING METHODS FOR THE ECCENTRIC SHAFT

Reconditioning methods of a freezing equipment component can be of the following types [4]:

- Replacing worn elements with sparing parts;
- Reconditioning the worn elements by different methods and procedures.

Considering that the crankpin and the shaft wearing is of 0.25 – 0.30 mm caused by the connecting rod, this paper will describe the reconditioning method. Knowing that the wearing is not on a large scale, we can use the metallization.

4. METALLIZATION

Metallization is a procedure of covering the worn surfaces, a modern and complex procedure, which in essence consists in the pulverization with high speed of a melted metal on the reconditioned surface, with the help of an air or gas jet.

Reconditioning procedures of the parts through metallization are the most efficient from the economic point of view, representing in many cases the only technological repairing solution for worn parts. Covering through metallization is carried out according to international standards and it assures a longer lifetime for the repaired components as compared to similar procedures for this purpose. This procedure can be applied for the reconditioning of parts by covering surfaces and stuffing cracks as well as a remedy for expensive parts suffering a fabrication or molding error or just for acquiring an anticorrosive layer.

Considering the state of the filler material as a classification criterion, the reconditioning procedures based on metallization can be of two types:

- With filler material in the form of a wire;
- With filler material in the form of dust.

5. RECONDITIONING TEHNOLOGY OF THE ECCENTRIC SHAFT THROUGH METALLIZATION

The procedure of reconditioning through metallization generally consists in the following operations [4, 5]:

- Visual control of the part;
- Cleaning and degreasing;
- Complex verification to detect cracks, deformations, wearing, etc.;
- Preparing the surfaces for metallization;
- Metallization itself;
- Finishing the surfaces subjected to metallization;
- Final control of the reconditioned part;
- Conservation, depositing or mounting of the reconditioned part.

5.1. Visual control, cleaning and degreasing, complex verification of the part

Visual control of the part consists in the approximate definition of the shaft wearing – as shown in *Figure 1.* The wearing effects can be easily noticed in the crankpin areas.

The visual control of the shaft is followed by degreasing (cleaning). The eccentric shaft will be degreased in a hydrate of sodium solution, which is used for the parts that will be subjected to metallization. Complex check consists in measuring the wearing, verification of possible deformations (bending, twisting) and detection of cracks. By wearing measurement, a level of 0.30 - 0,35 mm diameter reduction has been determined, without any other deformations of the shaft (*Figure 3*).

Fig. 3. Measuring the wear at the crankpin

5.2. Preparing the surface for metallization

Preparing the surface for metallization can be done using one of the following different procedures:

- Preparing through threading;
- Preparing through grinding.

The grinding has been selected as a preparation method in this study. Such a method is recommended for surfaces with wearing under the repairing dimension. In this case the worn area of the part will be machined at the repairing dimension reduced by 0.5 mm (*Figure 4*).

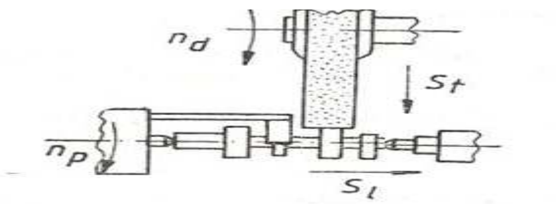

Fig. 4. Surface preparation by grinding

5.3. Metallization with electric arc

This process of pulverizing with arc realized in a correct way is known under the name of "cold process" while the surface of the lower layer can be kept at low temperature during the process, avoiding deterioration, phase transformations and geometric deformations of the lower layer. Coverings acquired by electric arc are denser and adherent than coverings acquired by combustion, lower costs of functioning, as well as higher efficiency. All these make the process very competitive in the covering of large surfaces (*Figure 5*).

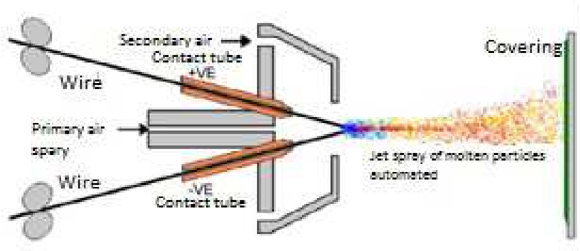

Fig.5. Process of metallization with electric arc

In this study the metallization was made using the machine ARC 140 S250-CL, under the following conditions: filler material, stainless steel wire with 0.8% C; compressed air pressure 5 at; pulverizing distance 125 mm; peripheral speed of the shaft 15 mm/min; rotation speed of the turn-bench's cart on which the device was mounted 1.5 mm/rot; intensity of the electric current 100A (*Figure 6*).

Fig.6. Arc140 S250-Cl device and metallization

5.4. Machining of surfaces subjected to metallization

After the deposition of the pulverized metal, the parts undergo a machining process; turning and grinding, so they can be brought exactly to the nominal dimension. The layer thickness is calculated using the following formula:

$$h = \frac{D-d}{2} + a \qquad (1)$$

in which h is the thickness of the deposited layer, D is the nominal diameter of the part before wearing, d is the diameter of the surface on which the metallization is carried out, a is the allowance. After replacing numerical data in the above relationship, one obtains:

$$h = \frac{69.5-69}{2} + 1.9 = 2.15 \text{ mm} \qquad (2)$$

In the afterwards machining the turning was made at the diameter of 69.70 mm and the grinding at 69.50 mm. The turning is made after 1-2 days from the metallization. For avoiding the smearing or fragmenting of the metal, well sharpened cutting tools or new tools with carbide insertions are used. The feed and the cutting depth are also set to small values. The grinding is made either after turning for bringing the part to the functional dimension, or without turning, when the pulverized steel contains a high percentage of carbon. The operation is executed with abrasive discs made from carborundum with high granulation to prevent mixing with metallic dust.

5.5. Final control

At the final control, measurements are made to see if the metallization was successful and part was brought back to the functional dimensions (*Figure 7*).

Fig.7. Eccentric shaft after metallization and finishing

6. CONCLUSIONS

This study allows to formulate the following conclusions:

- The reconditioning by metallization is an ideal procedure for retrofitting eccentric shafts from freezing compressors;
- The metallization of worn parts is the most efficient from the economical point of view and assures a much longer lifetime for the repaired parts;
- The increase of the lifetime assured by metallization will be the subject of future research.

7. REFERENCES

[1] Jakab, Z., *Kompresszoros hűtés II.*, Magyar Médiaprint Kft.

[2]***www.termo.utcluj.ro/ufa/ufapdf/ufa14.pdf

[3]***Tech Service-Training, *Why Compressors fail II*, Carrier Corporation, 1998.

[4] Zamfir, Gh., *Tehnologia recondiţionării pieselor uzate,* Editura Tehnică Bucureşti, 1968.

[5] Marcu, V., *Metalizarea prin pulverizare,* Editura Academiei Române, 1963.

RECONDIŢIONAREA UNUI ARBORE EXCENTRIC DE LA UN COMPRESOR SEMI-ERMETIC

Rezumat: Compresoarele frigorifice au un rol important în funcţionarea echipamentelor de frig. Se poate spune că compresorul este inima echipamentului, fiindcă acesta menţine în circulaţie agentul frigorific folosit. Dacă compresorul se defectează, atunci se defectează şi echipamentul frigorific la care este montat. În industrie sunt multe tipuri de compresoare în folosinţă, cel mai cunoscut dintre acestea fiind compresorul semi-ermetic. Probleme de ungere,lovituri hidraulice, supraîncălzirea sau contaminarea produc uzura fizică asupra compresorului, lucru care va conduce la defectarea şi deteriorarea elementelor componente ale compresorului.

Alpar BELENYI, Phd. Student Eng., Technical University of Cluj-Napoca, Department of Manufacturing Engineering, Muncii Blvd 103-105, Cluj-Napoca, ROMANIA, e-mail: alpar_belenyi@yahoo.com; *Satu-Mare 445500, Str. B.St. Delavrancea nr.11, Judeţ Satu-Mare, ☎0724 644333.*

Gheorghe ACHIMAŞ, Prof. Dr. Eng., Technical University of Cluj-Napoca, Department of Manufacturing Engineering, Muncii Blvd 103-105, Cluj-Napoca, ROMANIA, e-mail: gheorghe.Achimas@tcm.utcluj.ro; Cluj-Napoca 400537, Str. Clăbucet nr. 1/38, *Judeţ Cluj, ☎0720 054863.*