Polish J. of Environ. Stud. Vol. 16, No. 6 (2007), 927-931

Letter to Editor

Trends in Modern Car Washing

H. Janik[1]*, A. Kupiec

Departament of Polymer Technology, Faculty of Chemistry, Gdansk University of Technology, Narutowicza 11/12, 80-952-Gdansk, Poland

Received: April 26, 2006
Accepted: July 16, 2007

Abstract

Different techniques of car washing are presented in this paper, along with issues of water use, water contamination and its purification. Nowadays, technological advancements in the car wash industry fall into specific categories such as, new washing technologies (touch-free and hybrid washing technology), advanced water recycling systems (based on biological water treatment), water desalination and purification (by reverse osmosis) and other ecological and economical innovations (e.g. energy savings). Our conclusion is that as the water quality demand increases, viable water recycling systems are becoming a critical element of the modern car wash facilities.

Keywords: car washing technology, modern car wash, reverse osmosis, water desalination, water use in car washing

Introduction

In the past people used to wash their cars in the backyards of their homes or other places of convenience, and later, in hand-wash car washes. Nowadays, mechanical devices in designated areas mostly perform this task. Nevertheless, in every case the water used for cleaning the car gets polluted. A variety of pollution sources in wash water from cars are shown in Fig.1 [1].

In order to save natural resources and still provide a high-quality wash, new car washing technologies must be employed, including reuse of water. Some countries have made significant progress in reusing the wastewater by setting up rules and regulations, and investing in strategic projects, while other countries still lack adequate planning and regulations [2]. Switzerland, Germany and The Netherlands no longer allow their citizens to wash cars at home [3]. In Poland, Portugal, Italy and many other countries this issue is not strictly regulated. Quite often the existing regulations are mostly directed towards professional car wash facilities. Wash water in such facilities has to be pre-treated before discharging to the sewer, while water generated while washing a car in the proverbial driveway gets discharged directly to the storm drain without any treatment. In terms of chemical composition, residential car wash products are similar to products used in the commercial car wash industry. Thus, it is like regulating only the half of the market and ignoring the reminder of the discharges. In the near future, strict regulations aimed at preventing car washing at homes will be introduced in more and more countries. Considerable efforts towards cleaner technology of car washing have recently been made, and various trends in the car wash market have been observed in developing countries.

*Corresponding author; e-mail: janik@urethan.chem.pg.gda.pl

Trends in Car Wash Technology

Professional car washes can be divided into different types, depending on the construction and washing technologies involved [4].

Self-serve car washes allow washing the car by the customer. A wand disperses water and low-pressure brushes are used.

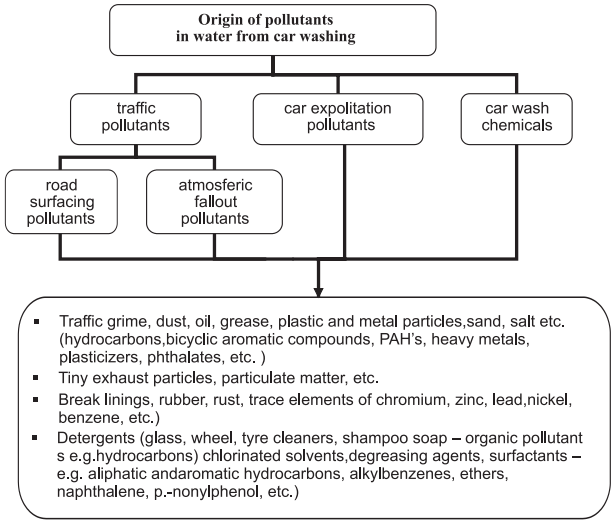

Fig. 1. The main origins of pollutants in water coming from car washing.

In-bay automatic car washes, mostly placed at gas stations. The driver parks the car, and the coin-operated car wash-machine moves back and forth over the vehicle to clean it.

Conveyor car washes mean full-service wash. They clean the exterior and interior of the car, while the customer waits outside; exterior-only cleaning is possible as well and the driver stays inside the car. The car moves on a conveyor belt. Friction (brushes or curtains) or frictionless (high-pressure nozzles, touch-less wash) wash may be used.

Touch-free (touchless) car washing technology is the most modern vehicle wash system. It utilizes a touch-free cleaning technique, which means that nothing touches the vehicle except mild soap solutions and water [5]. They perform without contact; therefore, less damage is caused by wash equipment. Moreover, the ability to measure the length and width of each vehicle reduces the consumption of water, chemical solutions and time [5]. Totally touch-free washing is based on high water pressure with low volume flow. The driver parks the vehicle in the wash bay. While the vehicle remains stationary, one (or two) spray arm moves back and forth to clean it. Good cleaning result depends on effective and consistent chemical application [6].

Hybrid car washing technology is the process in which the brush washing is supported with primer prepping to reach high wash quality. Prepping is the chemical prewash (foam application) and high-pressure water jet application to rinse off contamination [6]. Prewash before brush washing limits scratches on the car finish by effectively reducing both chemical and physical bondage between soil particles and the vehicle surface, promoting removal of difficult dirt. Hybrid washing combines high-pressure washing and brush or soft cloth washing operation [5]. A touchless cleaning in-bay requires more attention from car wash operator because the process needs suitable chemicals, temperature and water pressure with high-quality soft water to work smoothly.

Nowadays, the major goal in car wash technology is to reduce friction (coming from cleaning brushes or cloth) and manual vehicle prepping, and to produce cleaner and drier vehicles faster [6]. At present, good washing technology leads to high quality of wash and usually to high water consumption. The car wash operator has to balance (especially in touchless in-bay car washes) some cleaning factors such as time, temperature, chemical concentration and friction of brushes. If one factor is at the improper level, the other must take on its role (e.g. if time is short, additional mechanical or chemical action or higher temperatures are required). More recently, some innovative manufacturers and car wash investors have been able to build environmentally friendly car washes that provide modern washing techniques and allow conserving water and energy, as well as sewer discharge fees, which consequently lead to saving money and the environment.

Economical and Ecological Aspects of Modern Car Wash Technology

The application of modern car wash technologies results in higher cost of equipment and maintenance. Touchless and hybrid technologies are twice as expensive as traditional washing techniques. Moreover, they lead to higher energy consumption as they are operating with water volume of about 200-300 l per car at high temperature (50-60°C) and high water pressure (70-100bar), which need suitable electrical power and heat energy [5]. Operators are trying to reduce operating expenses, in particular electricity costs, by using solar and wind energy sources. Although their motives are purely economical, the outcome is beneficial not only for them, but also for their customers and the environment.

Alternative Energy Use in Car Washes

One of the new trends in car washing is solar power. Typically it will include one or more solar panels on the building's roof to heat the water for vehicle washing. Solar pool heating technology helps heat the water. It significantly reduces CO_2 emissions and natural gas consumption [7]. Geothermal heating may also be employed as an alternative heat source that is taken from the ground around the facility. If the location is suitable a wind turbine may be installed. Another method of energy reduction is a variable-speed-drive vacuum pump. The two-pump system is designed to nearly shut down when not in use. Additionally, heat pumps and heat exchangers may improve energy savings [8]. Car wash operator can also cut energy use by other means, e.g. by installing special doors, which are part of energy conservation management. Such doors have an open and closed time operation system that helps to maintain appropriate temperature in the car wash bay,

especially during winter season [5]. During colder weather, the entrance and exit doors will cycle up and down to retain heat.

New Building Materials

Additional savings while investing in a new car wash may be achieved from the building itself. The use of recycled, environmentally responsible materials may lead to lower building costs. Materials may include insulating concrete wall forms made from recycled wood fiber and cement, and single siding made from reclaimed vehicle license plates [8]. Rubber safety mats made of recycled tires, and rubber parking wheel stops, trash receptacles and landscape timbers made from recycled plastic also are good examples of solutions possible to be used in the car wash industry. Additional features such as wall finish, radiant floor heating and continuous trench drains would help to ensure a safe, low-maintenance building [7].

Chemicals

Environmentally responsible soaps and waxes used in the washing process may improve the water treatment systems. Moreover, chemical savings may be obtained while using a computer to maintain the proper dose of cleaning agent through arms that move smoothly around the vehicle corners and keep the spray aimed at the car [5].

Water Consumption in the Car Wash

High development of transportation and vehicle washing installation causes the amount of water use to rise. Together with rising water consumption, the amount of discharged wastewater and loads of pollutants rise [9, 10]. Only a professional car wash can provide the proper amount of water with the proper pressure needed to safely and effectively clean the vehicle. Home car wash is the process in which people do not realize how much water is being wasted. Fig.2 shows water use for various car wash types. The use of water in the case of touch-free car wash is always higher than in self-service; however, implementing a water-recycling system may reduce it. Modern car washes clean, recycle and reuse water in self-service car wash bays [11]. These systems use much less water than standard car wash premises.

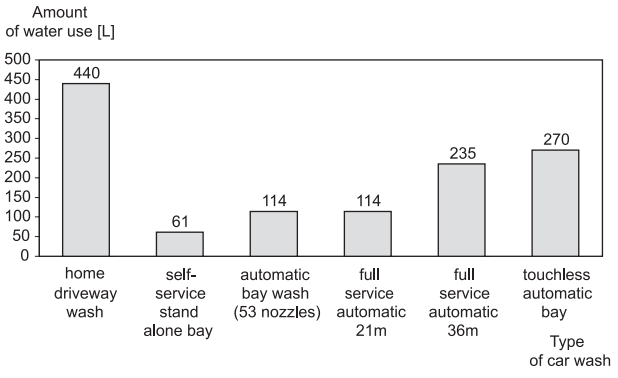

Fig.2. Types of car washes and the amount of water use. (Overworked on the basis of [10]).

Water Conservation

Water conservation in the car wash means the efficient use of water through water recycling systems [4]. Car wash water recycling is the use of wash water that is captured, treated and redirected back into the same water-use scheme (Fig.3). Firstly, wash water undergoes reclamation and then it is redirected for reuse in the wash process [12, 13]. Water reclamation involves treatment of wash and rinse water. A properly designed car wash is connected to a sanitary sewer that carries the wash water to a biological wastewater treatment plant.

Non-biological treatment systems in the car wash industry leave two waste streams, i.e. free oil and oily sediment. However, a properly implemented biological treatment system can address both these issues [14, 15]. If the oxygen level is adequate, aerobic bacteria will develop and consume all organic material in the wastewater without generating odour. Recently, physico-biological methods of water reclamation [14] have been suggested as an easy-to-implement water-treatment solution in the car wash industry, especially for high-pressure wash application.

The car wash investor has to choose the way of handling wash water depending on the locality and combination of solutions he wants to install in the system. He has to consider the volume of water used per day, chemicals and procedures used in the wash or rinse process, the water quality desired to obtain the intended use of the reclaimed water, and the desired quantity for its use, the nature of contamination to be treated and its concentration, discharge limits and others [4].

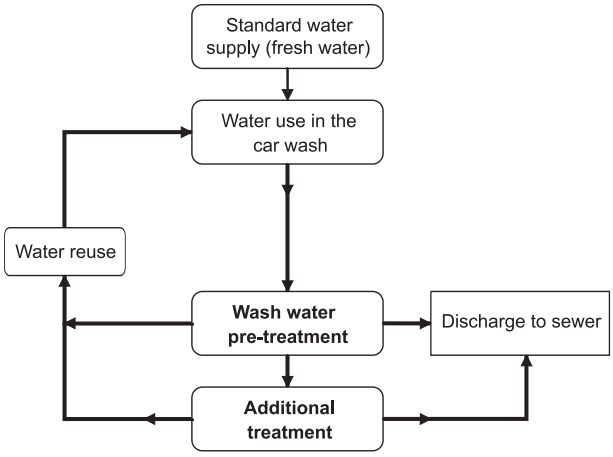

Fig.3. Possible water cycles in the car wash.

The following steps are advised in the advanced wash water recycling system [16]:

a. Pre-treatment (removal of coarse particles and sand),
b. Physical (mechanical) treatment by sedimentation for the removal of suspended solids (treatment efficiency may be improved by the addition of precipitating chemicals),
c. Biological treatment for the removal of organic substances, and
d. Complementary treatment by means of chemical precipitation step or a filtration step (other complementary methods may include activated carbon, reverse osmosis, etc.).

Sludge treatment with the purpose of reducing sludge volume and stabilizing the sludge.

Reverse Osmosis Application in Modern Car Wash

All car wash types can use a reverse osmosis (RO) system for fresh water purification and for water desalination. RO is the tightest possible membrane process in liquid/liquid separation [17]. Water is separated from dissolved salts in solution by filtering through a semipermeable membrane at a pressure greater than osmotic pressure. RO allows removal of particles as small as dissolved individual ions like sodium, chlorine, calcium, and magnesium, metal ions, minerals and organics [13]. RO produces water that meets the most demanding specifications.

Reverse Osmosis in Water Purification

Fresh water contains various amounts of dissolved impurities that are left on the car as spots when the water evaporates. The dissolved impurity level is characterized by total dissolved solids (TDS), measured in milligrams per liter (mg/l) or the equivalent called parts per million (ppm). The more TDS the rinse water contains, the more visible the spots are [18]. The average TDS in tap water ranges from 50 ppm to 1,200 ppm, with an average of about 300 ppm. The RO in the car wash industry may be applied in the purification of fresh water to receive spot-free rinse water. Cars rinsed with spot-free water are allowed to air-dry as they do not have to be wiped off, which eliminates the need for towels and additional personnel to dry cars at the end of the process. Spot-free water should have the level of TDS less than 30 ppm. RO can be easily added in all car wash types [18, 19]. Self-serve locations may offer RO spot-free water as a separate function. Tunnel washes dispense it through a final rinse arch just before the blower. In the RO process, pressurized feed water is pushed through the center of the membrane. As water is squeezed out through the membrane, the membrane captures the solids in the water and the spot-free rinse water is produced. RO is particularly sensitive to feed water temperature as the optimum condition for RO efficiency is 25°C. A typical membrane may lose 1-2% of its flow rate for every degree below that value. A preheater or a larger membrane may be required to achieve the desired level of performance. Pre-treatment is an important part of RO performance as it prevents fouling and premature membrane failure. A 5μm filter is mostly recommended, and where chlorine is present (chlorine can wipe out some membrane), carbon filters may be required to protect certain types of membranes [18]. Another pre-treatment aspect is softening of feed water for an RO system. It prolongs the life of the membrane and the system itself. Softener takes the harder particulates and makes them coagulate or bond together so that they become too large to clog the pores of the membrane.

Reverse Osmosis in Water Desalination

Salt (sodium chloride) is the most commonly used chemical to make winter roads passable. It is a low-cost chemical but in some countries its use is forbidden. About 30 to 85 kg of salt is spread per kilometer in some countries [20]. Salt on the vehicles originates not only from deicing the roads but also from ocean or sea spray. It accumulates on the vehicles, causing and accelerating the already existing corrosion. When the winter season ends, people want to get the salt off their cars. High saline water loads are deposited into the car wash water reclamation system during winter season and at the beginning of spring. If the salt gets recycled with the water, then increasingly concentrated brine is produced with each successive car. Salt may cause some problems in the car wash equipment and it limits water reuse applications. Desalination reduces the amount of dissolved solids in water to a usable level. RO for desalination may be implemented as the last step of a good treatment system [2, 18].

The RO system needs to be maintained properly. Membranes need to be cleaned regularly. The time in-between cleanings depends on the amount of water being produced per day. Desalination by reverse osmosis membranes combined with the use of conventional pre-treatment units as well as more advanced treatment technologies are now well established methods of wash water desalination techniques.

Conclusions

Developments in technology usually lead to environmental impact; however, in the case of a modern car wash such impact can be neutral for the environment. The environmentally friendly, modern car wash requires a good washing technology, proper water recycling system followed by advanced water treatment methods, and compatible washing chemicals. The following conclusions arise from the presented paper:

1. Developments in washing technology provide better quality of wash; however, they also lead to higher water consumption. That is why good car wash reclamation systems are in demand.

2. With frequently rising water costs it makes sense to recycle as much water as possible.
3. Good water reclamation systems based on the biological water treatment followed by filtration technique are innovative and effective water treatment methods that lead to consistently clean reclaimed water for better vehicle wash results. Water recycling system must be compatible with chemicals used to wash a car, and must be prepared for high salt loads.
4. Implementation of a water recycling system into a car wash leads to higher water quality reused in the washing operation, lower fresh water consumption and lower sewer discharge fees.
5. Reverse osmosis can be applied in fresh water purification and reclaim water desalination. Reverse osmosis membranes are highly efficient in rejection of solutes.

Water conservation should go together with energy conservation in order to make the car wash business efficient from the operator's and environmental points of view. Additional savings may be achieved while implementing alternative source of heat (solar energy), which can lower utility costs and lead to savings, despite significant initial costs.

References

1. PAXEUS N. Vehicle washing as a source of organic pollutants in municipal wastewater. Wat. Sci. Technol., **33** (6), 1, **1996.**
2. MADWAR K., TARASI H. Desalination techniques for industrial wastewater reuse. Desalination **152**, 325, **2002.**
3. NORDIC ECOLABELLING BOARD. Ecolabelling of vehicle wash installations. Criteria Document 074/1.7 (October 2000 – October 2007), 15.12. **2004.**
4. BROWN C. Water Conservation in the Professional Car Wash Industry. A report presented at International Carwash Association Meeting, Concord, North Carolina, 17 July **2002,**
5. WILLIAMS E. Drying Systems. Auto Laundry News **4**, 1, **2003.**
6. NORLAND J., NORLAND E. Prestigious Market Creates Unique Challenges. Auto Laundry News **12**, 1, **2001.**
7. RIDDLE J. Carwashes put earth first. Businesses reduce, reuse, recycle. Modern Car Care **5,** 1, **2003.**
8. RUSSO S. Can geothermal heating lower your wash's utility costs? Professional Carwashing & Detailing **5**, 1, **2003**
9. BARTKIEWICZ B. Cleaning of industrial sewage (Oczyszczanie ścieków przemysłowych). PWN, Warszawa pp. 280-281, **2002**
10. ANONIMUS, City of Huston: 'Water Conservation Program', (http://www.publicworks.cityofhouston.gov/utilities/conservation/newsletter/page9.html).
11. HANSEN J. Cleaning up the dirty words of car washing. Modern Car Care **4** (1), 1, **2002.**
12. REITH C., BIRKENHEAD B. Membranes enabling affordable and cost effective reuse of wastewater as an alternative water source. Desalination **117**, 203, **1998.**
13. TCHOBANOGLOUS G., BURTON F.L. Wastewater engineering. Treatment, disposal and reuse. McGraw-Holl Publishing Company, London, pp. 66, 757-758, 1140, **1991.**
14. DANISH EPA. Guidelines to Statutory Order on the Licensing of Waste Water Discharges. Environmental Guidelines **501** (June), 1, **1999.**
15. HENZE M. Trends in advanced wastewater treatment. Wat. Sci. Technol. **35** (10), 1, **1997.**
16. RYDEH L., MIGULAP. P., ANDERSSON M. Environmental Science, Understanding, protecting, and managing the environment in the Baltic Sea region. A Baltic University Publication, Uppsala, pp. 516-518, 532-533, **2003.**
17. WAGNER J. Membrane filtration handbook. Practical tips and hint. Osmonics Inc, Minnetonka, pp. 7, 10, 13, 16-17, **2001.**
18. SAYERS D. Coming Clean at the Carwash Customers value a spot-free wash. Modern Car Care **9** (1), 1, **2002.**
19. OSMONICS INC. Pure Water Handbook *(*2nd ed.), Minnetonka, pp. 37, 77, **1997.**
20. The Wisconsin Transportation Information Center. Using Salt and Sand for Winter Road Maintenance. Wisconsin Transportation Bulletin **6**, 1, **1996.**