

STUDY THE INFLUENCE OF COLOUR RESIN ON THE EMISSION FOR DLP 3D PRINTING PROCESS

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ABSTRACT: The present study was conducted to determine the influences of colors resin on the LCD photo polymerization 3D printing process. In the paper, we present first the printing characteristics and the resin type. In second part of the paper, we presented the printer, apparatus and measurement methodology for both aspects. In the three part of paper, we made the determinations of emission value from the start point of printing. For the analyzed cases, the regression equations specific to each analyzed made. From the study, it is possible to see that the color have an influence in direction of emission for gases. For particles, the influence is lower.
KEYWORDS: emission particles. Air pollution. Resin material. DLP printing.

1. INTRODUCTION IN EMISSION FOR DLP 3D PRINTING WITH RESIN

In industrial printing at a height level of precision, the color of the resin is level necessary. In the specialized literature exists, studies made for generated components with a thermoplastic process in which are determine the emission of gases and particle. Some of these elements issued by printing materials in the printing process affected the environment or the worker. In the literature, there are studies that it made for thermoplastic materials. Some are for PLA material in [1, 3] and/or other to ABS [2, 5] material. For different types of materials, it is made a comparative analysis in other papers [4]. Comparative study of emissions in the resin 3D printing process DLP type by color or type is not made. In this study were followed, the elements specific for temperature and humidity and the components of gaseous and particulate emissions emitted. If it is taken into account that humidity and temperature can influence both the printing process and the measurement process, it was decided to determine it in parallel with the specific elements of the resins with their coloring elements. For particles are determine the PM_{2.5} (Fine Particulate Matter) and PM₁₀ (Coarse Particulate Matter), and for air gases, it is determine the TVOC (total volatile organic compounds) and HCHO (Formaldehyde).

The element that generates gas emissions and particles respectively are to the same measure by the resin through its chemical structure specific to the polymerization process. In addition, the pigment is introduced into the resin by specific phenomena of dissolution and mixing. The chemical composition of the pigment or resin has not a specification. The mixture of resin is 30 to 60 % polyurethane acrylate, 10 to 40 % acrylate monomer, and 2 to 5% photo

initiator [6]. In Figure 1, it is possible to see the types of resin between which the comparison is made for the emissions generated in the printed process.

From the datasheet analysis of the specifications related to the resin, the gas emissions are higher than those of the particles are in the printing medium.

Although the printers are equipped with filtering systems, this does not mean a significant or total reduction, especially in the part of the emitted gases. Due to this fact, it is essential to identify the level of the gases, their type if possible, and subsequently to identify the possible conditions that may occur at long-term exposure to such emissions.



Figure 1. Resin used in the testing for made probes in the 3D printed process

2. CONSIDERATIONS ON THE PRINTER AND APARAT FOR DETERMINATED OF EMISION FOR 3D PRINTING

In the printing process are used a 3D printer by type ANYCUBIC PHOTON Figure 2. The graph shows the arrangement of the emission measurement device concerning the printer. The phase in the picture is the extraction from the printed component printed and its introduction into the liquid resin cleaning system of the printed part.

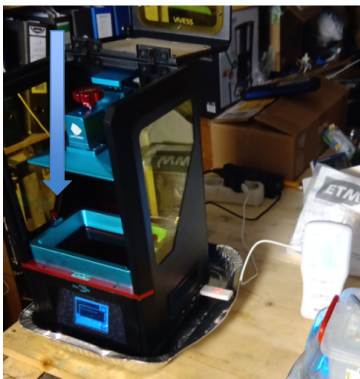


Figure 2. The printer used in the testing for made probes in the 3D printed process

The printer, although it is equipped with a ventilation and filtration system, emits unfiltered elements from/in the printing environment atmosphere. The principal motive for this experiment is to determine the emission from a different color of resin in the environment atmosphere.

The measurement of emission is made using an apparatus specialized for such determinations. It can determine some of the elements mentioned in the first part of the work Figure 3. It is possible to see that the apparatus JBL-B600 [7] ensures the determination of the intended emission elements. The position of the device is marked in the figure with a blue arrow. It must show that separate determinations for gas type emitted it is possible to make in the workspace.

One of the devices is possible to make a specific measurement at a different period in the function of the speed time in one minute. Due to this reason, the measurement results are determinate and displayed successively during the measurement time.

In the 3D DLP printing process, there are two types of phases of generating the part. First is the bottom adherent part, which is a number of layers (approx. 8) expose a long time (50 to 70 seconds) for polymerization for generated a solid structure for printing. The second is the 3D print effective, which is dependent on the height of the layer created and the characteristics of resin used. For printing, a 0.05 mm layer height is determined to be suitable for resin ANYCUBIC, and time is 8 seconds. In the printing process, it is essential the time for regenerated the resin propriety after polymerization, which is for our printer 6.5 seconds. This consideration is necessary, and it is possible to observe that for one layer generation, it is required 12.5 seconds.

The second aspect is the time of determinate the value of emission by measuring the value. For the selected for measuring apparat time are 3 second for one determination.



Figure 3. Apparatus for determinate emission in the 3D printed process

From this presentation, it is possible to see that in one period of measuring are approximate 7 period of polymerization. In one minute are there are 20 period of obtaining the data. In the first study conduct and presented in the last paper it is take in consideration the value of one reading. This method is not very accurate and for a good approximation of the emission, we made a change to determinate the medium from 1 minute of processing. In order to determine an average value and to see if, within the time interval of a period, the values were changed, determinations it is possible to make with the frequency of measurement and data processing in Table 1.

Table 1. Value for emission gas and particle in a minute of printing component

No	HCHO in [mg/m ³]	TVOC in [mg/m ³]	PM2,5 in [µg/m ³]	PM10 in [µg/m ³]	Obs.
1	0,979	5,456	2	6	
2	0,992	5,566	2	6	
3	0,979	5,456	2	6	
4	0,995	5,588	2	6	
5	0,979	5,456	2	6	
6	1,018	5,786	2	6	
7	0,979	5,456	2	6	
8	1,021	5,809	2	6	

From the determination made it can be seen that in order to be able to make a more accurate assessment, it is first necessary to process the data within the one minute time interval and at equal time intervals depending on the print time of the component. It is possible to see that the changes are significant only on the gas emissions side. The other elements are stable in the range of determining the determined average value.

3. CONSIDERATIONS ON THE PRINTER AND APARAT FOR DETERMINATED OF EMISION FOR 3D PRINTING

The volume and implicitly the mass of the reference has an influence on the printing time. Workpiece orientation may also cause changes in emissions due to angled surfaces [8-10].

The color probe are printed in the position angled at 15° from the horizontal direction. For the red sample, the transparency is medium. Temperature in the printing process is 23.5 °C and humidity 1.5 %.

For gas emissions, TVOC and HCHO for color resin are presented for comparing in Figure 4. It is possible to observe that the tendency is increasing for red resin and a small increasing for with resin. For transparent resin are two point of greater emission on the start and the final process of printing.

For particle emissions, PM2,5 and PM10 for color resin are presented for comparing in Figure 5. It is possible to observe that the tendency is the tendency is to slow down for red resin and oscillating for with and transparent resin.

From the comparative analysis, it can be observed that the emissions at the level of the gases are higher irrespective of the color compared to the emissions of the particles. Due to the gas emissions, a good ventilation of the workspace with gas filter elements is recommended.

4. CONCLUSION

The present study intended to be a beginning of research on the plan part generation with different

color in 3D printing process, which can be used for pneumatic/hydraulic system. The interest are for constructive solution for water jet cutting installation and abrasive water jet cutting installation.

It is possible to see that in rapport of the deviation of nominal dimension for part generated the colour are influence in rapport of the emission with different solution and variation.

Based on this study it is necessary to extend the researches both on the influence side of the emissions but also on the dimensional one by the color of resin. In order to increase the measurement accuracy, it is necessary to introduce a data acquisition system that allows following the way in which the measured parameters evolve. It is also important to see if the vibrating phenomenon has an influence on the generation of gas and particulate emissions.

1. ACKNOWLEDGEMENTS

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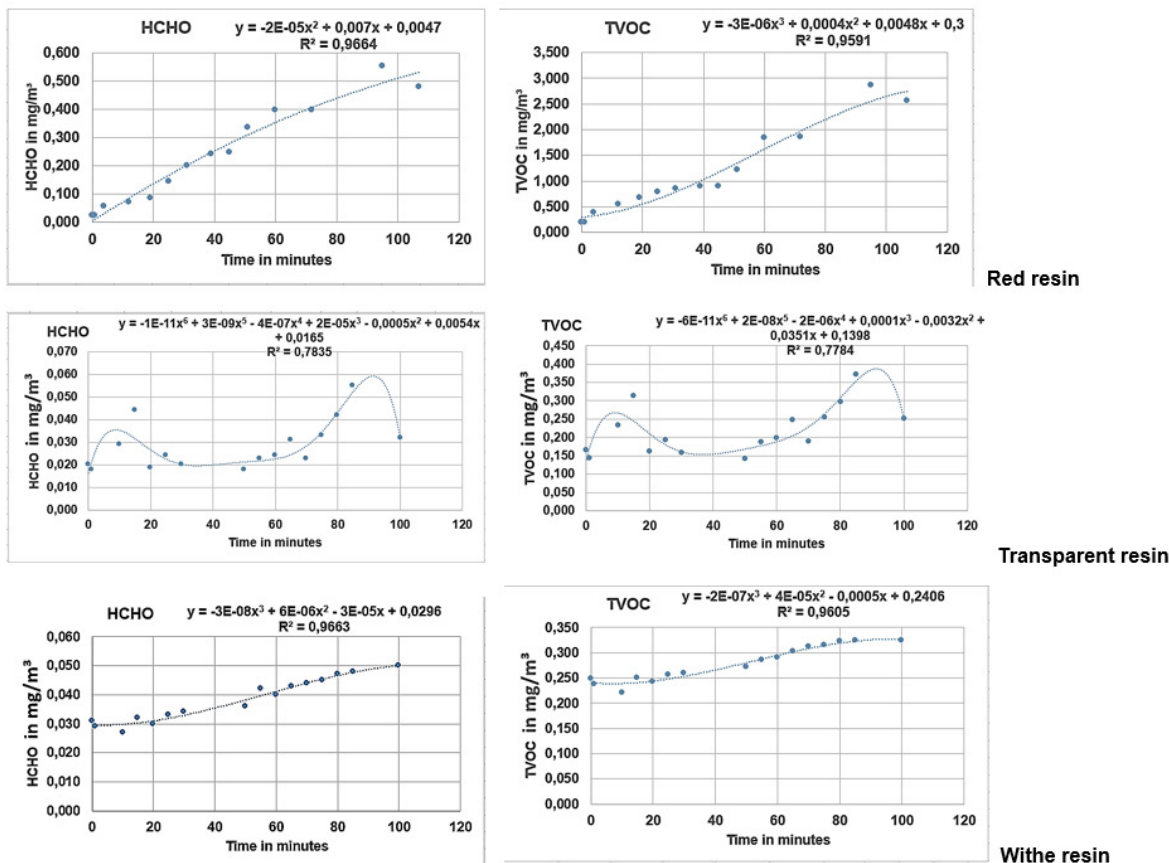


Figure 4. Comparative diagrams for HCHO and TVOC for different color resin

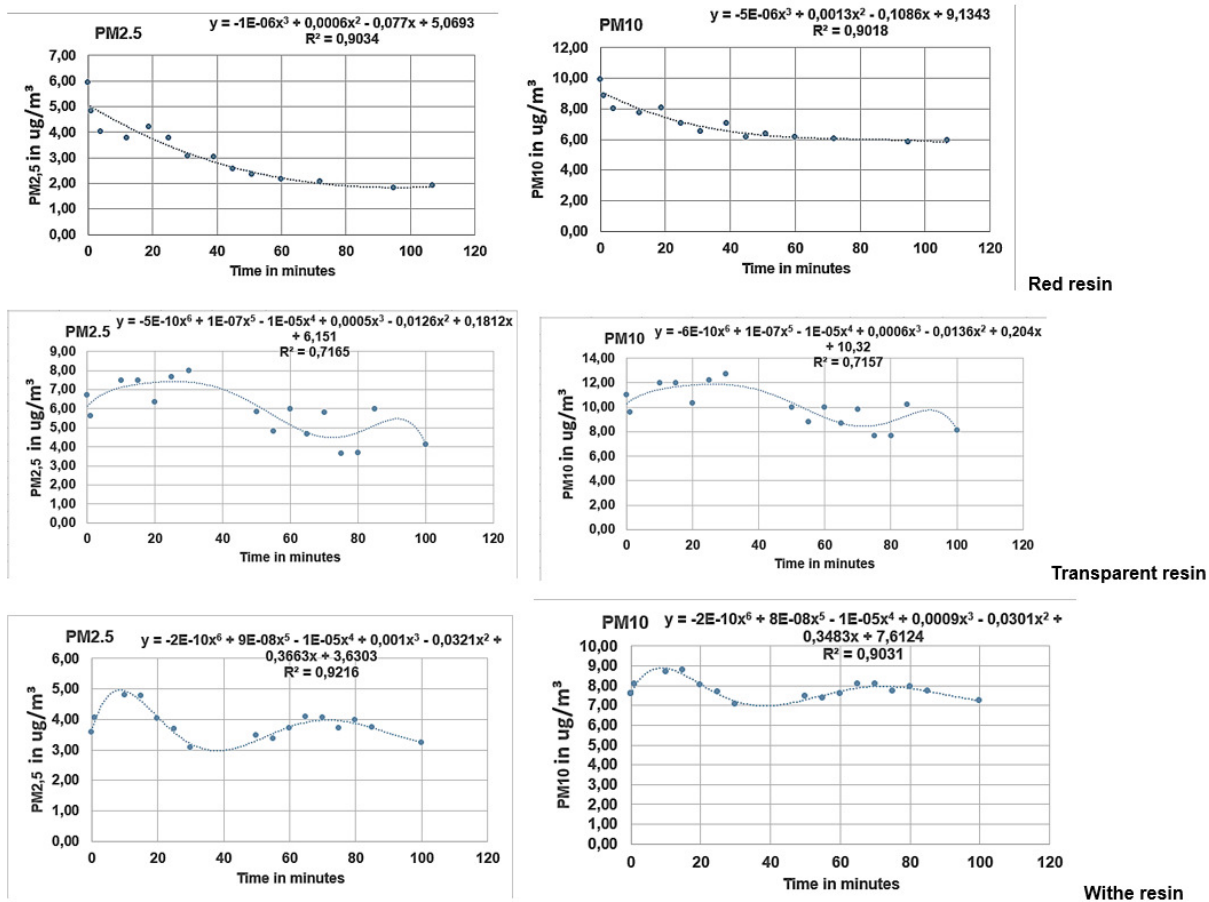


Figure 5. Comparative diagrams for PM2,5 and PM10 for different color resin

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