ECOLOGICAL POWDER COATING TECHNOLOGY BASED ON INNOVATIVE SOLUTIONS

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SUMMARY

In this article the authors present pro-ecological technology of the powder coating of cooker hoods, which is based on modern and innovative solutions.

The coating process is divided into several phases. Initially, all the surfaces of all cooker hood elements are properly prepared (cleaned), and then they are covered with the protective layer of powder (paint) by using ecological, environmentally friendly technology of electrostatic powder coating. The protective layer is then hardened and strengthened. In all these processes (phases) many other innovative and eco-friendly technological solutions are applied.

INTRODUCTION

The innovative technologies of powder coating have been implemented in the MAAN Company, which has nearly 30 years of experience in the production of cooker hoods. The secret to high quality of the MAAN Company products lies in modern machinery for (sheet-) metalwork and experienced employees [3]. Furthermore, all products are made in accordance with European and Polish standards and regulations for using safety, and meet the requirements of ergonomics and ecology.

The most important goal of any manufacturing company is providing products that meet technical standards and market requirements. To achieve this goal, Customers needs and expectations must be taken into account. It is well known, that Customer satisfaction strongly contribute to the development and strengthening of the company's position in the market. This objectives are achieved through the following activities [1, 2]:

- continual professional developing of staff (employees), permanent improving of products quality, and systematic improvement of efficiency and effectiveness of quality control system;
- defining and monitoring of goals and processes quality;
- monitoring and/or measuring of processes to guarantee the quality of the products and to assure accordance of particular production phases and processes with the constraints related to
ecological requirements and environmental protection law, as well as with the requirements resulting from work health and safety law and regulations;
• implementing of environmental technologies.

1. PRO-ECOLOGICAL POWDER COATING TECHNOLOGICAL PROCESS

The pro-ecological process of electrostatic powder coating, implemented in the MAAN Company, is performed on a modern automated production line according to the cycle shown in Figure 1.

Hoods elements, which have passed through whole pro-ecological technological process of powder coating (see Figure 1), guarantee high quality, long exploitation time, and high fastness. Qualitative acceptance of the powder coated products, which are treated with electrostatic coating technology, depends on checking the specific values and features required by Customer. The MAAN Company accept also Customer requirement of additional control of the certain number of products (specified in percent of a whole number), which consist in thickness of the powder paint layer checking (with high precision of the micron order). Details are authorized to use if they meet the all quality criteria established for our technological process.

We use the following machinery and devices used by us to powder coating of hoods elements (they all support the environmentally friendly technology):

1. Automatic cabin Super Cube made of PVC.
2. Paint recovery and recycling systems.
3. Peristaltic pump for paint transport.
4. Powder Center - paint supply central unit - for low-pressure supply of the fresh IP 5000 Manipulatory paint.
6. Programming and control system Profitech M.
7. 5-zone pressure washer.
8. After washing drier and powder paint hardening furnace.
10. Automated overhead transport systems [4].
2. TECHNOLOGIES USED IN THE POWDER COATING PROCESS AND THEIR QUALITY

To cover hoods elements with protective and decorative layer, we use modern and environmentally friendly technology of electrostatic powder coating. The hoods elements are initially appropriately prepared (in the Phase II, see Fig. 1). All surfaces of the hoods elements are appropriately cleaned, defatted, and polished. All these processes are performed using innovative and environmentally friendly technical and technological solutions.

2.1 Technology of electrostatic powder coating

The electrostatic powder coating technology consist in applying of the electrostatic field to concentrate the micro-particles of the powder on a coated surface. It extremely increases efficiency of the coating process and simultaneously, decreases the powder consumption and demand. As opposed to the electrostatic liquid painting, electrostatic powder coating technology consists of the powder recovery and recycling technological unit. It means, that part of powder, which were not spread on coated element surface (the so called overspray) is recovered and (recycled) loaded back to the supply unit of the applicator by the recycle system (i.e. cabin, cyclone and/or filter). Therefore, we actually use of about 85% up to 99% of the powder, depending on the type and efficiency of particular recycling and recovery devices. This system of powder recovery and recycling affects the significant reduction of solid contaminants. An additional advantage of electrostatic powder coating technology is full elimination of organic solvents emission - 100% reduction of VOC (Volatile Organic Content). It is in full agreement with environmental protection law and regulations, and particularly with the Regulations of the Minister of Economy, Labour and Social Policy of 20 October, 2005 OJ No 216, item. 1826, implementing EUROPEAN DIRECTIVE 2004/42/CE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 April 2004 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC of. The Directive imposes high requirements for limitation of volatile organic compounds in the articles containing solvents and lacquer. These compounds contribute to ozone depletion in the stratosphere, and to so-called summer smog formation in the troposphere.

One should mention that powder covers belong to the "high performance" ones, in other words, they are covers with outstanding protective and decorative properties, and have a very long working life-period. It makes it one from the best currently available and environmentally friendly manufacturing techniques (BAT - Best Available Technique).

2.2 Technology of hoods elements surfaces preparing

The most important part of anti-corrosion protection process (before covering with protective and decorative layer) is appropriate preparing of element surfaces (groundwork). The main purpose of this treatment is to give them features which ensure good adhesion of the varnish coatings as well as to delay the corrosion processes and this way to prolong the anti-corrosion protection period. It is well known that even the best paint material, when applied to the poorly prepared surface, exhibits a weaker protective properties and poorer adhesion to this surface which will be manifested (earlier or later but rather in a relatively short period of product exploitation) by delamination (loosening) of the coating layer from the element surface. All methods of surface preparation can be divided into two basic groups:

- mechanical;
- chemical.
In practice one have to deal with the combined - mechanical and chemical - treatments. For many years iron (amorphous) or zinc (crystalline) phosphating technology has been widely used for metallic surface preparation (steel, galvanized steel, aluminum, etc.) for further varnish (and/or powder) coating. This technology must be applied in the case of high corrosion resistance requirements. However, the significant disadvantage of this process is large amount of slimes and contaminants, which are technological wastes and must be utilized due to their environmental hazards (in some countries, manufacturers using iron phosphate process must obtain a paid license authorizing its use). In the case of high corrosion resistance requirements (e.g. in household appliances, agricultural machinery and automotive industries), a so-called three-cations (zinc-manganese-nickel) phosphating is used. This process is difficult to control and unstable. It leaves a large amount of slimes and solid contaminants containing heavy metals (Zn, Mn and Ni), which are difficult to dispose. Despite phosphating process defects (slime, heavy metals, high temperatures) it was widely used in the industry. It was due to high corrosion resistance of a so-obtained conversion layer (together with paint coating) and lack of high quality alternatives. Currently, the environmental protection aspects and safety at the workplace become essential and therefore, the activity of many professionals is focused on new techniques of surface preparation, which let to eliminate or reduce the environmental pollution: gas, liquid and solid. In this article we would like to present the process of surface preparation for further powder coating, in which the MAAN Company production line is applied. There are two different newly-developed and innovative chemical compounds used in this production line, produced by two well-known chemical Companies: Henkel and Chemetall. The Henkel's one is based on the newly developed zirconia compound - its commercial name is "Bonderite M-NT 2011". The second one, of Chemetall Company, is based on a silicon compound. Its commercial name is "Oxilan 9807" [5].

2.2.1 Technology based on the "Bonderite M-NT 2011"

The processes of cleaning and defatting with simultaneous production of zirconium conversion covers are carried out in the 5-zones (stages) washer. In these processes the newly developed "Bonderite M-NT 2011" compound is used. Using this technology allows us to eliminate the phosphating one (with iron phosphate), which is actually widely used industry standard.

The main advantages of the technology in which "Bonderite M-NT 2011" compound is used, in comparison to that with the iron phosphate, are following:

- a significant reduction of the slime amount - less environmental pollution,
- longer "time of life" of a bath (up to 2 - 3-fold),
- less water consumption during a rinse,
- possibility of steel, aluminum, and zinc products treatment,
- reduction of energy demand by about 30%,
- better surface preparation for painting.

The technology of surface preparation by using "BODERITE M-NT, 2011" compound is one of the world's best (currently) available ones (BAT) and has an innovative character. It was developed in 2011 and introduced to the market in 2012 in Switzerland. In Poland, it was implemented for the first time in 2013 at the Amica - Wronki Company.

2.2.2 Technology based on the "Oxilan 9807"

"OXILAN 9807" is one of the silicon compounds of the general chemical formula R-Si-(OX)₃. It consists of the siloxane polymer and fluoride complex of zirconium. These compounds react with the metal surface and form a thin conversion cover permanently bonded to both metal surface and lacquer covering layer. The entire process of initial treatment is carried out in
five stages. Why do we use the "OXILAN 9807" compound? - because it contains no heavy metals and phosphates, leaves no slimes and solid contaminants, need very short time of treatment (a few seconds), and does not require final rinsing (therefore the water is not consumed - what usually is a significant problem and additional cost source in a case of surface preparation for painting). Application of "OXILAN 9807" is an important step forward in comparison to the standard phosphating treatment. The salt tests of corrosive properties of the conversion covers obtained with the "OXILAN 9807" are very good and therefore, the properties of so-obtained covers can be compared with those used in the automotive industry (the highest requirements) obtained by cataphoresis.

The technology of surface preparing by using "OXILAN 9807" compound is one of the world's best (currently) available ones (BAT) and has an innovative character.

CONCLUSIONS

New pro-ecological production technology consists of a number of technical and technological elements, which make it one of best available technologies in the field of production of protective and decorative layers. Let us name only a few of these elements, namely:

- powder coating (used to form protective and decorative layers), which allows us to eliminate (in 100%) organic solvents emission into the atmosphere;
- initial surface preparation of hoods elements, which is based on innovative environmental technologies (Bonderite M-NT or OXILAN 9807); and
- applying of modern and innovative control system of the technological process of powder coating (PROFITECH M), which allows us to keep full control of its phases and, in particular, of paint recovery. For the first time in the world, the system was used in 2013.

Implementation of the new innovative technological process based on automatic powder coating line assures the MAAN Company increase of its competitiveness in the market by using the world's best manufacturing techniques.

REFERENCES

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