DOI: http://doi.org/10.21698/simi.2026.ab25

COMPARATIVE STUDY OF SURFACTANT LOADS AND PHYSICOCHEMICAL CHARACTERISTICS OF CAR WASH WASTEWATER

Alina Silvia Pintilescu, Elena Adriana Albu, Mariana Tudor, Irina Dumitrescu, Daniel Gheorghe Rudaru, Denisa Andreea Caraman, Alina Roxana Banciu, Stefania Gheorghe*

National Research and Development Institute for Industrial Ecology-ECOIND, 57-73 Drumul Podu Dambovitei, district 6, 060652, Bucharest, silvia.pintilescu@ecoind.ro, Romania

**corresponding author: stefania.gheorghe@incdecoind.ro*

Keywords: *anionic surfactants; car wash wastewater; chemical oxygen demand; non-ionic surfactants; wastewater quality*

Introduction

Wastewater from industrial and commercial activities contains a wide range of pollutants, such as suspended solids, organic compounds, hydrocarbons, heavy metals, nutrients and surfactants. Car washes, which have become more common with urban expansion, are one of the sources that load wastewater with surfactants. Monitoring wastewater quality, including surfactant concentrations, is essential, both for checking compliance with legal requirements and for supporting environmental protection measures. Surfactants can be lost from stored samples through biodegradation or adsorption onto suspended particles and container walls. As compliance decisions rely on the measured concentrations, it is important to know how much these values change between sampling and analysis.

This study aimed to determine the concentrations of anionic and non-ionic surfactants in decanted wastewater from five self-service car washes in Suceava County. COD-Cr, BOD_5, suspended solids and solvent-extractable substances were also measured to describe the pollution load at each site, and the results were compared with the NTPA 002/2005 (GD no. 352/2005, amending GD no. 188/2002). In addition, surfactant concentrations measured within 24 hours of sampling were compared with those obtained after a worst-case 10 days of storage at 4°C, to assess whether delayed analysis can compromise the reliability of the results.

Materials and methods

Wastewater samples were collected from five self-service car wash facilities in Suceava County, Romania, located in the village of Dumbraveni (P1), Calea Unirii Street, no.28 (P2), the Itcani neighborhood (P3), the village of Mitocul Dragomirnei (P4) and the Burdujeni neighborhood (P5). The sites were selected to compare the quality of the wastewater generated by car washing activities.

Grab sampling was used to collect individual wastewater samples after the decantation stage, so the samples reflect the quality of the wastewater once suspended particles had settled. All five samples were collected on the same day and analyzed within 24 hours of collection to establish the initial concentrations of anionic surfactants, non-ionic surfactants, COD-Cr, BOD_5, suspended solids and solvent-extractable substances. The same samples were then stored in a refrigerator at 4 °C for 10 days without preservatives, and the surfactant determinations were repeated. This storage period was chosen as a worst-case scenario, considerably exceeding the recommended

holding time for surfactant samples and long enough for primary biodegradation to occur and measurable differences to appear.

Anionic surfactants were determined spectrophotometrically according to SR EN 903:2003, based on the methylene blue active substances (MBAS) method, while non-ionic surfactants were determined using the bismuth active substances (BiAS) spectrophotometric method according to ISO 7875-2. Chemical oxygen demand (COD-Cr) was determined by the volumetric method according to SR ISO 6060:1996, while biochemical oxygen demand after five days (BOD_5) was determined according to SR EN 1899-2:2002. Suspended solids were determined gravimetrically according to SR EN 872:2005, and solvent-extractable substances according to SR 7587:1996, Chapter 4, and EPA Method 1664:2010, Revision B, Section 7.10. Dilution factors of 1, 10 and 100 were applied for surfactant determinations, depending on the measured concentrations.

Results and conclusions

The investigated wastewater samples showed considerable differences in surfactant concentrations among the five sampling locations. Within the first 24 h after sampling, anionic surfactant concentrations ranged from 10.30 to 116.25 mg/L, while non-ionic surfactant concentrations ranged from 5.37 to 60.91 mg/L. The highest concentrations were recorded at P2, whereas the lowest values were observed at P5.

Compared with the 25 mg/L limit set by NTPA 002, the total anionic and non-ionic surfactant concentrations exceeded the limit in samples P1 and P2 within the first 24 hours after sampling. After 10 days, only P2 remained above the limit, while P1, P3, P4 and P5 were below it. These differences between the two time points emphasize the importance of proper sample preservation and analysis as soon as possible after sampling.

The highest COD-Cr (1588 mg O_2/L), BOD_5 (664.90 mg O_2/L) and suspended solids (616 mg/L) concentrations were also recorded at P2, exceeding the corresponding NTPA 002 reference values. Solvent-extractable substances were below 20 mg/L in all samples, remaining below the reference value of 30 mg/L.

The decrease in surfactant concentrations after 10 days of storage at 4°C may be due to biodegradation, adsorption onto suspended particles or container surfaces, and other physicochemical changes, as well as to changes in sample homogeneity and analytical variability. The COD-Cr/BOD_5 ratios ranged from 2.39 at P2 to 11.97 at P4, suggesting differences in organic matter biodegradability among the sampling locations. Overall, P2 exhibited the highest pollution load, highlighting the need for effective monitoring and additional treatment of car wash wastewater following decantation to ensure compliance with applicable discharge limits.

The five car wash wastewater samples exhibited significant variations in surfactant concentrations and physicochemical characteristics, with P2 displaying the highest levels of surfactants, COD-Cr, BOD_5 and suspended solids. After 10 days of storage at 4°C, mean concentrations decreased by approximately 72.6% for anionic surfactants and 63.4% for non-ionic surfactants, altering the compliance status of P1. These findings highlight the need for prompt sample analysis and more effective monitoring and control of car wash wastewater following decantation, as this treatment stage alone may be insufficient to ensure compliance with applicable discharge limits. Appropriate additional treatment measures are therefore necessary before discharge.