Development of an eco- friendly mobile plant for car wash wastewater recovery

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Abstract

The global increase in the number of vehicles has a negative impact on the sustainable development due to the increased energy consumption, noise, and air pollution, as well as the increased water consumption used for car wash. The car wash is one of the main after-sale services in the automobile sector. If car wash wastewater (CWW) could be reused, fresh water customarily used in car washing could be preserved. To achieve this goal, it is necessary to implement "on-site" wastewater treatment systems (*i.e.* at car wash stations). In this research, a novel pilot plant is developed for „on site" treatment of CWW. This pilot plant presents combined methods. It consists of three innovative modules: a multipurpose reactor (for coagulation/flotation, aeration/oxidation), deep bed filter (for filtration), and a two-stage bed coalescer (for coalescence filtration). In all these units packing materials are very light (expanded polystyrene (EPS) and polyurethane (PU)) and therefore energy consumption is significantly low. The pilot plant has a simple and light construction, so that it can be easily moved. It has shown very high COD reduction efficiency as well as removal efficiencies of suspended solids, and oil/grease, thus exhibiting high potentials for water recovery at car wash stations.

Keywords: Car wash station, on-site wastewater treatment, new modular technology, reclaimed water, environmental protection.

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1. INTRODUCTION

In the year 2020, around 1.5 billion cars were estimated in the world [1]. The permanent increase in the number of vehicles globally threatens sustainable development because of the increase in energy consumption, increased noise, increased air pollution, as well as the increase of water consumption used for car wash.

The crucial after-sales service in the automobile sector is the car wash [2]. Many different technologies are applied for vehicle washing in the car wash industry. The water consumption per vehicle depends on the type and size of the vehicle (*i.e.* bike, car, bus, or truck), on the applied washing technology as well as on the type of chemicals used [3-7] and it can vary from 60 up to 1300 l per car [3-9].

Car wash technologies could be divided into two main groups: non-automatic car wash like hand wash and self-service wash, and automatic car wash like tunnel wash (conveyor wash), roll-over wash and touch-free wash [3,7]. In tunnel wash, the car is pulled through the washing installation (consisting of brushes, nozzles, *etc.*) while in the roll-over wash the washing installations move over the car. In touch-free technology, the car is parked in a bay and washed by special nozzles delivering high-quality soft water at an optimal temperature and at high water pressures of 480 to 690 kPa [3,7].

Car wash industry consumes huge amounts of water, consequently leading to generation of huge amounts of wastewater. As water consumption depends on the type of car wash installation and the car size, consequently it was reported that from a car wash an average of 150 to 600 l wastewater is produced [10]. Composition of car wash wastewater (CWW) varies dramatically depending on the vehicle soiling level, size and type, as well as on the washing technology that is applied. Impurities in the car wash wastewater (CWW) mainly originate from traffic, car operation and service, as well as from washing chemicals [7]. Generally, it is thought that car washing wastewater is not highly contaminated compared

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with other industrial wastewater [10]. Yet, this is a large misconception because CWW contains high concentrations of surfactants (different detergents), oils, waxes, greases, suspended solids (like sand and dust), *etc.* [7,8,11].

If CWW is discharged into a recipient without any treatment, it could cause eutrophication in water ecosystems and toxicity to aquatic environment [11,12]. CWW is often discharged into sewage systems without any treatment [13]. Yet, emulsified oil and suspended solids could be dangerous for sewer systems due to possible clogging [7,13]. Therefore, it is very important to treat CWW at the place where it is generated *i.e.* at the car wash station. However, only a small number of these stations have a wastewater treatment system on-site [10,11,14].

From an environmental protection viewpoint and effective utilization of water resources, it is very beneficial to implement more on-site wastewater treatment systems providing possibilities for water recovery (reuse). If CWW after treatment could be reused, utilization of fresh water could be drastically decreased [8,11,14-17]. CWW reclamation requires the separation of suspended solids and oils/greases before it can be reused [5,15]. The required quality of reclaimed water depends on the wash stage at which it will be used (i.e. pre-soak, wash, rocker panel/undercarriage, first rinse and final rinse) [8,11,14]. So, lower water quality is needed for pre-soak, wash, rocker, panel/undercarriage steps, while for the first and final rinses water quality should be very high. At most car wash stations that have systems for CWW recovery, reclaimed water is not used for the final rinse, as it would require very expensive CWW treatment technology that is usually not cost-effective [8,11,14].

There are many methods used for CWW treatment, but not all of them are suitable for “on-site” installation at car wash stations, because of different cost-effectiveness.

The methods used for CWW treatment are coagulation, adsorption, membrane filtration electro-chemical processes, biological treatment, combined methods or hybrid methods [7,18,19]. Coagulation is the most utilized method for treatment of CWW, as it is applied in more than 70 % of water treatment plants. Coagulation is highly effective in removing total suspended solids (TSS) and turbidity from CWW, but it is not so effective in the reduction of chemical oxygen demand (COD), *i.e.* organic compounds [7,18-20]. Adsorption is also a very often applied method in wastewater treatment but not for CWW treatment, because of the complex CWW composition [7,19- 21]. Membrane filtrations that could be applied for CWW such as microfiltration (MF), ultrafiltration (UF), nanofiltration (NF) and reverse osmosis (RS) are highly effective methods for removing solids and organic matter [7,10,12,22-24]. However, a huge disadvantage in the application of these methods for CWW treatment is frequent membrane fouling, high price, and very high-energy consumption [7,8,11,14,19,21-24].

Still, use of only one individual method may not effectively remove all pollutants from CWW. This approach is especially not feasible in full-scale systems and combined/hybrid methods are more effective and even more economically viable [7,21,25].

As previously said, the number of cars is drastically increasing every year, leading to an increase in number of car wash stations located in high population of the residential and urban areas [10]. Only in the EU, around 250 million cars are registered in the year 2020 [1,26]. The car wash stations consume a high amount of fresh water, generating at the same time huge quantities of wastewater. Therefore, it is important to reduce the amount of fresh water used for car washing. The need for implementation of wastewater systems at car wash station (“on site”) is rising every day. In several European countries, like Scandinavian countries, Germany, Austria, Netherlands and Belgium water recycling in car wash stations is already legislated [22,24,26,27]. For example, in Belgium minimum of 70 % of CWW has to be recycled, while in Germany and Austria, this percent is even higher, and it is 80 %. On the other hand, in Scandinavian countries and the Netherlands, the maximal allowed consumption of fresh water per car is 60 to 70 litter [22,26,27].

The aim of this research was to develop a low-cost, compact, highly efficient, eco-friendly, and mobile plant for CWW treatment that could be installed “on site” for water recovery. This pilot plant for CWW treatment was developed and investigated “on site” at a car wash station of one car workshop in Serbia.

2. MATERIALS AND METHODS

2. 1. Raw wastewater

Raw car wash wastewater was obtained from a car wash station of a car workshop in Serbia. Each vehicle that has to be serviced at the car workshop is washed before it enters the car workshop. This car wash station includes the following activities that affect wastewater quality: anticorrosion protection, engine wash, and complete car wash. These activities produce highly polluted wastewater that contains high organic loads, oils and suspended solids. Characteristics of the raw car wash wastewater monitored during an 8-month period are presented in Table1.

Table 1. *Characteristics of raw car wash wastewater (CWW) used, 60 samples*

	COD, mg dm^{-3}	Content of total solids, mg dm^{-3}	Loss of ignition, mg dm^{-3}	Content of suspended solids, mg dm^{-3}	Content of oil, mg dm^{-3}	pH
Mean	703	1321	786	384	54	7.78
Minimum	222	900	296	104	10	7.60
Maximum	3333	2671	1800	1520	518	7.90

The car wash technology applied in this car wash station was tunnel wash, where the car is pulled through the washing installation containing brushes, nozzles, *etc.*

2. 2. Pilot plant

This pilot plant consists of three innovative modules in which combined methods for CWW treatment are applied. In the first module coagulation/flotation, aeration and mixing are simultaneously performed, followed by the second module applying deep bed filtration and third module performing coalescence. The pilot plant was working discontinuously, and the separation efficiency was evaluated by 8 tests carried out for 8 months. In this way all seasons were covered, which certainly had a significant impact on wastewater quality. Each test lasted until the pressure drop reached a determined value, afterwards the deep bed filter needed to be washed. Thus, the test duration was from 17 to 60 h depending on the influent CWW quality. The novel modular pilot plant has a capacity of 1.0 m^3 h^{-1}.

The pilot plant treated 331 m^3 of car wash wastewater during 331 h, in total.

There were four sampling points at the pilot plant: at the plant inlet and outlet, as well as in-between all three units. In this way, it was possible to monitor not just separation efficiency of the pilot plant, but also the separation efficiency of all three modules. The samples of 1 dm^3 were taken, every working hour of the Pilot plant and from these current samples, a daily composite sample was formed, which was further analyzed.

Efficiency of wastewater purification (E) was calculated based on pollutant concentration in the influent, C_i, and the effluent water C_e, using equation:

$$E = \frac{C_i - C_e}{C_i} \quad (1)$$

2. 3. Selection of coagulants and flocculants

Coagulants and flocculants and their optimum dosages were determined by jar tests. These tests were performed for all wastewater samples that were treated by the pilot plant to determine the optimal clarification conditions. Aluminum sulphate and ferric chloride were tested as coagulants, in the concentration range of 60.0 to 400.0 mg dm^{-3}, while polyacrylamide and sodium aluminate were tested as flocculants, in the concentration range of 0.5 to 2.5 mg dm^{-3}.

2. 4. Analytical methods

2. 4. 1. Determination of oil concentration

The oil concentration in influent and effluent was determent by Fourier transform spectrometry, FTIR (spectrophotometer Thermo Nicolet 5700, Netherlands). Wastewater samples were stabilized and adjusted to pH 2 by adding HCl. The oil was extracted from the water samples by CCl_4.

2. 4. 2. Determination of chemical oxygen demand and other characteristics of wastewater

Chemical oxygen demand (COD) was determined by the colorimetric method using the Hach DR/3000 spectrophotometer (Hach Company, USA). $K_2Cr_2O_7$ was used as an oxidizing agent. H_2SO_4, Ag_2SO_4 and $K_2Cr_2O_7$ were added to the water sample. The sample is then heated for 2 h at a temperature of 148 °C. After cooling the sample, the COD value is determined. Total solids, loss of ignition, and suspended matter were determined gravimetrically.

2. 5. Properties of packing materials

The packing materials used in this Pilot plant were three different types of expanded polystyrene (EPS) particles as well as PU fibers. The EPS particles were kindly supplied by INA-OKI Zagreb (Croatia), while PU fibers were obtained as a waste material from the furniture, generated as the excess parts from tailoring chairs and beds from a local store. The EPS particle size and density depend on the initial particle size as well as on the duration of the thermal expanding process [28]. Density of the materials was measured by the weighing method. The bed porosity was calculated based on the material density and bed bulk density. The bed permeability was calculated by performing the Darcy's experiment as explained in detail in our previous research [29].

Properties of the bed materials and the resulting packed beds in different pilot plant modules are summarized in Table 2.

Table 2. The properties of bed materials and unit packed beds

Property	Unit / Module			
	Multireactor	Deep bed filter	Bed coalescer	
	Bed materials			
	EPS			PU
Mean diameter, mm	6.5	1.8	2.2	-
Effective diameter, mm	6.5	1.6	2.0	-
Uniformity	1.0	1.6	1.4	-
Bulk density, kg m^{-3}	30	94	16	50
Density, kg m^{-3}	52.8	173	25	1200
Bed porosity, %	43.0	50.0	36.0	95.8
Permeability, 10^{-9} m^2	-	5.86	6.79	5.40

3. RESULTS AND DISCUSSION

The novel pilot plant, shown in Figure 1., presents combined methods for „on-site" treatment of car wash wastewater (CWW). This pilot plant consists of three innovative modules:

1. the multipurpose reactor (MR),
2. deep bed filter (DBF), and
3. two-stage bed coalescer (TBC),

and one tank (TA).

The multipurpose reactor and deep bed filter are open vessel, but the coalescer is under pressure. Therefore, it was necessary to place a tank between the deep bed filter and the coalescer. The capacity of this novel modular pilot plant is 1.0 m^3 h^{-1}.

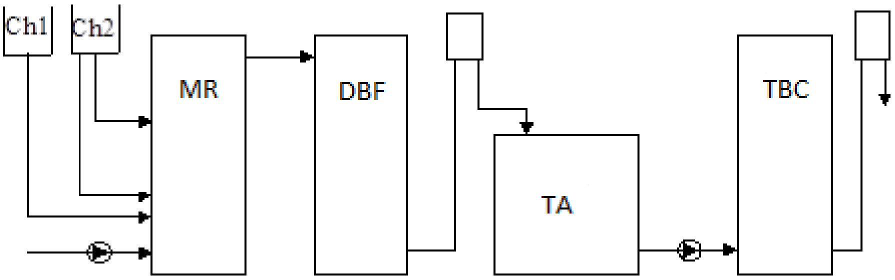

Figure 1. Pilot plant: multireactor (MR), two dosage vessels (Ch1 and Ch2), deep bed filter (DBF), tank (TA), and a two-stage bed coalescer (TBC)

The multipurpose reactor is first unit in the pilot plant. This reactor is a bubble column, 3 m in height, consisting of three pipes 1 m in length, each. Two beds (0.30 m in length, each) formed of expanded polystyrene (EPS) granules, are placed at the connecting spots of the pipes (Fig. 2). Diameter of EPS granules is 6.5 mm in this module and the bulk density of the beds is 30 kg m^{-3} with porosity of 43 % (Table 2). The interspace between the beds is 0.7 m. The application of large EPS granules in these beds is minimizing the possibility of clogging/blocking the EPS bed with suspended solids and newly formed flocs.

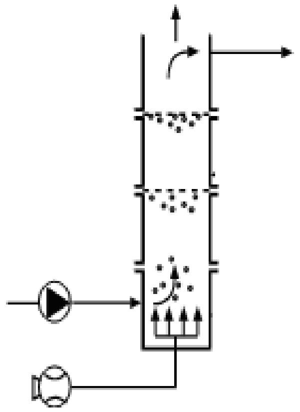

Figure 2. Multipurpose reactor with two EPS beds

Since EPS is lighter than water, the beds are fixed from the top with the aid of two perforated plates acting also as water distributors. The co-current gas-liquid flow is applied. Air diffusers at the bottom, distribute the compressed air in small bubbles thus providing very good mixing. Addition of coagulants and flocculants is possible simultaneously at the same spot of the column, or with a small time difference at different spots of the column.

This special construction of the bubble column allows the simultaneous occurrence of several processes, like aeration/oxidation, mixing, coagulation and flotation. Therefore, this unit is named multireactor.

Obtained results for chemical oxygen demand (COD) measurements for CWW before and after the multireactor (MR) for tests 1 lasting 54.5 h and test 3 lasting 29.5 h are presented in Figure 3. The maximal COD values at the MR inlet and outlet in test 1 were 2763 and 322 mg dm^{-3}, respectively, while the average COD reduction efficiency achieved was 68.4 %. Similarly, in test 3., the maximal COD values at the MR inlet and outlet were 2189 and 138 mg dm^{-3}, respectively, while the average COD reduction efficiency was 65.3 %.

The MR was working at the car wash station for 331 h in total without any operative problems. Due to the very light bed material in this MR formed of EPS granules, this device is very light and therefore mobile. The MR construction is simple providing very intensive mixing and effective aeration/oxidation. For that reason, it is a very good choice for treatment of water with high concentrations of organic compounds, such as CWW.

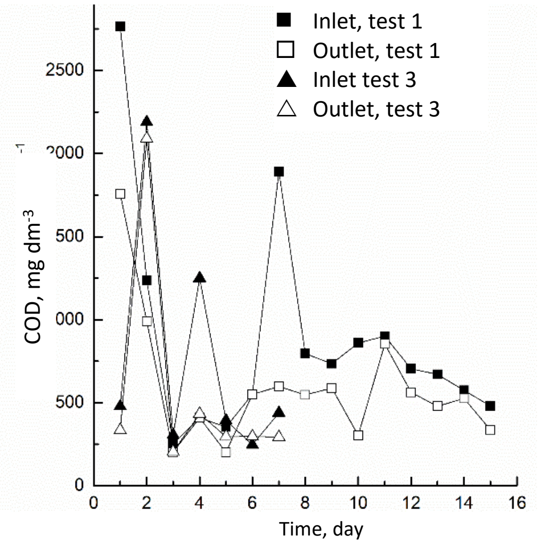

Figure 3. COD at the inlet and outlet of the multireactor in tests 1 and 3

The second unit in the pilot plant is a deep bed filter. In this deep bed filter the filter bed is formed from EPS granules, not from sand which is traditionally used bed material in deep bed filters. Although mostly used, sand as filter media in deep bed filtration has some significant disadvantages. First of all, sand is a high-density material, requiring heavy equipment with a concrete foundation [28]. It is very important to point out that EPS is ten-fold lighter than sand. Therefore, the EPS deep bed filter is very light and consequently it could be mobile. Secondly, the filter cycle for a sand filter bed, especially when wastewater is highly polluted, is very short because of stratification phenomena [28]. The relative density of the bed material (heavier or lighter than water) influences the direction of bed washing (upstream or downstream). For heavy filter media, such as sand, the filter bed has to be washed upstream (backwashed), causing the stratification phenomena. On the other hand, as EPS granules are lighter than water, they float in water, so that the bed formed from EPS granules is washed downstream without the possibility of stratification to occur. In specific, each particle fraction remains at its own position in the bed, irrespective of the washing cycle [28]. Sand filter bed washing requires also high pressures and large quantities of water. As an example, the compressor must be applied for fluidization of sand bed. For fluidization of sand grain of 2 mm, minimum velocity is about 112 m h^{-1} [28]. The total time for washing of sand filter beds is approximately 40 min [28]. On the other hand, for fluidization and washing of an EPS bed, 110 cm in length, only a water head of 1 m and water velocity of 80 m h^{-1} during 5 min is needed [28]. It is clearly seen that the energy demand is much higher for sand filter beds as compared to those of EPS granules. Finally, for the same wastewater quality, the filtration cycle for the EPS filter bed is much longer (between 30 and 50 h), compared to the sand filter bed (between 9 and 30 h). Based on all these facts, it could be concluded that the use of EPS granules as a filter medium drastically decreases both capital and operating costs [28].

When the pressure drop in the EPS filter bed increases dramatically, the filtration cycle is over, and the bed has to be washed. Bed washing is possible in the column by downstream fluidization of the bed. This is performed by opening a valve and applying the adequate water flow. Besides the occasional filter bed washing, there is no need for filter bed recovery, because of the unlimited lifetime of the EPS material.

The deep-bed filter, used in these experiments, is 2.5 m heigh, with the bed length of 110 cm (Fig. 4). EPS granules in the filter bed, had a diameter of approximately 1.8 mm and bulk density of 94 kg m^{-3}. The formed filter bed had the porosity of 50 *%* and 5.86 10^{-9} m^2 permeability (Table 2). Design of this deep-bed filter is described in detail in our previous research where it was tested and optimized for filtration of a model suspension of iron hydroxide [28].

The deep bed filter, described previously [28], was for the first time tested in the present study with real wastewater samples, and in combined methods in the „on site" pilot plant at a car wash station.

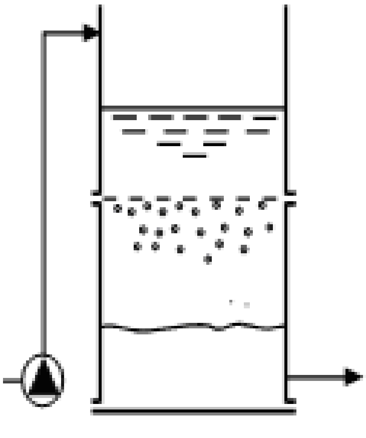

Figure 4. Deep bed EPS filter

Duration of the filter cycle depended on the concentration of suspended solids (SS) in the wastewater. When the SS concentration is high, the tests were shorter, than those for water with lower SS concentrations. As an example, test 8 lasted 40 h, while test 4 lasted 29.5 h. The obtained results of CWW filtration by this deep bed filter are shown in Fig. 5. The maximal SS concentrations at the filter inlet and outlet in test 8 were 544 and 10 mg dm^{-3}, respectively, while the average removal efficiency was 95.4 %. The respective values for test 4 were 766 and 25 mg dm^{-3}, with the SS removal efficiency of 91.7 %.

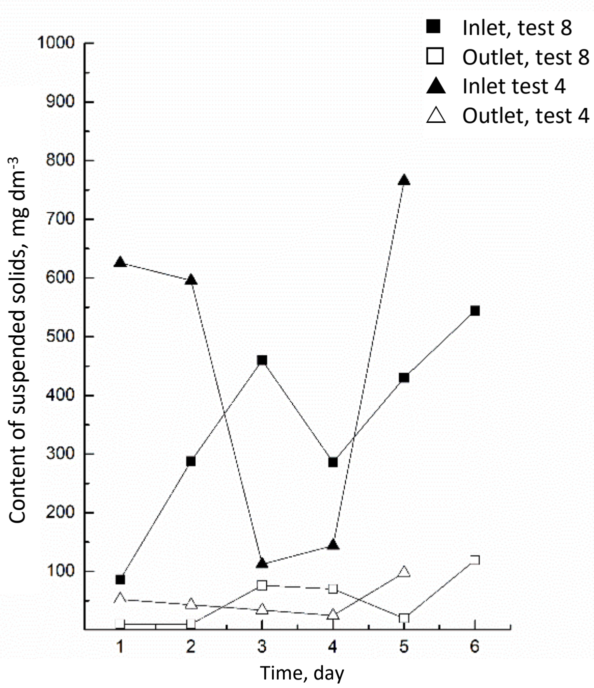

Figure 5. Suspended solids at the inlet and outlet of the deep bed filter in tests 4 and 8

The experimental two-stage bed coalescer consisted of a vertical pipe-in-pipe system presented in Figure 6 [30]. The inner pipe is filled with polyurethane PU fibers, while the outer pipe is filled with granular EPS. Wastewater first goes vertically up from the bottom of the coalescer through the outer pipe *i.e.* the EPS bed. When it reaches the top of the unit it changes direction and it starts to flow vertical down through the inner pipe filled with the PU material, and then it exits the unit.

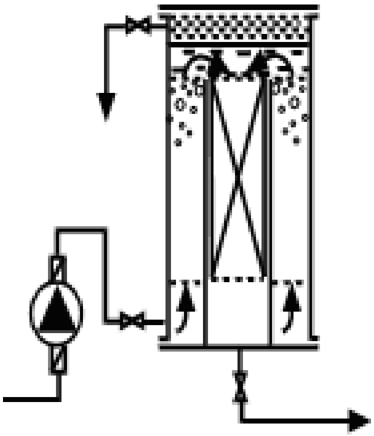

Figure 6. Two-stage bed coalescer [30]

The two-stage bed coalescer used in the present study represents an example of two-stage filtration where both filter beds are in the same coalescer body. The role of each filter bed is specific. The applied fluid velocity allows formation of an oily film at the entrance of both filter beds. In this way, coalescence is drastically increased, because the droplets are easily attached in oily films. Coalescence of large and medium droplets occurs in the EPS filter bed, while coalescence of very small droplets occurs in the PU filter bed. Coalesced droplets detach from oily films of the beds and settle at the top of the unit, from where they are discontinuously discharged by a valve. Therefore, the filter bed cannot be exhausted. The PU filter bed has also an unlimited lifetime as the EPS filter bed.

This two-stage bed coalescer is tested on real and model formation water as well as on hardening wastewater in our previous research where it has shown high separation efficiency of heavily polluted oily water [30]. However, this unit has never been tested „on-site“ for car wash wastewater treatment, and it was never applied in combined methods in the Pilot plant.

Oil concentrations at the filter inlet and outlet in tests 5 and 8. are presented in Figure 7.

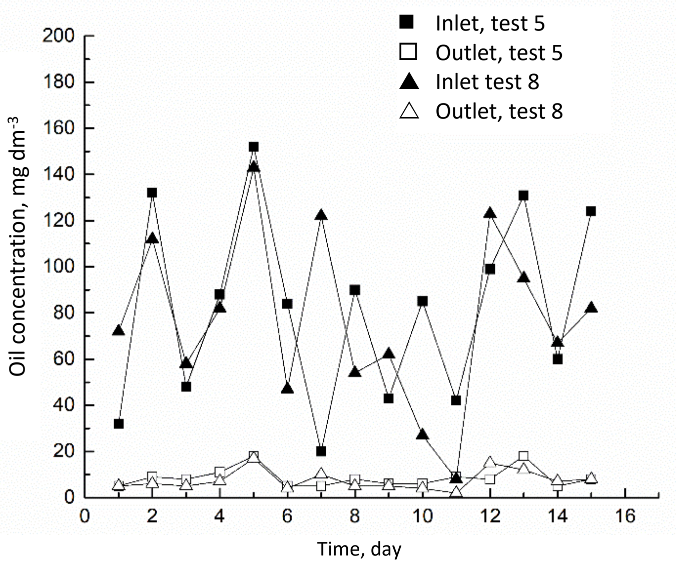

Figure 7. Oil concentrations before and after the two-stage bed coalescer in tests 5 and 8

Test 5 lasted 47.8 h, while test 8 lasted 40.0 h. The maximal inlet and outlet oil concentrations of TBC in test 5 were 152 and 18 mg dm^{-3}, while the oil separation efficiency achieved was 93 %. The respective values in test 8 were 143 and 17 mg dm^{-3} with the oil separation efficiency of 95 %.

The presented results show that all the modules exhibited high separation efficiencies and when combined in the pilot plant the treated water quality could reach very high levels. Mean, maximal and minimal values of COD at the pilot plant inlet and outlet, test duration and month in which the test was realized are shown for all 8 tests in Table 3.

Table 3. Experimental results of COD reduction in treated CWW in the pilot plant in 8 tests

Test number	COD at inlet, mg dm^{-3}			COD at outlet, mg dm^{-3}			Duration, h	Month
	Mean	Maximum	Minimum	Mean	Maximum	Minimum		
1	836	2763	192	117	322	51	54.5	Jun./Aug.
2	894	1952	299	122	150	48	17.0	Dec./Jan.
3	757	2189	247	90	138	39	30.3	Jan.
4	580	1600	187	136	463	19	29.5	Feb.
5	386	594	194	64	140	39	47.8	Feb/Mar.
6	190	255	75	41	165	10	61.5	Mar./Apr.
7	134	337	38	29	48	14	50.5	May
8	137	222	73	36	67	5	40.0	May

Maximal COD value at inlet of the Pilot plant is in the range from 2763 to 222 mg dm^{-3} while the maximal COD value range at outlet of the Pilot plant is from 463 to 48 mg dm^{-3}. The respective ranges of minimal COD values at the inlet of the Pilot plant are from 299 to 38 mg dm^{-3}, while at the outlet it is from 51 to 5 mg dm^{-3}.

The mean COD reduction efficiency for the whole pilot plant, for all tests, was in the range of 74 % up to 88 % (Fig. 8). It could be concluded that this pilot plant has shown very high efficiency for COD removal from the car wash wastewater.

The oil separation achieved in the whole pilot plant for tests 1, 3, and 6. is shown in Figure 9. The duration of the tests was 54.5 h, 30.3 h, and 61.5 h, respectively. The maximal oil concentrations at the plant inlet and outlet for test 1. was 481 and 21 mg dm^{-3}, for test 3. it was 231 and 17 mg dm^{-3}, while for test 6. it was 428 and 18 mg dm^{-3}. The separation efficiency of the oil removal by this pilot plant for these three tests was 96%, 95%, 95%, respectively.

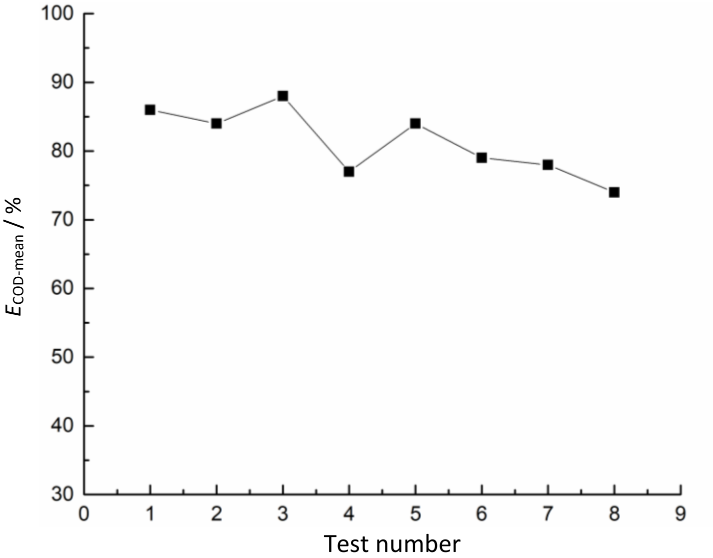

Figure 8. The mean COD reduction efficiency ($E_{COD-mean}$) for the whole pilot plant in 8 experimental tests

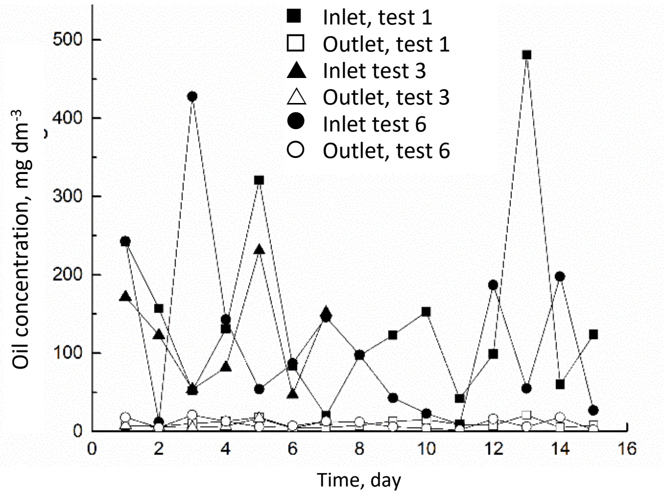

Figure. 9. Oil concentrations at the pilot plant inlet and outlet in tests 1, 3 and 6

The total amount of car wash wastewater was treated without losses by the pilot plant so that the ratio of raw wastewater and treated wastewater was 1:1. However, the amount of treated water that could be reused for car washing is 90 %, because 10 % of the treated water is used for the washing cycle of the filter bed in the second module.

The developed pilot plant is a low-cost plant, due to very low capital and operational costs. The capital costs are much lower compared to those of conventional devices. The novel modules are much lighter because the beds are made of very light materials i.e. of EPS and PU. For this reason, these devices do not need a heavy concrete foundation, and their walls are not as thick as the walls of conventional devices. Also, the bed materials are very cheap (EPS) or free-of-charge (PU), especially when the material is waste material, as PU is in the present case. The operating costs of this pilot plant consist only of the price of electricity needed for one pump and an air compressor and the prices of chemicals applied in the first device (MPR). The bed materials used in this pilot plant have unlimited lifetime, therefore there are not any operational costs for regeneration.

4. CONCLUSION

The novel pilot plant for „on site“ treatment of car wash wastewater at car wash stations presents combined methods in which three innovative modules are combined. In the first module, named multipurpose reactor, coagulation, flotation, aeration and oxidation are performed followed by the second module performing filtration through a deep bed filter of expanded polystyrene. Finally, in the third, last module, coalescence of dispersed oil is performed in a specially constructed coalescer. The modules have shown very high separation efficiencies, and when they are connected in combined methods like this novel pilot plant, they produce high quality of reclaimed car wash wastewater.

In all these three modules, packaging materials are very light*, i.e.* the expanded polystyrene is lighter than water, while the density of polyurethane, used only in the coalescer, is close to that of water. For this reason, the pilot plant has simple and light construction, and therefore it could be easily moved, *i.e.* it represents a mobile plant. Also, due to the use of light packing materials, especially EPS, energy consumption is significantly lower as compared to that in conventional units. Therefore, both capital and operating costs are much lower, compared to conventional devices for the treatment of car wash wastewater.

The presented pilot plant is an eco-friendly device because it could be easily installed „on site“ at car wash stations, it is low-cost, compact, highly efficient, and mobile, with low energy consumption with the potential to be fully automated if needed.

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Razvoj ekološki prihvatljivog mobilnog postrojenja za regeneraciju otpadnih voda iz autoperionica

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(Naučni rad)

Izvod

Stalni porast broja vozila na globalnom nivou negativno utiče na održivi razvoj zbog povećane potrošnje energije, buke i zagađenja vazduha, kao i povećane potrošnje vode koja se koristi za pranje vozila. Dominantni postprodajni servis u automobilskom sektoru je pranje automobila. Ako bi se otpadna voda iz autoperionica mogla ponovo koristiti u procesu pranja vozila, umesto sveže vode, mogla bi se značajno smanjiti potrošnja sveže vode. Kako bi se postigao ovaj cilj, neophodno je implementirati sisteme za prečišćavanje otpadnih voda „na mestu nastanka" tj. u autoperionicama. U ovom istraživanju razvijeno je novo Pilot postrojenje za tretman, „na mestu nastanka", otpadnih voda generisanih pranjem vozila u autoperionicama. Ovo pilot postrojenje predstavlja kombinaciju više metoda. Sastoji se od tri inovativna modula: višenamenskog reaktora (za koagulaciju/flotaciju, aeraciju/oksidaciju), filtera sa nasutim slojem (za filtraciju) i koalescera (za koalescentnu filtraciju). U svim ovim modulima materijali od kojih su formirani nasuti slojevi su izrazito laki (ekspandirani polistiren (EPS) i poliuretan (PU)), stoga je za njihovo pranje potrebna energija značajno niža nego kada je upitanju pesak koji se najčešće koristi kao filterski sloj. Pilot postrojenje ima jednostavnu konstrukciju i malu težinu, tako da se lako može premeštati po potrebi. Ovo novo razvijeno postrojenje pokazalo je veoma visoku efikasnost smanjenja HPK-a, kao i efikasnost uklanjanja suspendovanih materija i ulja, što ukazuje na njegov visok potencijal za rekuperaciji vode u autoperionicama.

Ključne reči: autoperionica, otpadna voda od pranja automobila, nova modularna tehnologija, ponovna upotreba vode, zaštita životne sredine