The use of sustainable development solutions in exploiting the waste of prepress of flexographic plates

Prof. George Nubar Semonian
Faculty of applied Arts-Printing, publishing and packaging department -Helwan University-Egypt.
george.nubar@acu.edu.eg
Assist. Prof. Dr. Tamer Abd miged
Faculty of applied Arts-Printing, publishing and packaging department -Helwan University-Egypt
tamer.flexography@gmail.com
Assist. Lect. Suzan Mohamed Farahat Hassan
Faculty of applied arts-Printing, publishing and packaging department -Helwan University-Egypt
suzanfarahat2030.SW@gmail.com

Abstract:

The principle of environmental sustainability has emerged since recent decades as a vital and necessary requirement in various fields and activities of our daily life, especially in industrial fields, and it has negative effects on surrounding environment at all levels, whether airy, watery, noise and others ... etc. and Perhaps this is most prominent challenges facing the printing and packaging industry, especially in the prepress stage, since there are large quantities of non-processed photopolymer as a residue after development of the flexographic printing plates whether prepared by the digital method (LAMS technology or prepared with negative films), and they are not then used in any recycling operations, due to their high sensitivity and hardening after exposing to light in addition to that they fall within the range of thermoset materials polymer, which occurs to photopolymerization and hardens, and then the bonds of the molecules cannot be re-bonded again in order to return them to their previous form. It is not used in any operations of recycling or enter in any manufacturing industry. Therefore, the aim of this study seeks to find alternative environmentally safe methods to exploit the Photopolymer wastes from flexographic plates prepress processes.

To achieve this, the research team followed the experimental method and descriptive analytical method in making experiments and laboratory tests to obtain practical alternatives to exploit that waste and test the possibility of using it in the production of printing molds and also ,the possibility of obtaining high thermal energy from the combustion of the non-processed photopolymer is higher than the thermal energy produced from activated coal ,paper and plastic wastes to take it in industries that require high thermal energy, such as cement, iron and steel factories and other heavy industries that require thermal fuel with a high energy taste as biofuel instead of disposing it as useless and environmentally harmful waste.

Key words:

Non- processed photopolymer - Bio fuels - UV polymerization - Environmental sustainability

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Introduction:

The emergence of the principle of environmental sustainability since recent decades as a vital and necessary requirement in various fields and activities of daily life, especially industrial fields, as these fields produce many negative effects on the environment at all levels, whether air, water, noise, etc., of industrial activities in the field of printing and packaging by reusing the waste resulting from the flexographic plate display operations, the most important of which is the non-processed deposit of the photopolymer and throwing it in the waste collection sites.

The research deals with trying to find alternatives to take advantage of waste photopolymer in safe ways that do not constitute a negative impact on the environment so that it can be used even if a limited percentage is better than disposing of them as waste.

Research problem:

There are large quantities of non-processed photopolymer as a precipitate after the operations of showing the flexographic plates, whether prepared by the digital method (LAMS) technology or prepared with passive films), and they are not reused in any recycling operations, due to their high sensitivity and hardening once exposed to light that it falls within the range of thermoset raw materials. polymer, to which photo polymerization is completed, and it is not possible to re-bond the molecules again to return them to their previous form.

Research Significance:

Introducing new visions for the safe disposal of waste from flexographic plate equipment operations, in order to achieve the principle of environmental sustainability.

Research Objective:

Searching about alternative methods to exploit the losses from the non-processed photopolymer from the operations of the flexographic plate equipment to reduce the negative impact resulting from the accumulation of these produced wastes and negatively affecting the surrounding environment.

Hypothesis:

The research assumes that:

• The possibility of converting part of the waste from the flexographic prepress stage as a biofuel suitable as a safe and environmental solution for disposal.

• The possibility of exploiting the non-processed photopolymer in the reproduction of flexographic plates with 3D printing technology, which reduces the percentage of waste and helps to reduce the rates of environmental risks.

Methodology:

This research follows the descriptive, analytical and experimental method.

The theoretical framework:

The method used in preparing digital flexographic plates:

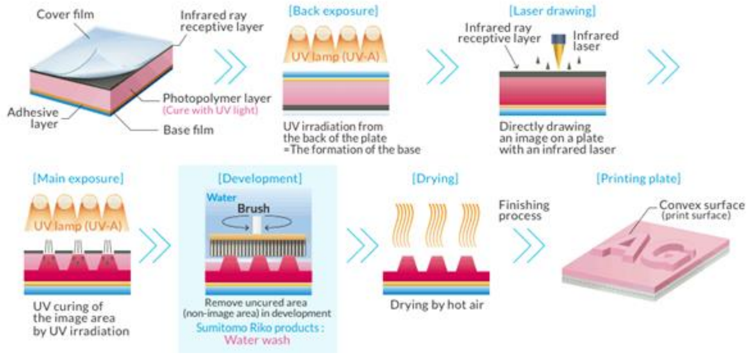


Figure (1) shows the steps for preparing LAMS flexography surfaces
https://www.sumitomoriko.co.jp/aquagreen/en/images/reason/reason_img_03.gif
5-8-2019-5pm

1. **Back Exposure**:

The photopolymer plates are exposed to ultraviolet rays from one side of the support with the aim of creating a uniform thickness of the solid photopolymer layer and increasing the adhesion strength between the support and between the photopolymer layer.

2. **Main Exposure:**

The protective layer is removed from the surface of the photopolymer sheet to be exposed in the presence of a photographic negative film or by producing the design in the form of a film negative with (LAMs) techniques, so that in the presence of UV units, the transparent areas of the negative are polymerized while the rest of the areas remain non-polymerized.

3. **Plate Processing:**

After exposure, the printed plate is placed inside the display unit in order to remove the non-processed polymer areas and keep the photopolymer that has been processed and polymerized in the presence of solutions for exposure and with the help of brushes that directly contact the surface to remove the photopolymer present in the non-printing areas.
A consideration must be given to controlling the friction force and the type of brushes used to remove non-processed photopolymer and taking into account the renewal of the display solutions and monitoring their concentrations.

4. **Plate Drying:**

Its function is to get rid of the solutions that were absorbed during the treatment process in order to return the standard thickness of the printed surface due to the swelling of the plate and the waviness of lines and grid points on the printed surface. This stage is considered an important stage for resetting the print surface thickness to its first shape during exposure to ensure the safe transfer of the image details. The two factors, time and temperature, are considered as governing variables in the success or failure of the drying process of the photopolymer sheets, if the temperature exceeds 60 ° C, it will lead to a negative reflection on the polyester backing leading to damage to the printed surface, and the safe transportation of the photopolymer sheets must be maintained after the washing process, also not to leave any greasy traces so as not to affect the details of the image.

5. **High finishing and post-exposure:**
The finishing stage consists in placing the photopolymer sheets inside a curing unite with UV-C UV in order to eliminate the stickiness of the printing plate after the curing and drying process.

6. **Post exposure:**
Photopolymer plates are exposed to a UV-A unit to complete the entire polymerization process of each photopolymer page and increase the production run.

Risks arising from damaged flexographic sheets and non-hardening residues of photopolymers after the flexography operations:
The printing presses used for non-flexographic sheets face a great challenge in how to get rid of damaged flexographic sheets, due to the nature of flexographic paper processing, as it is one of the thermoset polymers whose bonds do not dissolve after being treated with ultraviolet rays and there are no practical applications to exploit them.

Practical framework:

Measuring the ability of a non-hardening photopolymer to polymerize and measure its different hardness rates:

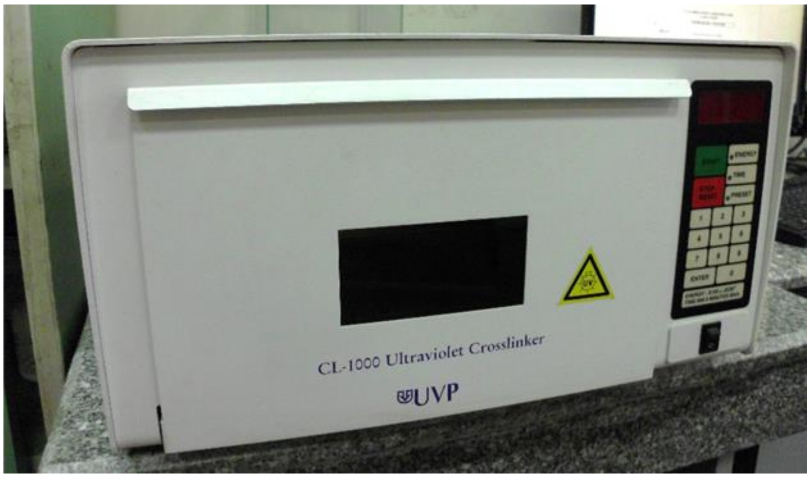


Photo No. (1) device CL-1000 Ultra violet cross linker
https://www.bruker.com/fileadmin/_processed_/csm_LUMOS_II_alone_8f9bdee6d5.jpg -2020--7--23

Experiment description:

Measuring the possibility of re-polymerization of the non-processed photopolymer after exposure and measuring the degrees of hardness in a laboratory sample using the CL-1000 ultra violet cross linker device.

Experiment objective:

Measuring the possibility of polymerization of the non-processed photopolymer using ultraviolet rays in the UV-A range or not, as the spectral range used in the CL-1000 Ultra violet cross-linker device.

It is the same spectrum range used for UV units for 3D printers of the type of direct lighting "DLP" to study the possibility of using them as flexographic plates again.

Experiment results:

• The interaction of the non-processed photopolymer in the three samples with ultraviolet radiation waves and their solidification simultaneously with the fish.

• The hardness values read from the samples did not reach the permissible range in the required hardness values for the flexographic plates.

Experiment 2: Examination of a non-stiffening photopolymer sample to find out the main

functional group of flexographic plates using FTIR device:

Experiment description:

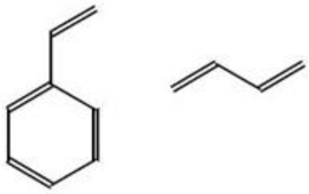
• Place a sample of a non-hardening photopolymer on the surface of a glass slide and place it inside the FTIR device.

• Adjust the coordinates of the device's imaging lens to the middle of the sample to take a photographic point.

• The test column contacts the sample inside the measurement to check the sample layers.

Pic. Number 5 FTIR Lumos II

Experiment results:



Compound Name	POLY(BUTADIENE:STYRENE), CARIFLEX 1712
Molecular Formula	(C4H6)x(C8H8)n
Molecular Weight	
CAS Registry Number	9003-55-8
Sample Preparation	ATR single bounce
Manufacturer	Kraton
Comment	copolymer BS
Reference	293/ MP0341
Copyright	(c) 2014 Nicodom
Entry No.	1419

Figure No. (3) Composition of the functional group of the used photopolymer followed by a description of the operating conditions of the FTIR Lumos II device

- By comparing the previous graph with the library of the existing functional groups of the database inside the National Center for Research and Calibration, it was found that the sample taken from the precipitated photopolymer from the expression processes is closest to the **Poly Butadiene Styrene group**.

Experiment 3: Measuring the combustion strength of a non-solidifying photopolymer as a biofuel alternative:

Photo no. (7) showing the calorimeter 6200 device
https://www.parrinst.com/wp-content/uploads/2011/06/6200-solo.jpg 10//2020--3pm

Experiment description:
Examining the possibility of reusing the waste photopolymer resulting from the processes of showing the flexographic sheets as a biofuel instead of disposing it in its solid form as unexploited waste due to the difficulty of reforming it in other manufacturing industries.

Experiment objective:
Measuring the heat strength resulting from the combustion of the photopolymer precipitate and comparing it with analogues from the wastes used as biofuels, such as: coal, plastic, and other wastes.

Experiment results:
The calorimeter 6200 showed the value of the thermal combustion resulting from the combustion of 1 gm of the photopolymer precipitate recorded a value of 9744.7 Cal / g, and this value is greater than the value of the thermal combustion of activated coal, which was recorded at 4892 Cal / g, while the value of the thermal combustion of paper waste was recorded at 5014 Cal / g against plastic waste, which recorded 9206.7 Cal / g.

Results:
The researcher reached the following results:
• The interaction of the non-processed photopolymer at the bottom of the ultraviolet irradiation units, which means that there is the possibility of re-use again from the liquid state to the form of flat sheets suitable for use as a printing plate even if it is employed in order to make Embossing Matrix.
• Analysis of the non-processed photopolymer sample under the FTIR device showed that the main functional group consisting of it is polybutadiene styrene.
• The possibility of obtaining high thermal energy from the combustion of non-hardening photopolymer is higher than the thermal energy generated from activated coal and waste paper and plastic to take advantage of it in industries that require high thermal energy, such as cement, iron and steel factories and other heavy industries that require thermal fuel with a high energy taste.

Recommendations:
Based on the findings of the researcher, she recommends the following:
• Utilization of the non-processed photopolymer resulting from the processing flexographic plates by re-using it in forming print molds while improving their physical properties, on top of which is increasing the stiffness range to obtain a greater production run.
• Research on raising the thermal power resulting from the combustion of the non-processing photopolymer to be used as an alternative thermal fuel for the petrochemical industries, which are the most expensive in heavy industries, with a study of the nature of the vapors and the resulting gases after combustion.

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