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INDUSTRIAL WASTEWATER

Miodrag Šmelcerović
High technology-arts vocational school, Leskovac, Republic of Serbia, msmelcerovic@yahoo.com

Abstract: Waste is any material or object that occurs during the performance of manufacturing, service or other activities. Items excluded from use, and waste materials generated in consumption and that, in terms of producers or consumers are not for further use and must be discarded. The research for this paper has two parts. The first part was to assess the amount of generated municipal waste, so that in the period of fourteen days was measured the quantity of municipal waste before selection, processing and landfilling. This includes also the test was sampling and analyzing morphological composition of waste in the city of Leskovac, in accordance with the European Waste Catalogue which is used for the classification of all wastes and for sorting waste, too. In the second part, solid waste on the basis of cellulose is used for the production of activated carbon, which is then used for the reduction of textile dyes coloration in the wastewater. Based on the results, it can be said that the activated carbon produced from waste paper has potential as an adsorbent for the removal of textile dyes from aqueous solutions after dyeing process. Prolonged contact time means a greater amount of dye on the adsorbent, i.e. the dye concentration in the solution decreases with the duration of the adsorption, and the actual amount of adsorbed dye increases with the increase of dye concentration.
Keywords:l wastewater, activated carbon, textile dye water, water purification.

1. INTRODUCTION

Waste is any material or object that occurs during the performance of manufacturing, service or other activities. Items excluded from use, and waste materials generated in consumption and that, in terms of producers or consumers are not for further use and must be discarded. Waste management involves the implementation of statutory control measures of occurrence and treatment of waste within storage, collection, transportation, treatment and disposal. It also includes the supervision of these activities and taking care of waste management facilities after paying. Methods of waste management depends, first of all, of the characteristics of the waste, which still dictates the solution minimizing, collection, transportation, recycling and disposal. In practice, waste management is carried out according to a certain order of priority. And so, the best options are the prevention of waste generation, reducing the amount and harmful characteristics of waste, re-use products for the same or a different purpose [1].

There are nowadays more than 100,000 commercially available dyes with an estimated annual production of over 70,000 tons. It is also estimated that 15–20 % of that production is lost during the dyeing process in several industries such as textiles, food, paper and plastics [2]. Solid waste based on cellulose (paper, cardboard, waste wood mass, etc.) can be used to obtain, for example, a solid adsorbent - activated carbon. Among other things, this obtained a new product may be used for adsorption - purification of waste from wastewater fight various industries.

Activated carbons are the most commonly used adsorbents in separation and purification processes. Lately, the efforts of scientists to find alternative adsorbent to replace the costly activated carbon have been intensified. Some of the potential low-cost adsorbents for the removal of metals and organic substances are industrial waste materials. The purpose of activation is to obtain effective low-cost adsorbent. Activation can be carried out by chemical and physical methods. In chemical activation, the basic material is impregnated by various chemical substances, and then carbonized. Physical activation involves carbonization of carbonaceous feedstock, followed by gas processing of the obtained carbonizate, or direct activation of the initial material by activating agents (such as CO_2, water vapor, N_2, H_2, O_2 ...) [3-5]

2. METHOD USED

There are several methods used to determine the quantity and composition of the waste. The methodology used in this paper has arisen on the basis of observation and analysis methodology and experience in EU countries, which are adapted to the conditions in the Republic of Serbia, by Department of Environmental Engineering, Faculty of Technology and Higher Vocational School for textile in Leskovac, in cooperation with company PWW, that is in charge for collection and disposal of waste in the city of Leskovac. This methodology consists of two segments. The first segment is to effectively evaluate the generated quantity of municipal (household) waste. The second step is sampling and analysis of morphological composition of waste for reference municipalities. The data obtained will help PWW company to more effectively collect and manage waste.

2.1. Measuring the amount of waste generated in the municipality within 14 days

The first step is measuring a total mass of municipal waste generated in the period of two weeks, in collaboration with the company PWW. The measurement is carried out in the following way-first, it was measured the weight of trucks before and after going to the field, and waste collection. Collected waste is disposed of in a landfill and the process is repeated until each truck completes provided collection, measurement and disposal for the day at regularly scheduled gathering in communal services in the municipality.

2.2. Determination of morphological composition of municipal waste

Morphological analysis of municipal waste was done by the sampled waste (approximately 100 kg) in the following sectors or zones: City zone - the urban zone, Suburb, Industrial Zone, Rural zones within the city. A sample from each sector must be selected at random way or by selecting the different streets from a particular sector, and within them, randomly selected bins/containers to be analyzed and to be as representative sample to represent the selected sector. After separation, representative samples are transported to the place provided for sorting and analysis. For the purposes of sorting and analyzing the morphological composition of waste are sufficient 4-6 workers, and the engineer who is responsible for overseeing the process.

3. RESULTS

In order to obtain more reliable data on the amount of municipal waste in the city of Leskovac, as part of the tests, it was decided that they measure the amount of waste generated in the proposed municipality for a period of 14 days. Determination of the total weight of waste generated in the municipality of Leskovac, table 1-3.

Table 1: Measured mass of waste collected in the municipality of Leskovac, first week

1st week	March 2017. (09.03.-15.03.)	May 2017. (18.05.-24.05.)	September 2017. (07.09.-13.09.)
Monday	120.08	117.75	147.07
Tuesday	134.26	129.60	152.40
Wednesday	112.87	122.72	148.84
Thursday	160.60	147.73	151.96
Friday	141.50	131.66	153.76
Saturday	113.20	113.60	146.68
Sunday	123.34	118.43	132.65
Total mass (in tones)	905.85	881.49	1033.36

Table 2: Measured mass of waste collected in the municipality of Leskovac, second week

2nd week	March 2017. (16.03.-22.03)	May 2017. (25.05.-31.05)	September 2017. (15.09.-23.09.)
Monday	116.87	122.72	143.44
Tuesday	149.60	147.73	151.96
Wednesday	141.90	133.26	155.76
Thursday	121.08	119.45	147.07
Friday	134.26	129.00	152.40
Saturday	116.87	112.34	143.64
Sunday	150.60	132.73	151.96
Total weight (in tones)	931.18	897.23	1046.23

Table 3: Percentage of different categories of waste per residential sector in Leskovac

Waste category	Residential sector								
	Suburb			Urban zone			Rural zones		
	17.09. 2015.	11.03. 2015.	13.05. 2015	17.09. 2015.	11.03. 2015.	13.05. 2015.	17.09 2015.	11.03. 2015.	13.05. 2015.
1. Garden waste	19.45	10.57	31.29	8.32	4.95	7.05	7.40	14.78	36.11
2. Biodegradable waste	40.84	38.89	32.08	37.73	32.54	24.68	39.00	29.26	29.64
3. Paper	5.80	11.20	6.57	5.47	19.44	16.45	3.94	9.03	5.47
4. Glass	3.64	2592	11.65	9.41	8.57	8.96	4.19	4.66	4.93

5. Cardboard	7.18	6.89	6.41	6.21	15.30	11.73	4.88	11.37	6.90
6. Tetra Pak	3.46	3.57	3.50	3.61	3.50	4.68	3.31	3.26	3.52
7. Cardboard with Al	3.31	3.73	3.38	3.41	3.69	4.12	3.97	3.32	3.34
8. Metal packaging	4.61	4.46	3.12	3.55	4.17	6.66	3.60	3.72	3.48
9. Al cans	3.25	3.40	3.70	3.39	3.20	4.50	3.12	3.04	3.97
10. Plastic packaging	6.62	5.73	4.91	6.28	6.17	6.87	8.91	4.91	5.05
11. Plastic bags	9.27	15.23	6.07	14.56	15.04	11.93	13.64	12.3	6.46
12. Hard plastic	5.69	6.98	8.04	9.57	10.12	12.19	5.73	6.73	6.52
13. Textiles	6.73	10.19	5.35	18.02	3.59	5.44	9.80	10.74	11.36
14. Leather	3.00	3.33	3.58	3.00	3.15	3.89	3.74	3.07	3.84
15. Diapers	4.61	8.00	6.69	6.67	5.04	9.55	15.49	6.80	4.15
16. Fine elements	20.54	9.91	11.63	8.80	8.53	12.31	17.28	22.01	12.27

On the basis of city population, which waste generation determining this, it's easy to calculate how much waste generates one resident daily and annually-average amount. Also, it is possible to get information and how much waste is produced in the territory of a municipality for a period of one year. However, it should be noted that they can not be taken as definitive indication of the amount of waste produced, because there are substantial and permanent seasonal variations in waste generation. This only confirms the fact that the measurements generated amount of waste is very important for the entire waste management system and that it should be done consistently throughout the year.

The activated carbon obtained from waste paper is relatively fine bulk material with heterogeneous porous particles of diverse shapes and forms. Within larger particles, there are conspicuous cracks, cavities and channels that form the basis of the microporosity of materials. Otherwise, the inherent high porosity of activated carbons is provided by the presence of particles of irregular shape, a high degree of amorphization and a number of gaps in the structure.

EDS system allows rapid assessment of the elemental composition of the sample. Sample analysis is non-destructive and quantitative analysis can be obtained by a spatial resolution of the order of magnitude of 1 μm. Table 4 shows the quantitative composition of active carbon, i.e., the percentage of one element in relation to the sum of all detected elements. All elements (e.g., C, O, Na, Al, Si, S, and Ca) detected in this analysis constitute 100 % and the individual percentages of each element means that 100 g of all detected elements contain that exact quantity in grams of each element.

Table 4: Quantitative composition of the adsorbent used according to EDS spectrum analysis

Spectrum	C	O	Na	Al	Si	S	Ca	Total
Weight %	61.95	29.82	4.70	0.03	0.06	3.44	0.00	100.00
Std. deviation	2.35	4.83	1.36	0.04	0.14	2.79	0.00	-
Max.	65.19	33.66	6.64	0.07	0.31	8.02	0.00	-
Min.	59.86	23.69	2.79	0.00	0.00	1.55	0.00	-

The effect of contact time on the removal of azo dyes by the adsorbent is shown in Figure 1. The dye was quickly adsorbed in the first twenty minutes, and then the adsorption rate decreased gradually and reached equilibrium in about 60 minutes. At the beginning, the adsorption rate was high because the dye ions were adsorbed by the outer surface of activated carbon. When the adsorption of the exterior surface reached saturation, dye ions were adsorbed by the interior surface of particles. This phenomenon has a relatively long contact time. It is believed that adsorption of matter on activated carbon also depends on the pore structure and chemical properties of the carbon surface as the adsorbate. From the point of view of the free energy of adsorption, the compounds are first adsorbed in the pores of

similar size as the adsorbate due to the larger number of points of contact between the molecule and the adsorbent.

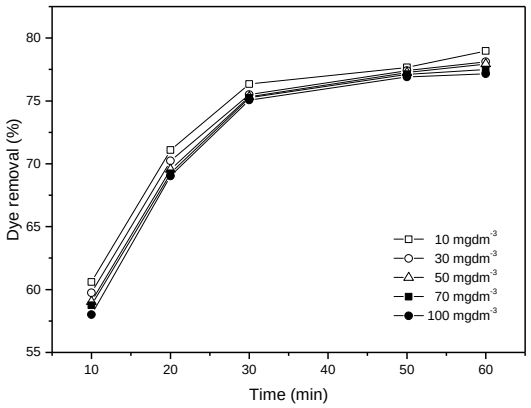


Figure 1: The effect of adsorption time on the amount of removal azo dyes

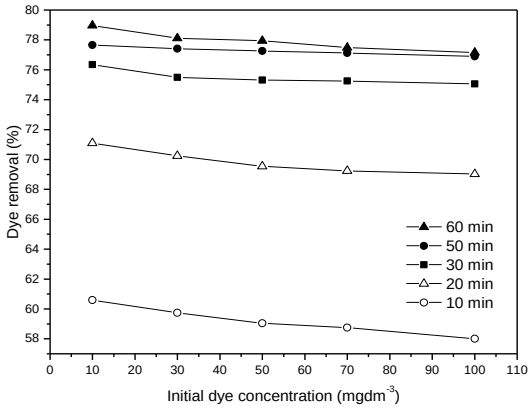


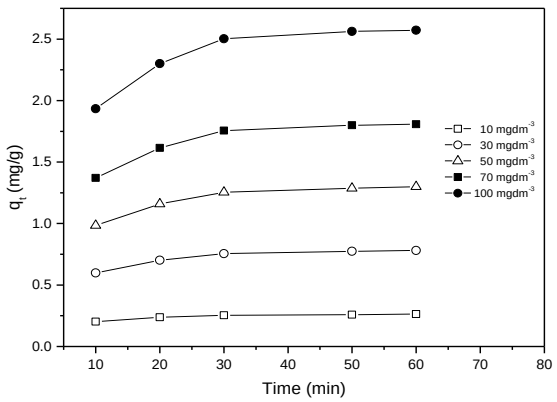
Figure 2: The effect of the initial dye concentrations in the solution on the amount of azo dye removed

Figure 2 shows the dependence of the degree of dye removal on the initial dye concentrations for different times of adsorption. At lower dye concentrations, a slightly higher degree of dye removal is achieved. In reality, however, larger quantities of dye are adsorbed on activated carbon at largest initial concentration of azo dyes as will be explained further.

The results of the changed adsorbed amount of adsorbates on the adsorbent during time, for different starting dye concentrations, are showed on diagrams on the figure 3. The continuity of changes in the period of time is present, i.e. longer time brings larger amount of adsorbed dye per adsorbent mass, i.e. there is the highest adsorption at the highest applied dye concentrations.

The continuous increase of the amount of exhausted dyes compared to the mass of adsorbent is also evident. At a given initial dye concentration, a major change of the adsorbed dye occurs in the first 10 minutes of dyeing process, while in the later stage of adsorption these changes are minor.

Figure 3: Adsorbed amount of dye during time



4. CONCLUSION

Information on the composition and quantity of municipal waste in the city of Leskovac based on current results, can never be precise data. The methodology for assessing and determining the amount of generated morphological composition of municipal waste is essential in order to create a standard methodology that will provide a reliable gauge for determining the amount and composition of municipal waste at national level.

The results are the first concrete step in city of Leskovac i.e. the Republic of Serbia in this segment of waste management. The data and results of measurement of volume and composition were obtained directly from the field and represent the first reliable information about the nature of municipal waste. The data represent the basic information necessary to adopt a waste management plan that municipalities are obliged to make pursuant to the provisions of the Law on Waste Management. Thus, part of the waste collected is employed to obtain a useful product, activated carbon, which was used for the purification wastewater resulting from the industry to textiles.

Removal of azo dyes using activated carbon was investigated under various conditions. It was found that the adsorption depends on contact time and the initial dye concentration. Based on the experimental results the following conclusions can be drawn:

- Activated carbon derived from waste papers can be an effective adsorbent for the removal of azo dyes from aqueous solutions with a logical tendency of application in industrial environments.
- Prolonged contact time means a greater amount of dye on the activated carbon, i.e. the dye concentration in the solution decreases with the duration of the adsorption.
- The percentage of the removed dye decreases with increasing the initial dye concentration in the solution, but the actual amount of the adsorbed dye increases with the increase of dye concentration.

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