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FOOD INDUSTRY DEVICES' FUNCTIONING OPTIMIZATION USING THE COVER PROCEDURE FOR CERTAIN SUBASSEMBLIES PRONE TO CORROSION

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Abstract

This work has as an aim researches related to a new cover procedure of certain subassemblies from food industry devices in order to optimize their functioning. This new procedure leads to a decrease of metal loss due to corrosion, obtaining thus, beside a longer functioning period of time, anti- corrosion and anti-friction properties a nice decorative aspect of the manufactured parts.

The multi-layer structures from thermoplastic objects are obtained by heating the metallic piece at a temperature higher than the melting temperature of the polyamide and by the introduction of the piece in such an environment in which the particles of the plastic material are vortexes. The multi-layer structures from thermoplastic objects are obtained by heating the metallic piece at a temperature higher than the melting temperature of the polyamide and by the introduction of the piece in such an environment in which the particles of the plastic material are vortexes.

Key words: Optimization, food device, subassembly, multi-layer, corrosion

INTRODUCTION

Friction is a physical phenomenon which appears in those processes that put different bodies into contact with each other or that may appear inside the parts which are mechanically used in devices and thus it can appear in the food industry devices as well. The friction from the surface of the subassemblies in contact is an external friction and the one inside them is called internal friction. (Pascovici 1985, Pavelescu 1983, Balart et all 2001)

External friction represents the interaction of a body in move with another body or with the environment. Friction is a physical phenomenon which leads to energy spreading. When a solid body moves or has the tendency to move on the surface of another body the force of friction appears in the contact areas. The force of friction is the resistance opposed to the movement or to the tendency of movement of the solid body on the surface of the other body. (Chişu 1981, Hellerich 1989, Florea 1998, Manea 1970)

The measure of friction is the FR force of friction, being characterized through the quantity of energy spread on the way unit. Solid bodies can be in direct or indirect contact through a fluid film called lubricant. The mechanical work of the forces of friction transforms itself greatly and irreversibly in heat. (Nica 1978, Lupuţiu 1977, Saechtling 1983, Smith 1998, Horun at all 1988)

The forms of friction met in nature and in technics are classified after the following criteria: movement estate, type of relative movement, and the lubrication regime. (Hubca at all 1999, Iudin at all 1973, Marcu 1979, Palfalvi 1988, Seltea at all 1966, Ungur at all B,107429 C1 RO, Manea 1977, Tehnologii 2007)

a. The movement estate

Having in view the movement estate, friction is static or kinetic. The static friction exists as long as at the sub assembly there is only the tendency of movement and the kinetic friction exists when there is relative movement at the sub assembly. For the same sub assembly and in the same conditions the static friction determines greater forces than the kinetic friction.

b. The type of relative movement

The relative movement in the contact area can be one of sliding, of rolling, of swivel, combined with sliding and rolling, specific. According to the type of relative movement the following notions can be issued: sliding friction, rolling friction, swivel friction, joints and bearing friction, wire, cable and strap friction. (Hubca at all 1999, Iudin at all 1973, Marcu 1979, Palfalvi 1988, Seltea at all 1966, Ungur at all B,107429 C1 RO, Manea 1977, Tehnologii 2007)

c. The lubrication estate

The presence or the absence of a solid or fluid environment in the carrying area between the surfaces of the sub assembly determines the friction regimes related to the lubrication estate. In practice one can meet the following types of friction: the rigorously dry friction, the technically dry friction, the limit friction, the fluid friction and the mixed friction.

The rigorously dry friction is realised in vacuum, in the conditions of the absence of any contamination of the sub assembly's surface with fluid or solid environments. The rigorously dry friction is realised in laboratory conditions at devices of vacuum technics and at space technics outfits. The rigorously dry friction is a friction regime often used in nature and in technics when the surfaces of the sub assembly are not anointed. The dry friction can be realised in the presence of air or of another gaseous environment. ((Nica 1978, Lupuţiu 1977, Saechtling 1983, Smith 1998, Horun at all 1988)

The limit friction (14) is realised when on the surfaces in contact of the sub assembly there is a very slightly anchored layer or a pellicle from a substance with polar molecules (absorbed layer) or from an active chemical substance from the materials the sub assembly is made of (chemically absorbed layer). The thickness of the adherent layer on the surfaces in contact of the subassembly is of the order of $10^{-3} – 10^{-2}$ μm. According to the quality of the surfaces, for rugosities of the order's size of the layers' thickness (polished, lapped, super polished up surfaces), the contact between them is continuous. In case of greater bumps the contact is discontinuous, the forces of friction corresponding to this lubrication regime obeying to the laws of the dry friction.

In the conditions of the limit friction the forces of friction can drop 2 or 3 times in comparison with those corresponding to the dry friction.

Through the limit friction, the wear of the surfaces decreases thousands of times in comparison with that registered in the conditions of the dry friction. By the wear of the absorbed layer the wear of the real surfaces of the subassemblies are avoided. The reduction of the wear at surfaces that are in relative movement, determine the maintenance of the limit friction regime. The lubricant used and the smoothing degree of the surfaces have a decisive role in the reduction of the surface wear. The moistening degree and the unctuosity help to the formation of the absorbed layers. The increase of the unctuosity can be realised through some addition substances known as unctuosity additives. The fluid friction happens when a carrying fluid film (lubricant) interferes between the surfaces of the subassemblies and when this film is thicker than the maximum asperities of the surfaces found in a relative movement. ((Nica 1978, Lupuţiu 1977, Saechtling 1983, Smith 1998, Horun at all 1988))

The contact between the lubricant film and the surfaces is continuous in the carrying area. The forces of friction in the carrying area are determined by the tangential tensions from the fluid. The fluid friction force does not respect the laws established for the dry or for the limit friction. The limit friction appears in the situations when temporarily or spatially different friction regimes meet. The mixed forces of friction are the same as the limit friction. Aspects of the moxed friction are found in the sliding bearings, where due to the variation of the functional parameters it successively passes through the dry, limit, mixed and fluid friction regimes.

MATERIAL AND METHOD

Non-ferrous metallic materials are introduced in order to obtain composed materials with special properties in the basic mass of plastic material (pm).

Plastic-metal associations combine the friction qualities of plastic materials with a good conductivity of the metals. Covering the metals with thermoplastic macromolecular compounds is done for antifriction, anticorrosion and decorative purposes. The metallic frame can also be covered through the following procedures: immersion in a fluid layer, flame spraying, covering through veneering, covering through normal spaying and powdering, etc.

These procedures are realised with different technological devices specific to each coverage way. Many times the metallic frame is too much covered through galvanization/electroplating with a minimum layer of zinc and copper which leads to the increase of the adherence in the thermoplastic material and to a better mechanical anchorage.

The important parts in technics that are subject to the coverage procedures are usually the sliding bears and the axle-boxes.

The multi-layer structures from thermoplastic objects are obtained by heating the metallic piece at a temperature higher than the melting temperature of the polyamide and by the introduction of the piece in such an environment in which the particles of the plastic material are vortexes. The plastic material particles that move come into contact with the walls of the heated piece and melt, sticking themselves to the metallic surface. A thin and homogenous layer of plastic is formed through the fusion with other particles. The thickness of this layer is according to the nature of the metal, to the thermic properties of the piece and to the time the piece is maintained at the polyamide's melting temperature. In a relatively short period of time the plastic pellicle receives a viscous aspect which solidifies itself after the piece is removed from the storage environment. After the solidification there is a cooling in water or in oil in order to ensure the piece a decorative aspect.

For an efficient adherence, before realizing the coverage, the surface must be skimmed and cleared of any oxidized areas so that it ensures an efficient protection of the submitted polyamide layer. For a better adherence the metallic pieces can be vortexes through known procedures with copper, tin, zinc, cadmium, etc. Very good results have been obtained with the PG6 polyamide under the form of colored powders.

The disadvantages of the known procedures consist in a limited number of submission variants, all of them having a dull aspect and differing only through the color of the polyamide.

In the current work we present a new coverage structure of the metallic pieces with polyamide powders which increase the range of known submission variants and which lead to a decrease of the metal losses due to corrosion thus obtaining a pleasant decorative aspect of the metallic pieces. The structure obtained after the experiments is a multi-layer structure: metal-plastic-metal.

The metallic piece is covered with a mixture of polyamide powder and fine bronze powder. The piece is either subject to sanding or to skimming, to ridding or to drying. Then the piece to be covered is heated at 320°C 10°C. A homogenous mixture is prepared of polyamide powder and fine bronze powder which shall contain 1,5...5 % bronze powder. This mixture is powdered through screening, through a strainer situated in an oscillatory horizontal movement, on the piece about to be covered situated under the strainer; in order to recover the fallen material a tray is put underneath it. The piece is tied with pliers or with a screw or with another device on one or on more non representative surfaces, according to its configuration and it is spinned until all the representative surfaces are covered. When the powder mixture comes into contact with the heated piece, the polyamide powder melts and the bronze powder separates itself at the surface of the polyamide layer. The powdering procedure of the representative surfaces using the mixture of powders must be performed quickly according to the thermic inertia of the piece to be covered, so that the piece does not get cold during the powdering, at a temperature close to the melting temperature of the polyamide, situation in which the mixture does not submit without adherence and corresponding aspect. After all the surfaces have been powdered the piece is left to cool.

When powdering a homogenous mixture which contains 1,5...5 % fine bronze powder, in the black colored polyamide powder a submission is obtained that has a metallic aspect of the bronze color, with a good adherence to the frame piece and resistance to corrosion.

The scheme of the procedure and of the obtained structure is presented in figure 1.

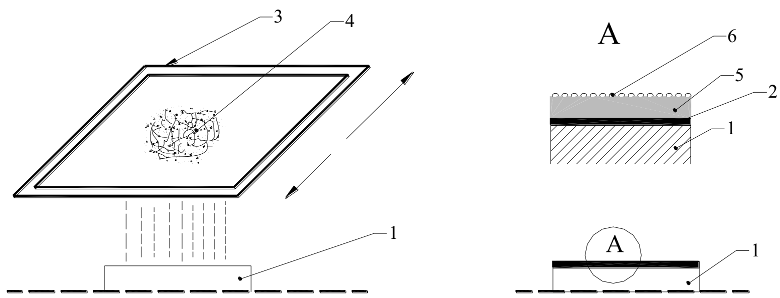

Figure 1. procedures to obtain the metal -plastic- metal frame.

1. metallic piece, 2. galvanically submitted layer, 3. strainer, 4. homogenous mixture polyamide powder with metallic powder, 5. polyamide pellicle, 6. metallic layer

The metallic piece is covered with a mixture of ployamide powder and fine aluminum powder. The procedure is as in the 1st example.

When powdering a homogenous mixture which contains 1,5...5 % fine aluminum powder, in the black colored polyamide powder a submission is obtained that has a metallic aspect of grey color, with a good adherence to the frame piece and resistance to corrosion. The quality of the submission and of the aspect is optimum for a concentration of 2,5% aluminum powder.

RESULTS AND DISSCUSIONS

The principle on the basis of which an adherent pellicle with metal-plastic-metal structure has been obtained is principle of Archimedes.

Starting from the observation that, for a short period of time, according to the temperature of the piece, the polyamide powder becomes viscous and the submitted pellicle is a stationary viscous liquid so that any inclusion submerged in the liquid is trained at the surface by the lifting power.

The training coefficient is given by the relation:

$$q' = \frac{q_m - 1}{q_i - 1}\sqrt{\frac{q_m - 1}{2(q_i - 1)}}$$

where:

g is the gravitational acceleration

v – volume of inclusion

q_i – density corresponding to the inclusion

q_m – density of the polyamide in liquid estate

As inclusions bronze and aluminum powders have been chosen and we have realized a homogenous mixture with the polyamide powder, in a percentage of 1,5 – 50% metallic powder.

The used experimental procedure was the powdering procedure, the metallic pieces with thermic inertia being heated at a temperature higher than 320°c, higher than the melting temperature of the polyamide, the mixture being powdered through screening, through a strainer found in a horizontal oscillatory movement on the pieces to be covered, pieces situated under the strainer. When the powder mixture comes into contact with the surfaces of the heated pieces the polyamide powder melts and becomes viscous and the bronze or the aluminum powder separates at the surface of the polyamide layer, where it is surprised by solidification. The diagram of thermal parameter at procedures to obtain the metal -plastic- metal frame is presented in figure 2.

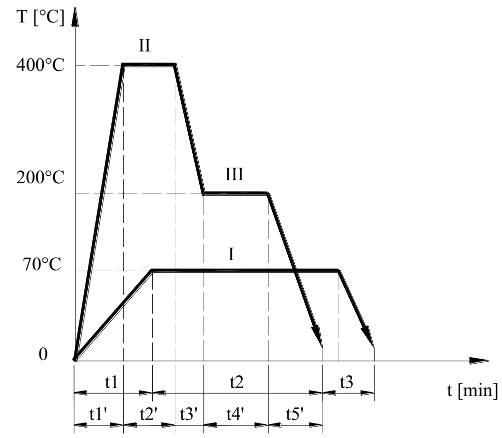

Fig. 2. The diagram of thermal parameter at procedures to obtain the metal - plastic- metal frame

The obtained structure is formed of a galvanically submitted metallic layer (with copper, cadmium, etc), a pellicle of polyamide and a metallic layer. In a homogenous mixture of black colored powder with 3,5% fine bronze powder a submission with a bronze colored metallic like aspect has been obtained, with a good adherence to the frame piece and resistance to corrosion. When a homogenous mixture which contains 2,5% fine aluminium powder has been powdered a submission with grey color metallic like aspect has been obtained.

CONCLUSIONS

The powdering procedure of the representative surfaces using the mixture of powders must be performed quickly according to the thermic inertia of the piece to be covered, so that the piece does not get cold during the powdering, at a temperature close to the melting temperature of the polyamide, situation in which the mixture does not submit without adherence and corresponding aspect. After all the surfaces have been powdered the piece is left to cool. When powdering a homogenous mixture which contains 1,5...5 % fine bronze powder, in the black colored polyamide powder a submission is obtained that has a metallic aspect of the bronze color, with a good adherence to the frame piece and resistance to corrosion. The open self-lubricant composite bearing ensures a continuous lubricant pellicle and it contributes to a carrying and to a pumping thermo - hydrodynamic effect.

The construction of the self-lubricant composite bearing is modern with an improved behavior to friction and wear.

The self-lubricant composite layer from polyamide with additives prevents the oil loss and the entrance of the air in the bearing's pores.

The described procedure is easy to be applied.

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