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**Institute of Chemical and Environmental Engineering**
**Slovak University of Technology in Bratislava**

# PROCEEDINGS

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# Separation of wastewaters from carwash stations by ultrafiltration

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**Keywords**: carwash wastewater, ultrafiltration, wastewater treatment, water re-used

The carwash stations use large volumes of water and release wastewaters containing harmful chemicals into the environment. Carwash wastewaters contain significant amounts of contaminants such as oil and grease, surfactants, solids, nitrogen, and phosphorus. Various treatment technologies have been used for the treatment of these wastewaters. Currently, the following processes are commonly used to separate these pollutants: sand filtration, electrocoagulation, chemical coagulation, ozonation, and biological methods. However, traditional methods mentioned above are often ineffective. Therefore, membrane processes such as ultrafiltration (UF), microfiltration (MF) and nanofiltration (NF), have gained great interest as an excellent techniques for the removal of carwash pollutants.

In the present study, the ultrafiltration process was applied for separation of effluents from carwash stations. However, the flux reduction was the significant limitations of the process. Therefore, the efficiency of several methods aimed to reduce the fouling phenomenon was presented.

In this work, the UF polyethersulfone membranes, MWCO of 10 (UE10) and 110 kDa (UE110), were applied. The transmembrane pressure (TMP) was maintained at 2.0 bar, and the feed flow velocity over the membrane was equal to 1.7 m/s. During the UF tests, the retentate was returned to the feed tank. The feed was prepared using commercial carwash chemicals: “white surfactant”, “blue surfactant” and “Turbo Active Green” – agents created the foam, and hydrowax – created protective layer on the cars. When the UF filtration run was completed, the membranes were cleaned with deionised water or with base (pH=11) solutions of agents (produced for car washing) and rinsed with deionised water.

The conducted research confirmed that the UF process can be successfully applied for the filtration of wastewaters generated at carwash stations. The composition of such wastewaters is complex and the significant membrane fouling should be expected. For this reason, the industrial implementation of the process requires effective cleaning methods. Results obtained in the present study have shown that alkaline car washing agents can be used for these purposes.

## Acknowledgments


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## Abstract

Carwash wastewaters contain significant amounts of contaminants such as oil and grease, surfactants, solids, nitrogen, and phosphorus. Various treatment technologies have been used for the treatment of these wastewaters. In the present study, the ultrafiltration process was applied for separation of effluents from carwash stations. However, the flux reduction was the significant limitations of the process. Therefore, the efficiency of several methods aimed to reduce the fouling phenomenon was presented.

## Introduction

It is well known that carwash stations use large volumes of water and release wastewaters containing harmful chemicals into the environment. According to the type of vehicle and equipment, water needed for washing each car is estimated in the range of 150 and 600 L [1,2]. The contamination of wastewaters is caused by three sources: carwash chemicals, car exploitation, and traffic pollutants such as road surfacing pollutants, dust, sand, salt and tiny exhaust particles [1]. Currently, the following processes are commonly used to separate these pollutants: sand filtration, electrocoagulation, chemical coagulation, ozonation, and biological methods [3]. However, traditional methods mentioned above are often ineffective. Therefore, membrane processes such as ultrafiltration (UF), microfiltration (MF) and nanofiltration (NF), have gained great interest as an excellent techniques for the removal of carwash pollutants [4].

It should be pointed out that the UF process conditions, such as pressure, highly affect the system efficiency. Indeed, they have the significant impact on the COD, oil and grease removal. The efficiency separation of the car wash effluent decreased with increasing the pressure from 1 to 3 bar by using ultrafilter due to flux reduction and the accumulation of particles on the membrane surface [4]. Undoubtedly, fouling and flux reduction lead to increasing operational costs and reducing treatment efficiency, thus, they are important limitations in the development of membrane technology applications. As recognized in the literature, the reduction of the fouling phenomena can be achieved by the following methods: feed water/wastewater pretreatment, membrane modification, and membrane monitoring and cleaning [5].

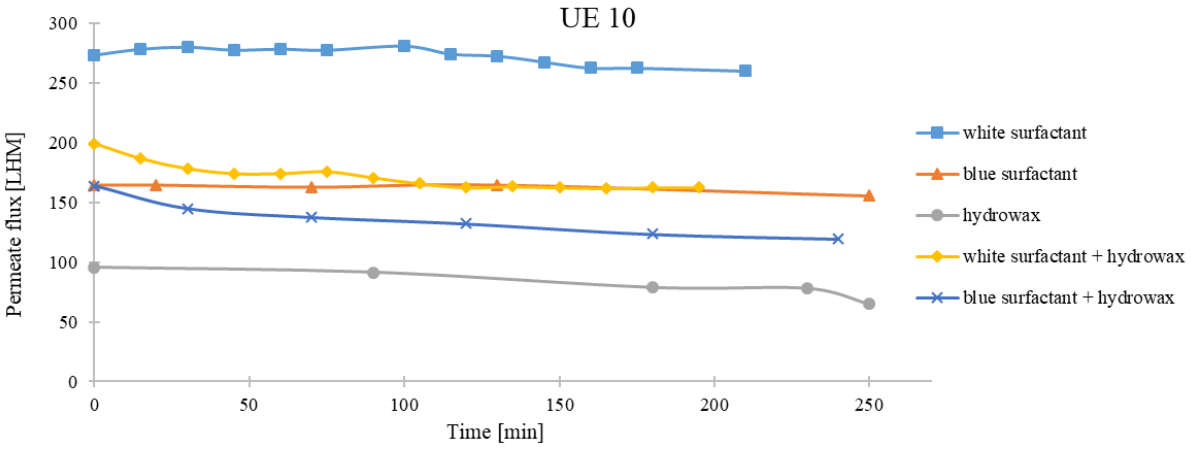
Water conservation in the carwash means the efficient use of water through water recycling systems. Carwash water recycling is the use of carwash water that is captured, treated and redirected back into the same use. Water reclamation involves treatment of carwash and rinse water. A properly designed carwash operation is connected to a sanitary sewer that carries the wash water to a biological wastewater treatment plant. However, the environmentally friendly and modern carwash requires a good washing technology, proper water recycling system followed by advanced water treatment methods, and compatible washing chemicals. This study aimed to investigate the possibility of water reuse by using the ultrafiltration process to separate the wastewaters generated in car washes.

## Experimental

Generally, ultrafiltration membranes have a pore size of about 0.01-0.02 micron. Therefore, they can be used for effective removal of large particles, most microorganisms (bacteria, protozoa, algae and virus) and some natural minerals such as divalent ions. In this work, the UF polyethersulfone membranes, MWCO of 10 (UE10) and 110 kDa (UE110), were applied. The transmembrane pressure (TMP) was maintained at 2.0 bar, and the feed flow velocity over the membrane was equal to 1.7 m/s. During the UF tests, the retentate was returned to the feed tank. The feed was prepared using commercial carwash chemicals: "white surfactant", "blue surfactant" and "Turbo Active Green" – agents created the foam, and hydrowax – created protective layer on the cars. When the UF filtration run was completed, the membranes were cleaned with deionised water or with base (pH=11) solutions of agents (produced for car washing) and rinsed with deionised water.

## Results

In the first stage of the UF studies, the impact of the type of car washing agent on the permeate flux was investigated. For this purpose, various agents were used as a feed. It has been reported that initially, the flux was comparatively high (200-400 LHM), nevertheless, due to fouling phenomenon, it decreased significantly within the process run (Fig. 1). This observation indicated that the UF process of liquids used to wash cars has a large fouling potential. It is related to the fact that applied membranes tend to be affected by components presented in a feed stream which leads to a significant reduction in the permeate flux. Results obtained in the present study clearly demonstrated that the permeate flux depends on the feed composition. Indeed, the highest steady state flux values (250 LHM – UE10 and 350 LHM– UE110) were obtained for the "white surfactant". In turn, for the "hydrowax" the steady state permeate flux of 70 LHM was noted. The smaller permeate flux was noted for "blue surfactant". It can be explained by the fact that "blue surfactant" beside mixtures of surfactants consisted additional of blue dye, the presence of which decreases permeate flux. The presence of "hydrowax" in the feed also increased the fouling impact on the process performance.



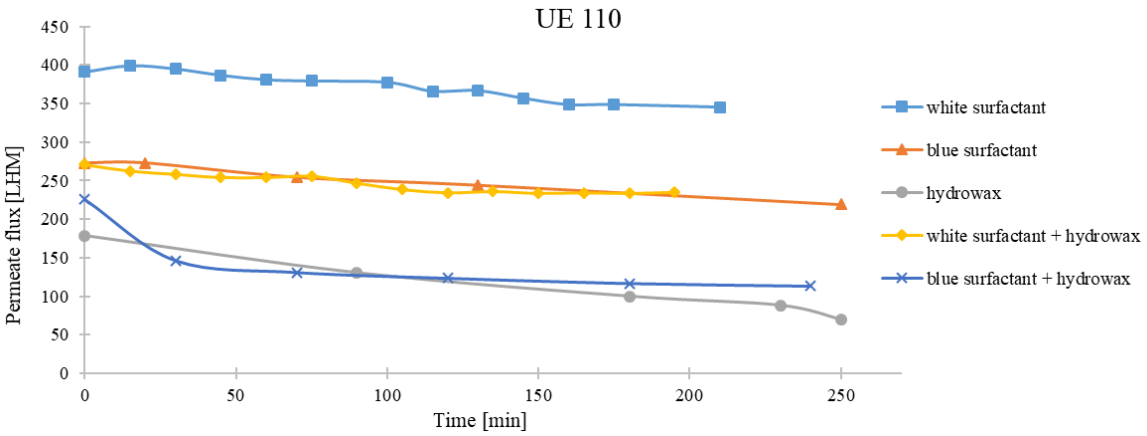



Fig. 1. Permeate flux changes during ultrafiltration of car washing agents

In the second stage of the present study, the UF membranes were rinsed with deionized water. It has been reported that for the first two or three cycles, it allowed to maintain the good UF performance, however, in the following days the permeate flow began to decrease significantly (Fig. 2). This result shows that rinsing the UF membranes contaminated with components of car washing agents only with deionized water does not ensure the maintenance of the membranes performance for a long time.

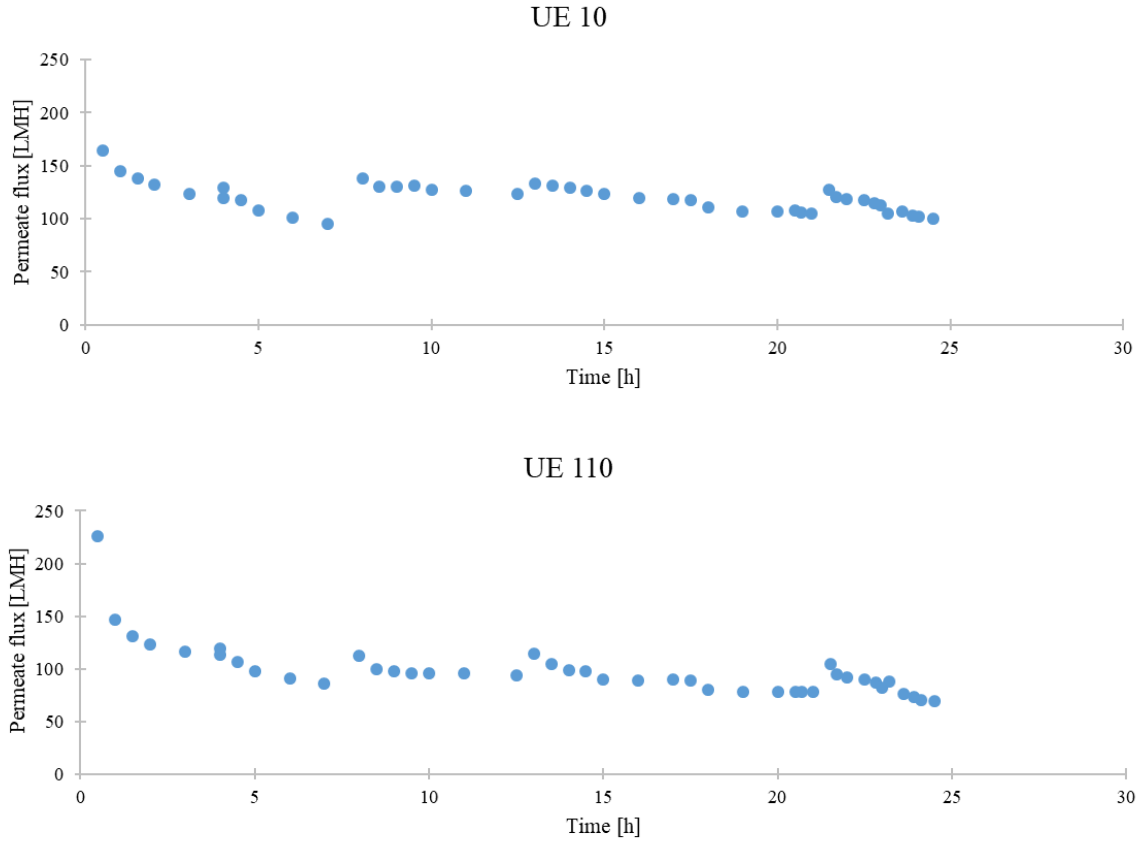



Fig. 2. The changes of the permeate flux during the UF process of feed containing: detergents (Turbo Active Green 0,5%) and hydrowax (0,2%).

For this reason, in the next stage of the presented study, the cleaning of membranes with the use of solutions produced for cleaning cars from insect residues and wheel cleaner that contained NaOH in their composition. The impact of these operations on the permeate flux in function of

transmembrane pressure was presented in Figure 3. It has been found that the effectiveness of the UF membranes cleaning depends on both the concentration of the solution and the contact time between the membrane and cleaning agent. The use of 0.5% solutions for 48 hours allowed to obtain the process performance similar to that reported for clean membranes.

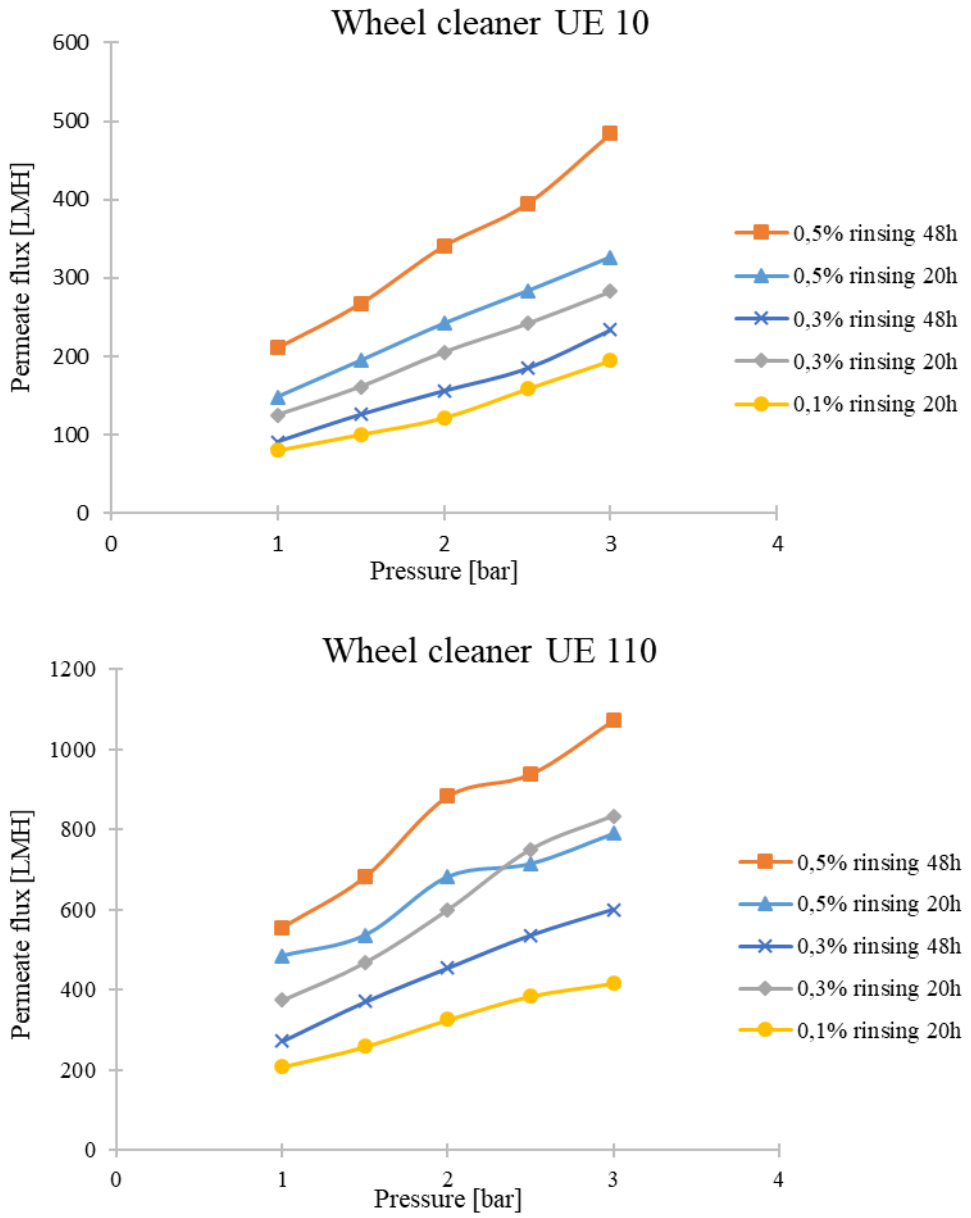



Fig. 3. Effect of washing solution concentration and contact time on the permeate flux

The method of static membrane washing presented above can be used during night shutdowns of the installation. However, this method requires several hours of the cleaning agent to act on. This time can be significantly reduced by using a dynamic system in which the washing solution flows along the membrane surface (1.5 m/s). The effective cleaning of membranes required 90 minutes of rinsing, which indicates that the agents used in the car wash strongly contaminated the surface of the membranes tested.

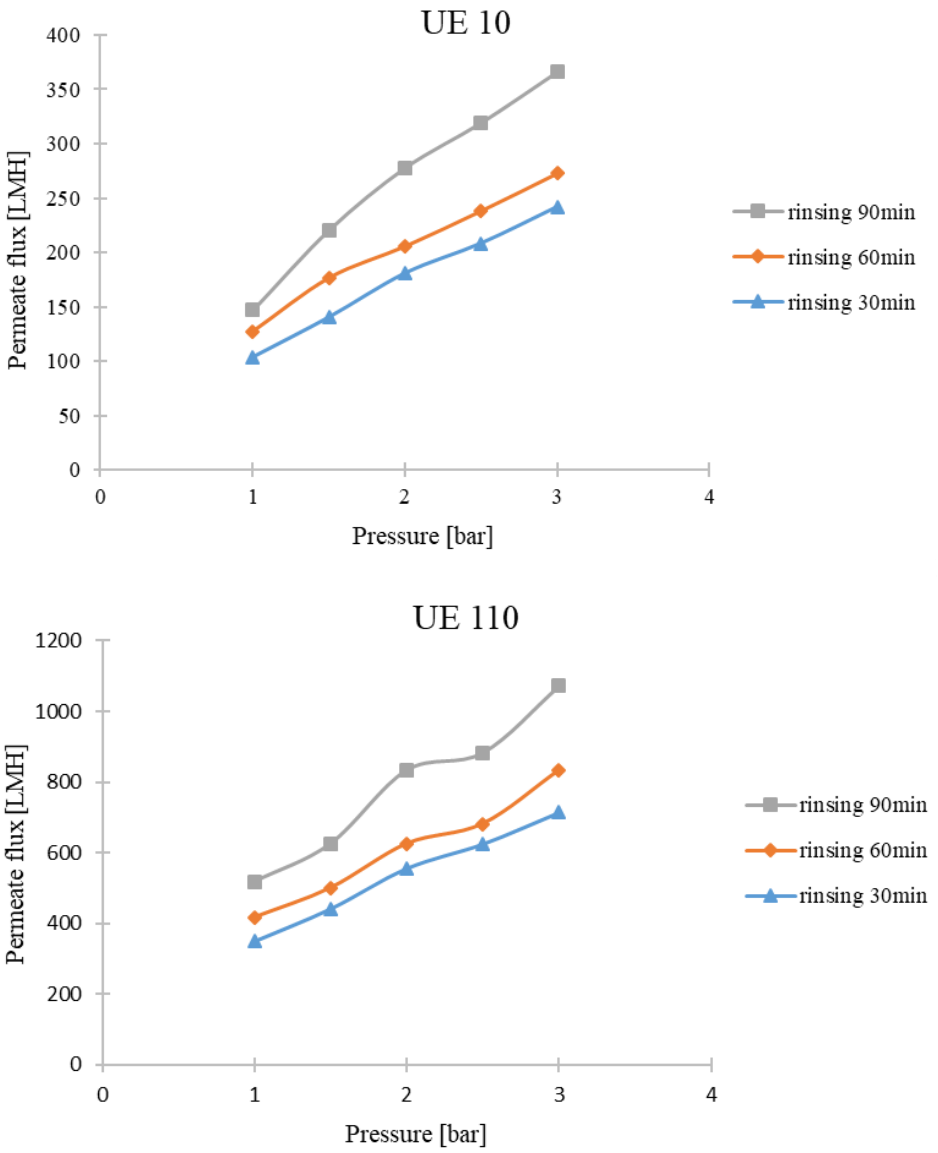



Fig. 4. Changes in the permeate flux depending on the rinsing time of the modules

## Conclusions

The conducted research confirmed that the UF process can be successfully applied for the filtration of wastewaters generated at carwash stations. The composition of such wastewaters is complex and the significant membrane fouling should be expected. For this reason, the industrial implementation of the process requires effective cleaning methods. Results obtained in the present study have shown that alkaline car washing agents can be used for these purposes.

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## Literature

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