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REDUCTION OF WATER CONSUMPTION IN WASTE WATER TREATMENT SYSTEMS IN THE AUTOMOTIVE INDUSTRY

Natalija Aleksić[1], Vanja Šušteršič[2], Dušan Gordić[3], Danijela Nikolić[4], Nikola Rakić[5]

Summary: *The automotive industry is a major consumer of clean water. The automotive industry uses a large amount of oil-based products, paint, synthetic liquids, and as a part of the car manufacturing process. The use of these products in different production processes leads to the generation of wastewater, which, depending on the process itself, may contain different types of pollution. Depending on the type of waste water pollution, automotive industries use different types of treatments of wastewaters. After the treatment, wastewaters are discharged into the recipient, and new amount of clean water is used in technological process. Water problems, such as increases in water stress and deterioration of water quality in rivers, lakes and other water sources, are important issues from perspective of risk in automotive industries. The automotive industry establishes its water environment policy, which involves comprehensively purify water and return it to the environment and also thoroughly reduce the amount of water used. The aim of this paper is to present possibilities for reducing the consumption of clean water by implementing various initiatives such as collecting rainwater to reduce industrial water usage and wastewater recycling to reduce amounts withdrawn from water sources. The paper presents possible clean water savings, which is replaced with recycled wastewater and collected rainwater in the manufacturing process.*
Key words: automotive industry, waste water, treatment, reduction

1. INTRODUCTION

Water is an integral part of life on the planet, and drinking water reserves are increasingly decreasing every day. The automotive industry is a big consumer, and at the same time a major polluter of water. In the automotive industry, a large amount of water is used to meet the needs of automobile production. Therefore, the automotive

[1] PhD student, Natalija Aleksić, Sestre Janjić 6, 34000 Kragujevac, Serbia, Faculty of Engineering, University of Kragujevac, natalija94u@gmail.com
[2] Full Profesor, Vanja Šušteršič, Sestre Janjić 6, 34000 Kragujevac, Serbia, Faculty of Engineering, University of Kragujevac, vanjas@kg.ac.rs
[3] Full Profesor, Dušan Gordić, Sestre Janjić 6, 34000 Kragujevac, Serbia, Faculty of Engineering, University of Kragujevac, gordic@kg.ac.rs
[4] Assistant professor, Danijela Nikolić, Sestre Janjić 6, 34000 Kragujevac, Serbia, Faculty of Engineering, University of Kragujevac, danijelan@kg.ac.rs
[5] PhD student, Nikola Rakić, Sestre Janjić 6, 34000 Kragujevac, Serbia, Faculty of Engineering, University of Kragujevac, nikola.rakic@fink.rs

industry should have a policy that assesses the impact on water environments. This policy should focus on reducing these impacts from two perspectives:

- The input side, where basic measures are taken to reduce water consumption and
- Output site, where comprehensive measures are taken to purify water.

In automotive industries where wastewater treatment exists, it is possible to apply measures to reduce water consumption by constructing a recirculation plant for the treatment of wastewater. The water recirculation plant implies additional treatment of purified wastewater, after which that water is supplied to the production processes in which its use is possible.

The automotive industry is a branch of the industry engaged in the design, development, production, marketing and sale of motor vehicles [3]. The automotive industrial complex contains typical industrial buildings such as: press shop, paint shop, body shop and assembly shop. However, it should be kept in mind that in some complexes there are also other buildings that are engaged in the production of certain automotive components. The complex of the automobile factory is infrastructurally equipped and connected to the systems of electricity distribution, water supply and sewerage.

Depending on the location of the car industry as input water can be: surface water, ground water, rainwater collected and stored directly in automotive industry and municipal water supplies or other public service providers. Drinking water is used in all civilian objects, while industrial water is used in press shop, paint shop, body shop, assembly shop and general service (includes a boiler plant, a demineralized water production plant, cooling plants and a waste water treatment plant).

2. WASTE WATER IN THE AUTOMOTIVE INDUSTRY

Wastewater in the automotive industry is generated in various facilities during the technological processes of production of certain parts: press shop (degreasing of sheet metal); paint shop (chemical preparation, cataphoresis, etc.); assembly shop (washing of tires, rain test, etc.); facility for the production of metal parts (cooling and lubricating agents); facility for the production of plastic components (painting of plastic parts); waste water from the process of production of demineralized water; waste water from boiler rooms, cooling towers, etc.. In the wastewater from the complex are also include sanitary-faecal wastewater and atmospheric wastewater. The most common pollutants in wastewater can be organic and inorganic substances. These pollutants can be expressed in the form of a total suspended solids. Depending on the type of process and pollution in different types of waste water different type of treatments of wastewater are used.

2.1 Wastewater treatment plant

At the wastewater treatment plant the input raw materials are untreated wastewater and wastewater treatment chemicals, and the products from the plant are purified waste water and sludge cake.

Due to the different quality of wastewater their treatment is different. These wastewaters can be divided into wastewater 1 (body shop- pre-treatment, cataphoresis - continuous emptying, bumper-degreasing), wastewater 2 (body preparation, car

painting cabine, bumpers - dyeing, cataphoresis - concentrates) and technological wastewater (car wash, water from assembly shop, water from other plants). There are special channels for the collection of these wastewater as well as special lines for their treatment. The reason for this is a big difference in the quality of these wastewater.

Wastewater 1 (Fig. 1) are not burdened with a large concentration of pollutants and can be purified by physico-chemical processes (coagulation, basification, flocculation) to the level of effluent quality required to meet the maximum permissible concentrations. After final neutralization they are transported to the purified wastewater 1 tank after which they are discharged into the city sewage system.

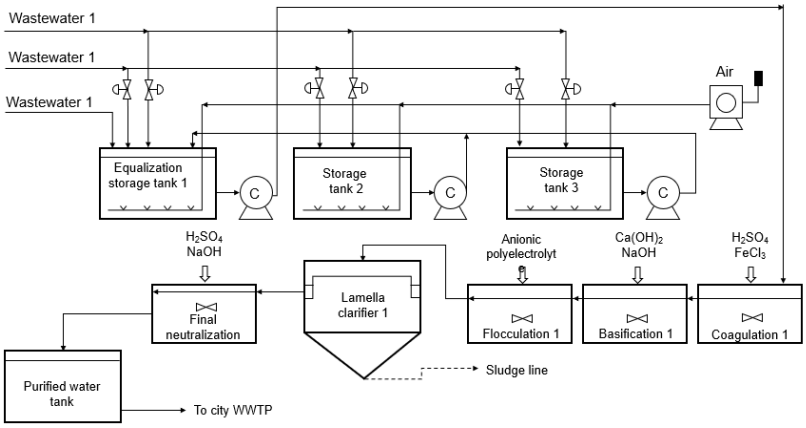

Fig. 1 *Treatment of wastewater 1*

Wastewater 2 (Fig. 2) are highly contaminated and requires beside physical-chemical treatment, biological treatment before being discharged into the city sewage system. It represents concentrates that are used for some time and recirculated in the process. After saturation, they are released and replaced with fresh solutions of technological chemicals. These saturated solutions are collected in equilibrium tank and from there they are sent to the wastewater treatment plant.

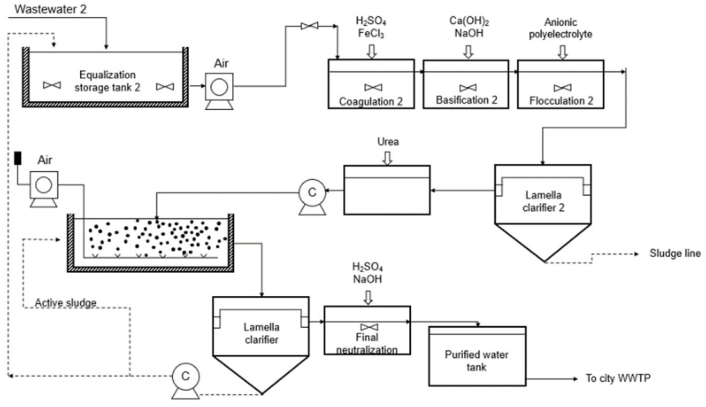

Fig. 2 *Treatment of wastewater 2*

Treatment of technological wastewater is the same as treatment of wastewater 1 with one important difference. Namely, these waters, occasionally, may have increased oil content, so it is necessary to separate oil and water phase before chemical treatment.

After the treatmant purifued wastewaters are with a demanded quality and they can be freely discharged into the recipient. The quantitative and qualitative analysis of wastewater from the automotive industry is a basic point used to select wastewater treatment, the possibility of their recirculation or discharging to the recipient. Reduction of water consumption can be achieved by recirculation wastewater by introducing additional treatments after treatment of wastewater in the wastewater treatment plant.

2.2 Potential reduction of water consumption using water recirculation plant

Regarding the automotive industry, the production areas of paint finishing and hardening can be seen as those areas with a high potential of process water reuse [2]. If it is assumed that 100% of industrial water is needed for satisfying all technological processes and based on known information on the operation of the wastewater treatment plant and the new recirculation plant, it can be calculated how much water can be saved by recirculating the treated wastewater.

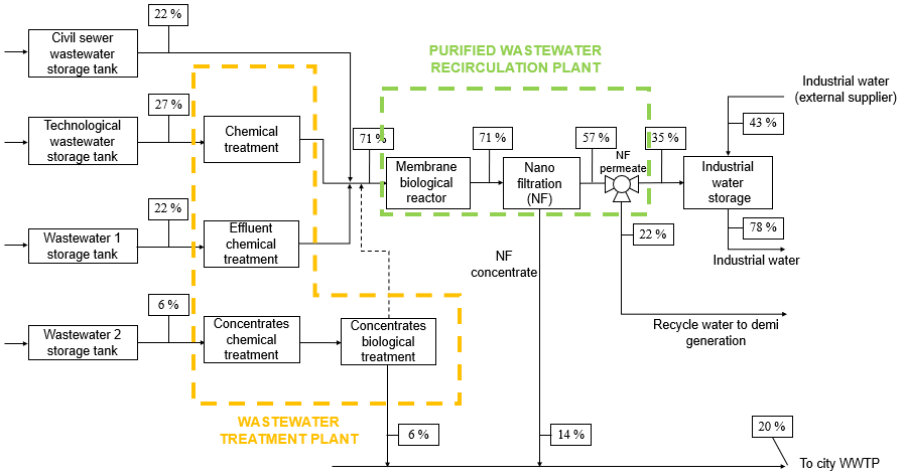

Fig. 3 *Flow diagram of possible recirculation of industrial water in percentages*

Of the total amount of industrial water needed for technological processes in the wastewater treatment plant, it is possible to collect about 77% of wastewater. The remaining amount of water that does not come into the plant is water consumed during the process (about 23%). After tretmant of the collected wastewater (chemical, biological treatment), it is possible to further purify this water so instead of being discharged into city recipent that can be used in industrial processes (Fig. 3).

The amount of wastewater 2 is significantly lower in relation to wastewater 1. It very important to separate of flows in the automotive industry and separate of treatment of wastewater 1 and 2. The reason for this is the possibility of recirculation of purified wastewater 1, which implies additional treatment of wastewater 1 in the recirculation

plant and their use in technological processes which require high quality of water.

After the final neutralization, treated wastewater 1 can be transported to the receiving tank for purified wastewater 1. From the tank this water can be transported through the pumping system to the recirculating plant to futher treatment. This means that it is possible to use about 71% of wastewater in the recirculation plant. Purified wastewater 2 are discharged into the urban sewage system due to poorer quality. If the quality of these waters, after purification, would improve, then these water could be pumped to the recirculation plant. The recirculation plant may consist of a biological MBR treatment and a desalination treatment. Purified wastewater is introduced into a membrane biological reactor (MBR). The water within the MBR reactor is passed through two ultrafiltration units, after which a certain quantity of concentrates from the ultrafiltration units is released into the city sewage system (about 14%). Aditionaly purified wastewater is pumped with the addition of sodium hypochlorite and citric acid to the basins of pure water (about 57%). From this tank clean purified water, part of water is taken to the demineralized water production plant (about 22%), and part is taken to the tank of industrial water (about 35%). After recirculation of purified waste water (about 57%), it is needed about 43% fresh water from the supplier. The consumption of fresh water is reduced from 100% to about 43 %.

2.2 Potential reduction of water consumption using rainwater harvesting system

Rainwater harvesting is one of the promising ways of supplementing thesurface and underground scarce water resources [1]. Rainwater harvesting is the collection and storage of rainwater for reuse on-site, rather than allowing it to run off. These stored waters in the automotive industry it can be used for various technological processes. A rainwater harvesting system in the automotive industry mainly constitutes of following sub components: catchments, transportation, filter and storage.

Catchments - the best places to collect rainwater in the automotive industry are roofs. Whether the roof is flat or even, the efficiency of collecting rainwater is high. Therefore, it is possible to set up rainwater collection tanks on most roofs within the factory complex.

Transport system - It involves the upgrade of the gullies and pipes (on already existing facilities of the interior factory) that allow the rainwater to be lowered to the place for its treatment.

Filtration - The quality of rainwater collection does not meet the required quality of water used in industrial processes. Therefore, the rainwater collected must be treated beforehand so that it can later be used in various technological processes. Filters are used for treatment of water to effectively remove the turbidity, colour and microorganisms. It removes silt, dust, leaves and other organic matter from entering the storage tank. There are different types of filters in practice, but basic function is to purify water. The rainwater passes through the filter, is significantly purified and then transported to the rainwater storage tank. In this method rainwater collected from the roof of the building is diverted to a storage tank. The storage tank has to be designed according to the water requirements, rainfall and catchment availability.

Based on data from the Republic Hydrometeorological Institute, the average annual rainfall in Kragujevac for 2018 is 641.4 l/m^2. The surface of the roofs, where rainwater can be collected, is 250 000 m^2. Based on these data, it is possible to calculate the total amount of rainwater that can be collected. If these data are compared with the

total consumption of industrial water in the automotive industry it can also be calculated the contribution of collected rainwater in procentage.

The rainwater harvesting system can collect about 20% of the total amount of industrial water. During the treatment of rainwater about 5% is disposed of in the city collector, which means that about 15% of the collected rainwater can come to the industrial water tank.

The purified wastewater recirculation plant supplies about 57% of water for industrial water tank and a rainwater harvesting system supplies about 15% of water for industrial water tank. That means that it can be saved about 72% of water supplied from an external supplier. From the 100% of water originally taken from an external supplier, after constructing a recirculation water plant and rainwater collection system, an external supplier must supply about 28% of the water.

3. CONCLUSION

Efficient use of water have a major impacts on environmental protection, public health and economic benefits, helping to improve water quality, maintaining aquatic ecosystems and protecting drinking water resources. One way to reduce the consumption of water in automotive industry is to recycled purified wastewater and use it in different industrial processes.

The advantage of putting into operation water recirculation plant is that a large part of water returns to the production process in the form of demineralized water and industrial water, which reduces the exhaustion of natural resources (water) and the load of the sewage system. Therefore, the recycling and reuse of wastewater is an optimal solution that helps reduce pollution and save water resources. Saving water means saving energy, gas, chemicals and wastewater costs.

The results have shown that considerable savings in water can be achieved by building these systems within the automotive industry. The main advantage is that the water reserves, and especially the fresh water, which are used in some factories for the preparation of industrial water, are significantly protected.

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