WASTEWATER CHARACTERISATION OF SCREEN PRINTING

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ABSTRACT

The paper presents a preliminary investigation of wastewater quality in screen printing facilities in Novi Sad. The experimental research includes two selected parameters: pH value and BOD. The measured pH values were in the range of maximum allowed values, but very high BOD values indicate dominant organic pollution. Determined BOD values of collected samples were in the range from 36 – 206 mg/l. These BOD values show great organic pollution of wastewater from screen printing facilities with biodegradable organic matter.

INTRODUCTION

Screen printing (SP) is one of five common printing processes. Screen printing is considered to be the most versatile of the printing processes and is applicable to a wide range of substrate materials, including textiles, plastics, papers, fabrics, wood, leather, glass, metals and ceramics. SP is also used to manufacture electronic printed circuit boards. It is used for specialty printing such as T-shirts, posters, banners, decals, and wallpapers. This type of printing process makes up a small but growing segment of the printing industry. The advantage of screen printing over other printing processes is that the press can print on substrates of any shape, thickness and size. SP is differs from other printing processes in that stencils and screens, rather than plates, are used to transfer the image. A significant characteristic of screen printing is that a micro thickness of the ink can be applied to the substrate. Because of the simplicity of the application process, a wide range of inks and dyes are available for use in screen printing. Cleaning or reclaiming screens in the screen printing process generates the specific wastewater. Screen printing facilities deal with many hazardous substances that can effect and contaminate air and water, indoor and outdoor. The major chemicals used in SP include screen emulsions, inks, and solvents, surfactants, caustics and oxidizers. As there is a lack of data on the characteristics of wastewater from this type of printing facility in Serbia, the experimental research was conducted. The preliminary experimental work includes determination of two selected parameters, i.e. pH value and BOD. Wastewater from screen printing plants was investigated in accredited Laboratory for monitoring of landfills, wastewater and air within the Faculty of Technical Sciences, University of Novi Sad. This kind of research has been conducted for the first time in the city of Novi Sad, focusing on the wastewater of the screen printing industry.

Screen Printing Process Overview

Screen printing consists of five processes: image processing, stencil and screen preparation, printing, finishing, and screen reclamation, and each of them can be identified as part of the prepress, press, or post-press steps. Primary waste streams of concern in a screen printing facility include the various hazardous compounds found in used photo processing solutions and VOC emissions resulting from the use of inks and cleaning solvents (Table 1).

Table 1. Screen Printing: Waste Streams of Concern (adapted from Washington State Department of Ecology, Environmental Management, and Pollution Prevention: A Guide for Screen Printers, 1994 [1])

Waste stream	Area of Concern	Environmental Concern
Aerosol Cans	Hazardous Waste Air Quality	"Listed" chemicals[1] VOCs
Developer	Hazardous Waste Wastewater	Hydroquinone
Fixer	Hazardous Waste Wastewater	High silver
Haze Remover	Hazardous Waste Wastewater	High pH value "Listed" chemicals[2]
Ink Remover	Hazardous Waste Air Quality	"Listed" chemicals VOCs Heavy metals[3]
Emulsion Remover	Wastewater	High pH Reactivity
Parts Washer Solvent	Hazardous Waste	"Listed" chemicals
Screen Degreaser	Hazardous Waste Air Quality	"Listed" chemicals[2] VOCs
Waste Screen Emulsion	Wastewater	Suspended Solids
Shop Towels	Hazardous Waste Air Quality	Improper disposal of inks and solvents
Waste Ink	Hazardous Waste Air Quality	"Listed" chemicals VOCs Heavy metals[3]

[1] Listed chemicals include the following chemicals: acetone, methanol, benzene, methylene chloride, carbon tetrachloride, methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), chlorobenzene, n-butyl alcohol, cyclohexanone, 2-nitropropane, 2-ethosyethanol, ethyl ether, isobutanol, etc.

[2] Formulations for haze remover and screen degreaser that do not contain listed chemicals are now readily available.

[3] Conventional, solvent-based ink systems are more likely to contain some amounts of heavy metals such as barium, cadmium, chromium, or lead.

Hazard chemicals which emerge wastewater of SP

Metals which could be classified as the emerging contaminants are found in some ink pigments and can end up in wastewater [2]. Solvents are used to clean and reclaim screens and are present in some inks [3]. Significant levels of organic solvents can been found in the wastewater samples from screen printers. Volatile solvents that vaporize readily into the air may pose health and safety hazards to employers in plants [4]. Cleaning solvent alternatives are available but may not present less environmental risk therefore they are synthesized chemicals. Effluent requirements for direct discharge are shown in Table 2.

Table 2. Effluent requirements for direct discharge according to US EPA [5]

Parameter	Maximum allowed value
pH value	6,5 - 10
BOD (mg/l)	30
COD (mg/l)	150
Cadmium (ppm)	0,1
Total Chromium (ppm)	0,5
Zinc (ppm)	2

MATERIALS and METHODS

In order to conduct the pilot pre-investigation on the wastewater from screen printing facility in Novi Sad, Vojvodina Region, 6 samples of wastewater after washing the screens, from XY screen printing plant in Novi Sad, were taken. The wastewater of SP was directly discharged in the sewage system and represents the serious source of contamination of air, water, biota and humans in biosystems.

Measuring of pH value was performed *in situ* with a portable Multi 340i WISSENSCHAFTLICH-TECHNISCHE WERKSTATTEN GMBH device.

The samples for determination of BOD were collected in sealed 1 litter sample containers, transported to the laboratory in hand refrigerator and analyzed immediately. Biological oxygen demand (BOD_5) was determined using HACH BOD TRAK device. The sample is kept in a sealed container fitted with a pressure sensor. According to manufacturer specifications, lithium hydroxide is added in the container above the sample level as a substance which absorbs carbon dioxide. Oxygen is consumed and, as ammonia oxidation is inhibited, carbon dioxide is released. The total amount of gas, and thus the pressure, decreases because carbon dioxide is absorbed. From the drop of pressure, the sensor electronics computes and displays the consumed quantity of oxygen.

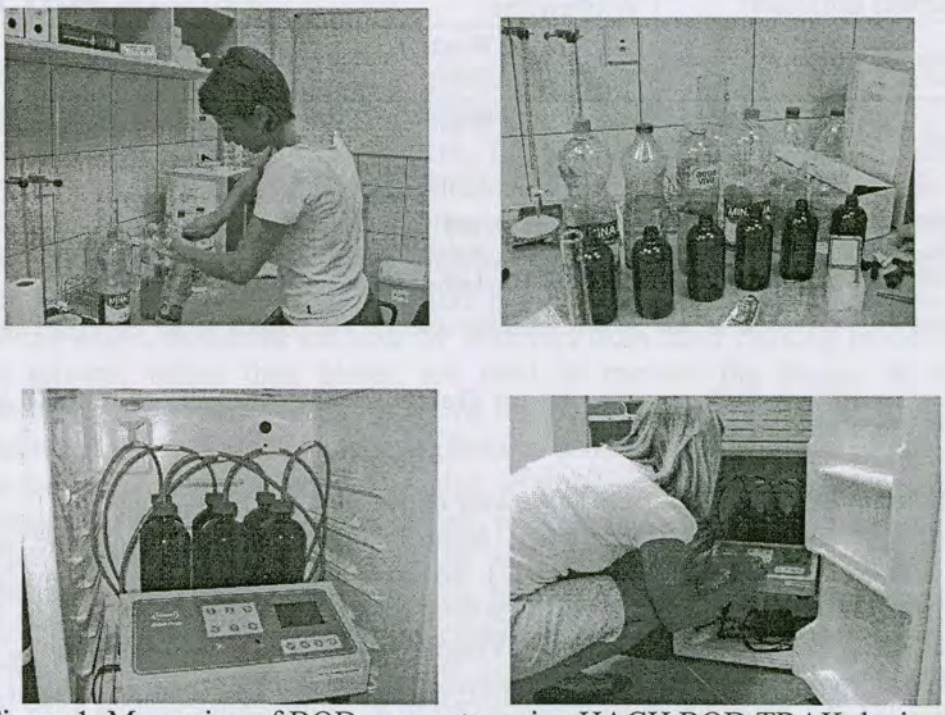

Figure 1. Measuring of BOD parameter using HACH BOD TRAK device

RESULTS

The results for pH value and BOD of 6 wastewater samples (S 1, S 2, S 3, S 4, S 5 and S 6) from SP facility, obtained in the Laboratory for monitoring of landfills, wastewater and air within the Department of Environmental Engineering and Occupational Safety and Health, Faculty of Technical Sciences, University of Novi Sad, are presented in Table 3.

Table 3. The results of wastewater samples

Parameter	S 1	S 2	S 3	S 4	S 5	S 6
pH value	7,2	7,4	6,3	6,1	6,8	6,1
BOD [mg/l]	38	36	206	58	46	102

The measurement data in Table 3 show that the pH values of each sample from screen printing facility in Novi Sad are in the range of maximum allowed values (Table 2) [6]. Regarding obtained results for BOD values it can be concluded that each sample of wastewater exceeded the maximum allowed values for effluent requirements (Table 2). Determined BOD values for collected samples were in the range from 36 – 206 mg/l. These values of BOD show great organic pollution of wastewater from screen printing facility with biodegradable organic matter. Discharging of wastewater in the sewage system may present several risks to human health and the environment.

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CONCLUSIONS

Evaluation of this experimental study indicated poor water quality of samples collected from screen printing facility in Novi Sad. On the preliminary results it could be concluded the serious contamination by organic matter and high risk to the whole environment and biosystem. The BOD values as the characteristic parameter of the biochemical and chemical status of wastewater shows dominant organic pollution from SP facility loaded by organic matter. Two values of Sample 3 (206 mg/l) and Sample 6 (102 mg/l) illuminate the high content of organic matter and imperatively require treatment before discharging into sewage system and continuous monitoring activities. The measured pH values are in the range of maximum allowed values, but very high BOD values indicate dominant organic pollution.

ACKNOWLEDGMENT

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