IMPROVING THE INDUSTRIAL PROCESS OF PAINTING AUTOMOTIVE PLASTIC COMPONENTS

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Rezumat. *Lucrarea face referire la îmbunătățirea procesului de vopsire a pieselor din material plastic (al barelor) pentru a asigura o creștere a cadenței conform cerințelor actuale ale fabricației, în condiții de calitate. Scopul acestei lucrări este de a oferi idei pentru îmbunătățirea calității produsului vopsit, astfel asigurând calitatea produsului final. Toate organizațiile mari au implementat metode de management prin care se pot afla cauzele ce produc defecte, dar și acțiunile ce pot fi luate pentru a remedia problemele și pentru a preveni reapariția lor sau a altora. Acestea dispun de tehnologii moderne și de personal calificat în toate departamentele.*

Abstract. *The paper refers to the improvement of the painting process of plastic parts (bars) in order to ensure an increase of the cadence according to the current requirements production, in quality conditions. The purpose of this paper is to provide ideas for improving the quality of the painted product, thus ensuring the quality of the final product. All large organizations have implemented management methods that can identify the causes that generate defects, but also the actions that can be taken to resolve the problems and to prevent them or other issues. These organisations have state-of-the-art technology and qualified staff in all departments.*

Keywords: quality, defects, actions, process**.**

1. Introduction

In the present paper we analyse the preparation and painting of the bumpers for manufactured vehicles. The overall objective is to improve the bar preparation and painting process to eliminate or significantly reduce the number of defects appearing on the plastic parts.

The **objectives** of this paper are:

- Identifying causes that generate defects,
- Applying corrective and preventive measures,
- Implementing ideas to improve bars preparation and painting processes,
- Ensuring the quality of the final product.

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Quality assurance means preventing non-quality from occurring by taking appropriate measures to provide the confidence that a product or service will meet quality requirements [1]. The objectives will be achieved with the help of the Management 5 Analysis Method. I use this analysis because it is the human factor involved in the preparation of painting bumpers, and because it is human, it has to be well trained and organized to yield. Analysis 5 of What Does the question repeat from What Up to 5 times, passing through symptomatic layers that lead to the root cause of the problem.

Benefits of Method 5 What [2] are the following:

- it helps identify root causes;
- it determines the relationship between the root causes of the problem;
- it is an extremely simple working tool;
- it can be used in current activity.

2. Analysis of the preparation and painting processes of plastic parts, of bars

We all want to buy a product that is of the highest quality and as cheap as possible [3]. The Dyeing Department of any automotive factory plays an essential role in the quality, durability and aspect of the vehicle, which has a primary role in protecting it from corrosion. Behind the beautiful colours of cars there is enormous work that involves many well thought-out and organized stages and processes. In the painting preparation processes of the bars are involved people who have to be dexterous, fit in time and deliver quality products. Both managers and operators must maintain and control what they produce, not to let pass or accept defective products - in the factory this means to master the quality produced at each post, not to accept defects from our suppliers or from the upstream station and not to let defects pass to the final customer or the downstream post [4].

Case study

2.1. Analysis of the bar preparation process

Covering operation

Covering of the bars for painting is the protection of certain areas on the plastic parts in the painting process to correspond to the technical diversification required by the customer, so half of the bar's surface is dyed and the other half remains plastic.

In the blurring process, operators carry out the step of preparing the manual bars using waxed paper bonded to the plastic tape with adhesive tape in order to protect the bumpers from gas or splash defects bars during the dyeing process.

The covering is done in 4 steps:

- Cutting large paper, according to the engineering design templates, on a preparation table;

- Attaching templates to a vertical panel;

- Sticking templates on the bar, depending on the bar pattern that is next protected;

- Sticking the 12 mm fineline adhesive tape, which forms the line of separation between the painted part and the part that will remain black.

Operators should ensure that the tape is well straightened on the bar in the vicinity of the painted area where the flame passes, to avoid ignition and to ensure that there are no remaining portions of tape or ripped areas in the waxed paper.

All these operations require dexterity from the operators, especially for the fineline strip that delimits the line of separation between the painted part and the part that remains unpainted.

The bars are covered both on the outside and on the inside. For covering bumpers on the inside or on less visible areas, wrinkled fine-grained paper is used and glued only with 15 mm adhesive tape.

Benefits of using paper waxed paper in the painting process:

- the high temperature resistance property passing through the flame stage of bars where the maximum temperatures are of 600°C.

- low cost.

The **risks** of using this paper are:

- low malleability, it does not perfectly copy the shape of the bumper and if a corner is left 10 mm above the bar, there is a risk of the paper being lit by the flaming robots;

- the risk of rupture when handling the bars after their covering, which results in paint being sprayed in the protected areas after switching over to robots applying dressing, base paint and lacquer.

Also, the covering operation:

- it is a good but slow process because it is entirely done manually;

- requires continuous control ensuring that the tape is positioned correctly at the edge, so the operator must perform the operation at a constant speed between the side glued on the paper bar and the part released from the roll;

- is a critical operation, on closed curves;

- the quality of the operation is related to the operator's dexterity. If the operator does not have enough dexterity, he can generate quality defects or there is a risk that he will not fit within the set time of the operation.

Defects generated as a result of an inappropriate covering operation:

- Line of separation not conforming, without continuity, due to the failure to comply with the step which says that the tape path in the separation channel must be well glued, with detached tape areas.

- Gassing, generated by the first operator that did not stick the self-adhesive tape equally, half the template and a half on the panel, then the fineline tape was not applied according to the Standard Operation Sheet, and in the base dyeing step, the robots blow with pressure and the paint penetrates into the area where the bar should remain black.

In the pictures below (see Figure 1: a, b), there are quality defects that can occur in the covering stage.

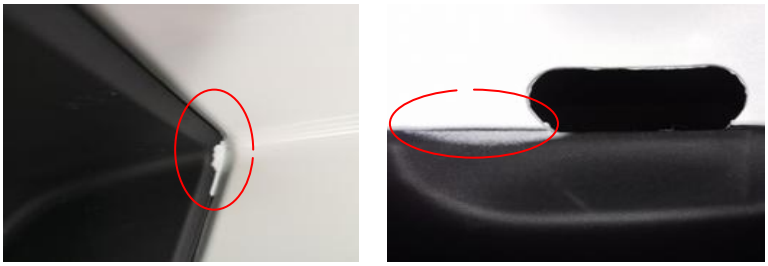

Fig. 1. Quality defects caused by inappropriate covering.

a. Separation line NOK **b.** Exterior bumper gassing

The Bumper Loading Operation

After being covered, the bar is discharged onto a buffer, then taken up by an operator who loads it on the conveyor belt. At this point in time, quality defects such as: scratches, deformations or peaks can be generated due to both the wrong handling by the operator during the loading of the bumpers as well as the ineffective cleaning of the buffer and the support brackets conveyor belt.

The operator must ensure that he grabs the bar as instructed by the Standard Operation Sheet, not touching unprotected metal parts, and the operator must not deliver bars that have deformations, burrs or lack of material.

The quality defect produced in the bumper loading is called Peak and it is the result of using a non-compliant device that came into contact with the bar.

The **actions** required are:

- Changing the standard supports;

- Introduction to the Standard Operation Sheet of the device compliance, check action before loading the bar on it.

The Blowing and Wiping Operations

From the supplier to their dyeing, the bars are exposed to a polluting environment from where they pick up impurities due to open area manipulations: loading from the supplier on the outer ramps, transport to the open dyeing station in open trailers, unloading and storage in the logistics area.

If these impurities remain during the painting process on bars they would cause serious quality problems (granules, craters, stains in paint and stains).

Therefore, after the covering and loading of the bars on the painting devices, there is a 2-stage manual chemical cleaning of the bars.

In the first stage, operators manually blow air with an air gun and wipe the bars with washcloths impregnated with isopropyl alcohol;

In the second stage, an operator at the entrance to the paint booths erases the polyester swabs impregnated with synthetic resins and mineral oil.

These operators at the wiping, degreasing and blowing stations prepare the bars for dyeing and have to deliver them without: traces of dust, traces of grease, impurities, scratches, deformations, or cuts.

Since they touch the entire surface of the bar by wiping, they can easily detect any of these possible defects and must advise the head of the Elementary Work Unit to remove the defective product.

The two blowing and wiping operations are essential before painting as the impurities (see Figure 2) and the particulate deposits (see Figure 3) accumulated during transport are eliminated.

Fig. 2. Impurities

Fig. 3. Particulate deposits

These **defects** can have several **causes:**

- the area of the bar has not been cleaned,
- transport impurities are not removed by degreasing with alcohol,
- robot arms are loaded with paint,
- the bars present hardened particles of gunpowder,
- the ceiling filters in the dressing and base cabins are leaking,
- air blowing ramps are loaded with soot.

Actions to eliminate these causes:

- Respecting the Standard Operation Sheet by operators at the blowing and wiping stations,
- Regular cleaning of robots arms from application to dressing and base,
- Regular cleaning of tubing and nozzles,
- Ceiling filters sealing.

Partial Uncovering Operation

Partial uncovering and visual control of the final product are operations performed by an operator at the last post in the manufacturing stream and involve removal of the adhesive tape after the bar has gone through the entire painting process.

This operator must ensure that he will not generate any defects, so he must not touch the painted area. The most common defect produced in this post is fingerprint on the painted surface.

Operators' responsibilities:

- have to remove the entire band - without stripes, otherwise there is a risk of peeling paint.
- visual inspection must detect possible defects, such as: paint or lacquer leakage, lack of paint or varnish, splashes and drops, granules or particulate deposits.

2.2. Analysis of the painting process of the bumpers

The whole painting process of the bars is robotic, so in the first step - the **flame** - there are 2 robots that, by flame burn all the impurities left by the manual wiping. If the flame does not occur uniformly over the entire surface of the bar, the exfoliations of the material appear which are more obvious after the application of the paint.

The second step in the dyeing process is the application of the **dressing**, which will be one by robots. The most common quality defect is the leakage caused by the non-conforming distance - too close to the robot and the bar, poor viscosity of the paint - inadequate ventilation in the dyeing cabin - increases, thus blowing the paint applied on the bar by the robots and disperses it. However, dressing leaks are hardly visible because they are covered in the following basic and lacquer steps.

The third step is the application of the **base** or the paint itself, robotized. Here are several types of defects (see Figure 4: a, b, c, d): paint leakage, lack of paint coating or rare paint, the problem of stings that appears in the next stage of lacquer application, paint splashes and hue differences.

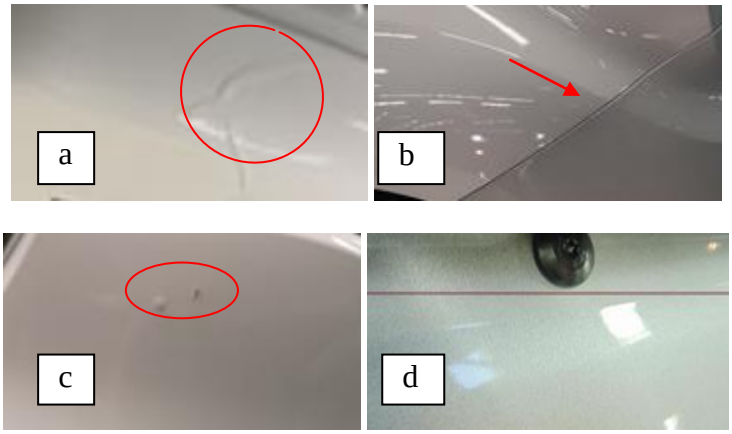

Fig. 4. Quality defects generated after painting
a. paint leakage **b**. hue differences
c. paint splashes **d**. rare paint

Lack of paint coating is a quality defect that may have several causes, such as:

- the bar was not covered with 2 layers of base paint because of a voltage drop failure. Thus the robot stopped and at restart he did not keep its trajectory;

- at the beginning of the application, the robot painted another hue remaining from the previous colour. Thus, there was not enough solvent on the appliance to wash the applicator when changing the paint hue;

- the wrong ventilation trajectory, which can blow the paint from the robot in a different direction than on the bar;

- the robot is at a great distance from the bar;

- base painting parameters are not optimal for the process.

Actions required to avoid generating this defect:

- Training the installation leader to restart the robots after a fault in the robotic installation and warning in the touchdown zone on the bars that have suffered possible defects after the power failure,

- Verification of robot elements, washing box and blowing disc, in technological breaks,

- Optimization of ventilation in dressing, paint and varnish application booths,

- Optimization of dyeing parameters (air flow).

The last step in the painting process is the application of the **lacquer**.

Generated **defects** (see Figure 5):

a) lack of lacquer coating,

b) orange peel is a defect caused by causes, such as: too rapid drying of the lacquer, abnormal temperature or the lacquer is viscous,

c) stings, is a quality defect that occurs due to a non-optimized temperature, in fact are paint bubbles generated in the base application painting stage but erupting in the lacquer application stage,

d) leakages of the lacquer occur due to:

- the spray application robots are too far away from the bar,

- the bar material is too thin,

- the lacquer is blown in other directions by the ventilation in the cabin.

Fig. 5. Quality defects generated after application

a. leakages of the lacquer **b.** stings

Actions required to eliminate these defects:

- Maintaining an optimal temperature in the lacquer application booth,

- Position robot arms at a suitable distance (30 cm),

- Ventilation optimization in the lacquer application booth.

3. Conclusions

I have analyzed the operations to be respected by each operator and the consequences of their non-compliance with the quality defects on the delivered bars.

I have also highlighted the main actions that can be implemented to avoid recurrence of these defects, both by respecting the Operations Standard Sheets and by providing the optimal environment for bar preparation and dyeing.

Following the implementation of the actions outlined in the analysis and by observing them by all the operators involved, the number of faults decreased significantly in only one month.

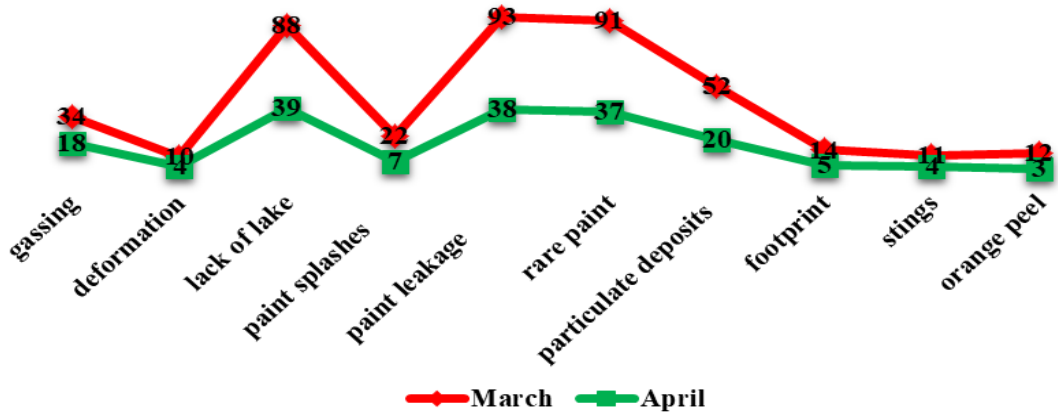

Fig. 6. Evolution of quality defects.

In graphical representation (see Figure 6) it can be observed that the evolution of the defects that occurred in April compared to March is favourable and I want to bring ideas for the improvement of the preparation and painting processes in order to eliminate all the causes that generate the defects of quality.

R E F E R E N C E S

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