THE INNOVATIVE AUTOMATIC TECHNOLOGICAL LINE FOR POWDER COATING

In this article the authors present the implementation of an innovative automated powder coating process line in a company producing cooker hoods. To coat cooker hoods elements with powder paint we apply the technology of electrostatic powder coating with the preceding process of surface preparation, which is based on innovative technical and technological solutions.

The implementation of fully automatized technological line for powder coating based on innovative technological solutions of surface preparing and coating allowed the Company (among others): to improve quality of anti-corrosion protection of powder coated cooker hoods, to maximize effectiveness of powder coating process and to realize production plans, to eliminate emission of hazardous substances, to decrease production costs, which significantly increase effective competition on the market.

INTRODUCTION

In this article we present the innovative automatic technological line for powder coating of cooker hoods. Originally, the method of powder coating was introduced by the company producing cooker hoods [14] to meet the European (EU) technical standards as well as Customers requirements and needs, because it is well known, that Customers satisfaction strongly contribute to the development and strengthening of the company’s position in the market [4],[17],[18]. Moreover, the high quality of the products ensures the enhancement of the Customers confidence as well as market credentials.[20][21][22] All these elements are important stimulus for permanent increasing of professional level of the manufactory at each stage of technological process and business activity [3], [5], [10], [11]. This objectives are achieved through the following activities: [1], [2], [7]

1. Continual professional developing of staff (employees), permanent improving of products quality, and systematic improvement of efficiency and effectiveness of quality control system;
2. Defining and monitoring of goals and processes quality;
3. 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;
4. Implementing of environmental technologies.

1. THE PHASES OF THE PROCESS OF HOOD ELEMENTS POWDER COATING ON THE AUTOMATIC TECHNOLOGICAL LINE

The technological process of powder coating is performed on the new fully automatized technological line (Figure 1), according to the following production cycle (Figure 2). [7], [19]

The process of washing, cleaning, and defatting of loaded on the traverses details (PHASE I- II) (Figure 2), with the simultaneous silane conversion layers coating is carried out in the 5-zones (stages) pressure-washer; it consists of the following stages (when using the Bonderite preparation):

1. Cleaning and defatting.
2. Washing in an industrial water.
3. Washing in a demineralized water.
4. Passivation with simultaneous conversion layer coating (Bonderite M-NT 2011).
5. Washing in a demineralized water.

If the “Oxilan 9807” preparation is applied, the washing process consists of somewhat different stages:
1. Pre-cleaning and defatting of hood elements.
2. Strong cleaning and defatting.
3. Washing in an industrial water.
4. Washing in a demineralized water.
5. Passivation with simultaneous silane conversion layer coating (Oxilan 9807).

**PHASE I**
- Process of hood elements loading on traverse.

**PHASE II**
- Process of hood elements surfaces preparation - washing, cleaning, and defatting with simultaneous conversion layers covering by using the “Bonderite M-NT 2011” or “Oxilan 9807” preparations.

**PHASE III**
- Process of elements drying in a furnace (at a temperature range of 90 - 120 Celsius degree).

**PHASE IV**
- Process of powder coating of hood elements.

**PHASE V**
- Process of paint hardening in a furnace (at a temperature range of 180 - 200 Celsius degree).

**PHASE VI**
- Process of hood elements cooling.

**PHASE VII**
- Process of hood elements unloading from traverses.

**Fig. 2. The phases of the process of hood elements powder coating on the automatic technological line**

The stage of washing of hood elements in a demineralized water is very important because it allows us to remove all ionic impurities (pollution) from elements surfaces, what significantly increases anticorrosion protection of cooker hoods. After washing, elements are dried in a furnace and then automatically coated with the powder; additionally, places difficult to access are coated manually with powder sprayers. A technology of powder coating enables for a quick change of a powder color without necessity of any technological stoppage. The coated hood elements are placed in a furnace for a paint hardening. The last two stages (VI, VII) (Figure 2) are designed for cooling of the elements and unloading them from traverses. Additionally, all elements are brought under visual quality control. All elements are transported by an automatized crane tracks (traverses).

To fully control the technological process of powder coating we use following instruments and equipment:
- Conductometers for measurements of water conductivity.
- pH-meters.
- Instruments for painting layers adhesion measurements.
- Time registers and temperature detectors placed in a furnace equipped with measuring sensors.
- Fume cupboard for chemical analyses.
- Instruments for painting layers thickness measurements.

The powder coating of properly prepared hood elements surfaces ensures not only a high quality of their anti-corrosion protection but is also a decorative element. It is the main stage of the whole technological process and it determines a quality of final products, what of course, strongly influence on the competitiveness of the company.

**2. THE EQUIPMENT USED IN PARTICULAR PHASES OF THE TECHNOLOGICAL PROCESS OF POWDER COATING**

To coat cooker hoods elements with powder paint we apply the technology of electrostatic powder coating with the preceding process of surface preparation (PHASE II) (Figure 2), which is based on innovative technical and technological solutions [6], [8], [9], [13], [16]. We use the following equipment [12]:

1. Automatic cabin “SuperCube” made of PVC. (Figure 3)

**Fig. 3. Automatic cabin “SuperCube” (Uniform air flow)**

2. Paint recovery and recycling systems.
3. Peristaltic pump for paint transport.
4. “Powder Center” - paint supply central unit with low-pressure supply of the fresh paint IP 5000.
5. Manipulators.
6. Pressure spray guns - automatic and manual. (Figure 4.)

**Fig. 4. Pressure spray guns**

7. Programming and control system Profitech M.
8. 5-zone pressure washer.
9. After washing drier and powder paint hardening furnace.
10. Fire detection systems in cabins.
11. Automated overhead (crane) transport systems.

The technological processes we use in Poland are based on the “Bonderite M-NT 2011” (Henkel) and “Oxilan 9807” (Chemetal).
preparations. The technology of surface preparation for further powder coating, based on the "Bonderite M-NT 2011", was elaborated in 2011, in Swiss. For the first time, in Poland, it was implemented in 2013 by the Amica - Wronki Company. The second one (based on the "Oxilan 9807" preparation) is also innovative and pro-ecological. This technology is considered as one of the best currently available ones [7].

It should be pointed out that to successful use of the electrostatic powder coating technology one must keep specific procedures, namely:

- materials which will be coated with a powder coating must be perfectly cleaned - they must be free from any corrosion sources, rusts, scales, contaminants, storage mark-offs, and mechanical damages (burrs, sharp edges, dents, breaks, and so on);
- a way in which hood elements will be hung on the technological hooks must be stable; it should guarantee free outflow and evaporation of chemical substances through the technological holes and should prevent coated elements from no-outflow areas.

3. THE CHARACTERISTIC OF THE CONTROL SYSTEM OF THE AUTOMATIZED TECHNOLOGICAL LINE FOR POWDER COATING

The "Profitech M" is the innovative control system applied by the company in the automatized technological line for powder coating. The system may save programs containing all operating parameters of particular devices. It enables also an effective powder coating of elements with highly variable shape [9].

The control involve the following parameters:

- Pneumatic: control of amount of supplied paint powder and its damping rate.
- Electric: voltage, current limitation, current characteristics (current-voltage dependence while detail approaching).
- Operating parameters of manipulators: stroke, velocity, correlation of manipulator velocity, conveyor velocity.

Innovative control system "Profitech M" enables to increase an efficiency of the process and to decrease material and energy consumption by:

- minimization of covering layer thickness differences,
- minimization of the time of device setting,
- possibility of the optimizing of specific device settings for each type of painted elements,
- reduction of cabin maintenance time (change of colors),
- programmable ventilation control - not applied in other similar systems as yet.

The "Profitech M" control system and manipulators "VH 1" are originally implemented in 2013. In Poland they are applied for the first time.

CONCLUSION

The implementation of the pro-ecological, innovative technology of powder coating allows the company producing cooker hoods to produce the modern paint coating in a completely safe way with the high level of workflow (working arrangement), and high level of health, safety and hygiene at work. This technology ensures the significant reduction of hazardous substances and contaminants with simultaneous increasing of the quality of protective and decorative features of paint coatings applied on the hood elements and components (and in effect the high quality of the final products). The fundamental advantage of electrostatic powder coating technology is full elimination of organic solvents emission - 100% reduction of VOC (Volatile Organic Content) and significant reduction of solid contaminants due to applied powder recycling process. The diminished and/or fully eliminated emission of hazardous substances is particularly important for the health of workers, who operate on powder coating line. It enables also to implement the regulations of the 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/ECof. 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.

In summary, the implementation of fully automatized technological line for powder coating based on innovative technological solutions of surface preparing and coating allowed the company (among others):

- to improve quality of anti-corrosion protection of powder coated cooker hoods;
- to maximize effectiveness of powder coating process and to realize production plans;
- to eliminate emission of hazardous substances,
- to decrease production costs, which significantly increase effective competition on the market.

REFERENCES

14. www.maan.pl

Innowacyjna zautomatyzowana linia technologiczna malowania proszkowego

W artykule autorzy zaprezentowali wdrażenie innowacyjnej zautomatyzowanej linii technologicznej malowania proszkowego w firmie produkującej okapy nadkuchenne. Do malowania detali, z których składa się okap kuchenny zastosowano technologię elektrostatycznego malowania farbami proszkowymi z poprzedzającym procesem przygotowania powierzchni detalu w oparciu o innowacyjne rozwiązania techniczne i technologiczne.

Wdrażenie zautomatyzowanej linii do malowania farbami proszkowymi w oparciu o innowacyjne rozwiązanie technologiczne malowania i przygotowania powierzchni pozwoliło firmie na uzyskanie następujących efektów: poprawy jakości lakierunga okapów kuchennych, maksymalnej efektywności malowania i realizację planu produkcyjnego, wyeliminowania emisji do atmosfery substancji szkodliwych, obniżenia kosztów produkcji, a przez to zwiększenie konkurencyjność na rynku.

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