Recycle and Reuse Car Wash Water Using Natural Coagulants

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ABSTRACT

People used to wash their automobiles in the backyards of their houses or other convenient locations in the past. People later wash their automobiles at hand wash car washes. Mechanical devices now do this function. In each scenario, the water used to clean the automobile becomes contaminated. If wash water is drained into storm drains, it eventually finds its way into rivers and streams, where it has an impact on aquatic life. If it's drained into sewers, it mixes with sewage, which includes a lot of pollutants and germs, increasing the burden on the sewage treatment facility. As a result, it is required to build a separate water treatment facility at vehicle wash centres, which will reduce the load of sewage water treatment. The installation of vehicle wash centres is a technological advancement. Technology advancements may occasionally have a harmful influence on the environment. The use of a water recycling system in a vehicle wash reduces the amount of fresh water used. As a result, vehicle wash water must be recycled and reused in order to save natural resources. After appropriate treatment, the water treatment facility at car wash centres is obliged to use the waste water obtained from a vehicle wash for washing the next automobile that comes around.

Keywords : Recycling, Washing, Treatment, Coagulants, Car Wash Waste Water

I. INTRODUCTION

Water, along with oxygen, is the most important ingredient for human survival. Water covers the majority of the earth's surface. 97 percent of it is salt water from the seas and oceans. Ice makes up 2% of the total. Fresh water, which is helpful to us, makes up only 1% of the total. This fresh water may be found in two forms: surface water and groundwater.

Agriculture, industry, and families all rely on water for products (drinking water, irrigation water) and services (hydroelectricity generation, leisure, and amenity). Many of these products and services are intertwined and are influenced by the quantity and quality of water available. Water management and allocation necessitates taking into account its distinct qualities as a resource.

1.1 WATER DEMAND

Water demand is skyrocketing due to a variety of variables like rising population, increased agricultural demands, industrial water consumption, water required for energy generation, and so on. This growing demand for water, along with water contamination, will have several negative consequences for the nation's ecology, growth, and economy. Water demand is growing, yet supplies are becoming increasingly scarce. Today's challenge is to learn how to utilise water wisely. As business and people continue to rise, this problem is larger than ever. For us and future generations, water is a valuable resource. It would be impossible to live without it. We must all start using this resource with greater care and efficiency. Not only will conservation conserve our water supply, but it will also save us money. Water recycling may be regarded one of the most efficient strategies of conserving water in this competition.

1.2 NECESSITY OF CAR WASH

While driving, the car's body gathers up a lot of dust and debris. Wind causes the dirt particles to shift, causing scratches and chipping away at the paint. As a result, the metal sheet beneath is exposed to air and moisture, allowing rust to grow. Rust can cause irreversible harm in rare cases. If dirt particles and tiny stones in the car's wheels are not removed, they will enter the wheels and cause significant damage. All of these issues may be prevented simply washing your automobile on a regular basis. Getting your automobile washed on a regular basis will help enhance its performance. As a result, the only effective approach to maintain and keep a vehicle's finish is to wash it often.

Water shortage is a major issue in many cities nowadays, including pilgrim places like Tirupati. Pollution exacerbates water shortage by lowering the amount of clean fresh water available. Recycling and reusing is a strategy that is being used in the majority of water-scarce areas. Both water scarcity and water pollution concerns can be alleviated to some extent if this approach is used in car wash facilities. As a result, a treatment facility for a vehicle wash centre in Tirupati has been planned.

1.3 ANALYSIS OF WATER SAMPLES

To preserve human health and limit the harmful effects of recycled water on the environment, a detailed understanding and adequate monitoring of input and output water quality is required. In addition to wastewater treatment, which is the most significant health protection strategy, it is critical to adopt and enforce rules of good practise.

As a result, a thorough examination of the water used in vehicle washing and the waste water that exits the car wash facility has been conducted, as both require treatment before being utilised as recycled water or discharged into public sewers.

From the vehicle wash centre, two types of water samples are taken. They are:

1) a sample of raw water and
2) a sample of waste water collected after a vehicle wash.

1.4 RAW WATER SAMPLE COLLECTION:

Water for washing the automobiles is purchased from tankers and stored in a sump. A motor pumps the water, which is then utilised for washing. The raw water sample was taken from the S V Magic Car Wash Center's storage sump, which is located near the entrance.

1.5 WASTE WATER SAMPLE COLLECTION:

The waste water from washing the automobiles and bikes is discharged into the sewers via the outlets. The car wash facility has two outlets, one on the floor and the other in the pit beneath the ramp where cars are forced to stand while being washed. Before beginning the vehicle wash, both outlets are blocked to prevent the waste water from forming a pool in front of the outlet. After finishing the whole vehicle wash operation, a waste water sample was taken from the accumulating pool and vigorously stirred.

2. DESIGN OF THE TREATMENT PLANT

The spectrum of technologies that can be used is extensive, ranging from tried-and-true conventional types to the most cutting-edge sophisticated varieties. The ultimate decision will, however, be heavily influenced by local factors, plant size, and water quality criteria. Appropriate selection, defined as the selection of the most proper or "best available" technology in a particular context, is critical for future dependable operation and ensures that appropriate water quality is maintained at reduced operating and maintenance costs.

2.1 DESIGN STEPS

The application of recognised technologies to improve or upgrade the quality of waste water is referred to as waste water treatment. Waste water treatment typically entails collecting waste water in a central, separated place and exposing it to a variety of treatment techniques.

Only preliminary washing should be done with this treated water. To minimise corrosion, vehicle wash shops must utilise water purchased from them for the final wash.

The stages involved in the treatment of vehicle wash water are as follows:

1) Pre-screening (removal of coarse particles and floating particles)

2) Sedimentation as well as collection (removal of sand and dirt)

3) The skimming procedure (removal of oil and grease)

4) Lime soda method (removal of hardness)

5) Sedimentation is a term used to describe the process of sedimentation (removal of precipitates

6) Filtration is the process of removing impurities from (removal of colour and total solids)

2.3 PRELIMINARY DETAILS FOR DESIGN OF TREATMENT PLANT

Due to the tiny volume of waste water involved in car wash facilities, treatment activities are carried out on a number of batches of waste water. According to the information gathered from the car wash facility, the centre is open from 8 a.m. to 8 p.m. As a result, the vehicle wash facility operates 24 hours a day, seven days a week. It will take less than 2 hours for the waste water to flow through the various treatment units. As a result, the water may be treated in six different batches.

The following basic details may be taken into account for the design of various component elements of the treatment plant, according to information given by the S V Magic Car Wash Center officials.

Maximum number of cars washed per day = 15

Maximum number of bikes washed per day = 10

Water required for washing single car = 100 liters

Water required for washing single bike = 50 liters

Water required for washing all the vehicles per day = (100 * 15) + (50 * 10)

= 2000 liters

Assuming the evaporation losses to be negligible,

Total waste water collected per day = 2000 liters

Water used for preliminary wash = 1000 liters

Water used for final wash = 1000 liters

So, the amount of waste water to be treated per day = 1000 liters

Since, the total number of batches are six, the amount of water to be treated per batch = 1000/6 = 166.67 liters

For treating 170 liters of water, the available capacity of tanks in market = 220 liters

As a result, 220 litre water drums are employed as various treatment units. Sintex tanks of 500 litre size were used to collect the waste water after the vehicle wash and the tank used to collect the purified water.

2.4 SKIMMING TANK

With the aid of a half-hp pump, the water from the collecting tank is transferred to the skimming tank in batches of 220 litres each. Skimming tanks, which are located before the sedimentation tanks, are used to remove oil and grease from the sewage. They are therefore utilised in situations when sewage includes excessive grease or oils, such as fats, waxes, soaps, fatty acids, and so on. If these fatty and oily substances are not removed from sewage before it enters additional treatment units, odorous scums may build on the surface of settling tanks, or the filtering process may be hampered.

In a skimming tank, these oily and greasy substances may be removed. To improve the separation of oil and grease from waste water, waste water enters the skimming tank at one elevation and escapes via apertures on the other side of the tank that are at a lower height. A baffle wall prevents the water from entering the tank. This baffle wall aids in driving the rising greasy material into the "stilling chambers" on the side. The oily elements are removed by hand on a regular basis. After that, it can be disposed of by burning or burial.

The skimming tank for removing oil and grease can be circular or rectangular in shape, and the skimming process is illustrated in Figure.

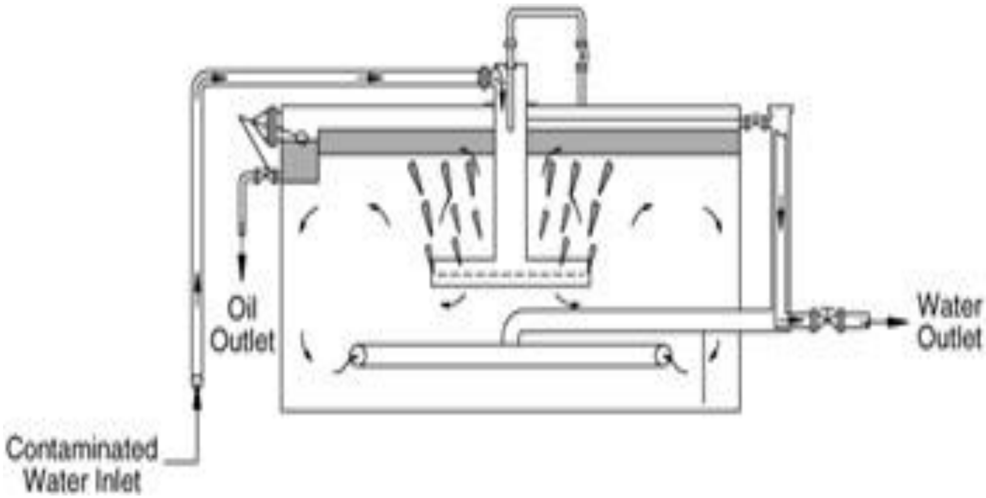

Fig.1 Tank used for Skimming Process

2.5 PIPE CONNECTIONS FOR ADDING LIME AND SODA ASH

In this procedure, specially engineered pipes linked to the main pipe that transports water from the skimming tank to the sedimentation tank drop lime ($Ca(OH)_2$) and soda ash (Na_2CO_3) into the water. Lime and soda ash react with calcium and magnesium salts to generate calcium carbonate and magnesium hydroxide, which are insoluble.

The chemical reactions which are involved in the Lime Soda process are as follows:

i. $Ca(HCO_3)_2 + Ca(OH)_2 \longrightarrow 2\ CaCO_3\downarrow + 2\ H_2O$

ii. $Mg(HCO_3)_2 + Ca(OH)_2 \longrightarrow Ca(HCO_3)_2 + Mg(OH)_2\downarrow$

iii. $MgCO_3 + Ca(OH)_2 \longrightarrow Mg(OH)_2\downarrow + CaCO_3\downarrow$

iv. $MgCl_2 + Ca(OH)_2 \longrightarrow Mg(OH)_2\downarrow + CaCl_2$

v. $MgSO_4 + Ca(OH)_2 \longrightarrow Mg(OH)_2\downarrow + CaSO_4$

vi. $CO_2 + Ca(OH)_2 \longrightarrow CaCO_3\downarrow + H_2O$

vii. $CaCl_2 + Na_2CO_3 \longrightarrow CaCO_3\downarrow + 2NaCl$

viii. $CaSO_4 + NaCO_3 \longrightarrow CaCO_3\downarrow + Na_2SO_4$

Lime aids in the removal of all carbonate hardness created by Calcium and Magnesium, and it reacts with Magnesium's non-carbonate hardness to convert it to Calcium's non-carbonate hardness. Calcium's non-carbonate hardness is eventually eliminated by soda. Lime also aids in the removal of any free dissolved carbon dioxide that may be present in the water.

The following results were obtained from the study of a waste water sample acquired from a car wash centre:

Total hardness	=	860 mg/l as $CaCO_3$
Total alkalinity	=	232 mg/l as $CaCO_3$
Carbonate hardness	=	232 mg/l as $CaCO_3$
Non-carbonate hardness	=	628 mg/l as $CaCO_3$
Calcium hardness	=	140 mg/l as $CaCO_3$
Magnesium hardness	=	720 mg/l as $CaCO_3$

Based on the analysis presented in the previous chapter, the dosage of lime and soda ash are to be calculated.

2.6 DOSAGE OF LIME

From the chemical reactions involved in lime soda process, we can say that lime converts the entire Magnesium hardness into Calcium hardness in 1:1 molecular ratio and carbonate hardness of Calcium finally uses lime in 1:1 molecular ratio. The original carbonate hardness of Calcium and Magnesium will require lime. Thus, the entire carbonate hardness requires lime, in addition to the lime required by the Magnesium hardness.

Total hardness to be removed by lime = Magnesium hardness + non-carbonate hardness

= 720 + 628 mg/l as $CaCO_3$

= 1348 mg/l as $CaCO_3$

From molecular weights, 100 parts of $CaCO_3$ requires 56 parts of quick lime (CaO) for treatment, or

100 mg/l of $CaCO_3$ requires = 56 mg/l of CaO

Therefore, 240 mg/l of $CaCO_3$ require = (56/100) * 1348 mg/l of CaO

= 754.88 mg/l of quick lime

Since, 1000 liters of water is treated per day, quick lime required = 754.88 * 1000

= 754.88 gm

2. 7 DOSAGE OF SODA ASH

From the chemical reactions involved in lime soda process, we can say that the removal of non-carbonate hardness of Calcium and that of Magnesium require soda. Hence, soda is required to remove the entire non-carbonate hardness.

Total hardness to be removed by soda ash = non-carbonate hardness

= 628 mg/l as $CaCO_3$

From molecular weights, 100 parts of $CaCO_3$ requires 106 parts of soda (Na_2CO_3) for treatment, or

100 parts of $CaCO_3$ requires = 106 parts of Na_2CO_3

Therefore, 628 mg/l of $CaCO_3$ require = (106/100) * 628 mg/l of Na_2CO_3

= 665.68 mg/l of soda

Since, 1000 liters of water is treated per day,

Soda Ash required = 665.68 * 1000

= 665.68 gm.

2.8 SEDIMENTATION TANK

The water flows from skimming tank to sedimentation tank through gravity with high velocity. Because of this, turbulence is created and the added chemicals get mixed up with the water. The chemical reactions take place and precipitates are formed. These precipitates must be removed in the sedimentation tank by settling. Otherwise, they may cause troubles by getting deposited on the filter to cause enlargement of the sand grains called “incrustation of filter media”. To avoid this problem, the water must pass through the sedimentation tank before filtration. The sedimentating process is presented in Fig.2.

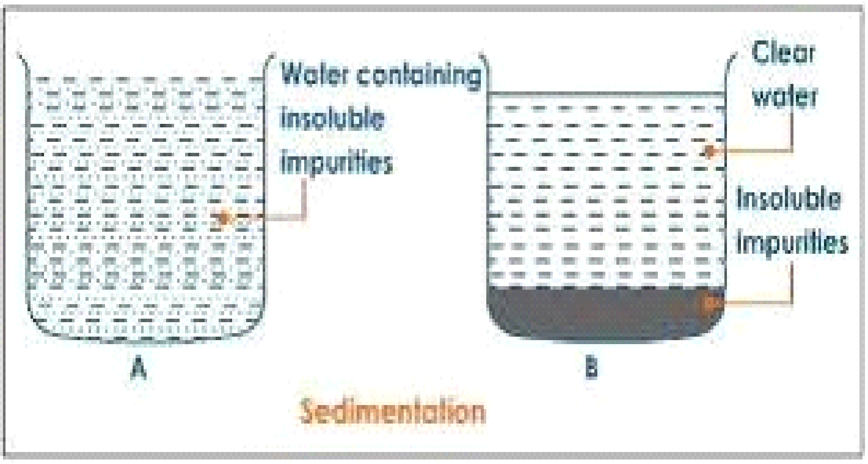

Fig.2: Sedimentation Process

II. RESULTS AND DISCUSSION

The analysis was done on the collected samples to determine the physical and chemical parameters only. Since the recycled water is used for car washing only, the biological parameters are not required and are not tested. The results of Physical and Chemical parameters of Water analysis are presented in table.

Table 1: Physical and Chemical Characteristics of Water Samples

S.No	Parameter	Raw water	Car wash water	Remarks
1.	Turbidity	0 NTU	155 NTU	Increased by 155 NTU
2.	Total solids	500 mg/l	8600 mg/l	Increased by 8100mg/l
3.	Settleable solids	0 ml/l/hr	10 ml/l/hr	Increased by 10 ml/l/hr
4.	PH	7.45	8.00	Increased by 0.55
5.	Alkalinity	212 mg/l as $CaCO_3$	232mg/l as $CaCO_3$	Increased by 20mg/l as $CaCO_3$
6.	Phosphates	0 mg/l	4.9 mg/l	Increased by 4.9mg/l
7.	Hardness	488 mg/l as $CaCO_3$	860 mg/l as $CaCO_3$	Increased by 372 mg/l as $CaCO_3$

From the results obtained from the analysis done on raw water sample and waste water sample, the following inference can be drawn:

- The turbidity, total solids and hardness in waste water sample are very high when compared with that of raw water sample.
- The phosphates, sulphates, oil and grease are increased in small amounts.
- The change in pH, acidity and alkalinity is negligible.

Thus, we can conclude that, turbidity, total solids, hardness, oil and grease must be removed from the car wash water by giving suitable treatment, so that the treated water can be reused for preliminary wash in the car wash process.

3.1 ESTIMATION OF PROPOSED TREATMENT PLANT

Cost of 2 sintex tanks of 500 liters capacity = 2000 * 2 = Rs.4000/-
Cost of CRI pump (1/2 hp) = Rs.2200/-
Cost of 3 water drums of 220 liters capacity = 800 * 3 = Rs.2400/-
Cost of 10m length of PVC pipes (1 inch) = 10 * 50 = Rs.500/-
Total cost = 4000 + 2200 + 2400 + 500
= Rs.9100/- (Nine Thousand and Hundred Rupees)
Cost of pipe connections, joints and installation charges = 20% of total = Rs.1820/-

Total cost of installation of water treatment plant = 9100 + 1820
= Rs.10920/-

3.3 ECONOMICAL ASPECT OF PROPOSED TREATMENT PLANT

In the car wash center, the raw water used for washing cars is bought from tankers and stored in a sump. The tanker water once bought is used for three days for washing. The capacity of each tanker = 6000 liters.

So, each day 2000 liters of raw water is being used on an average. The cost of each tanker will vary between Rs.300/- and Rs.400/- based on the seasons.
On an average, cost of each tanker of water = Rs.350/-.
For one month, cost of water = 350 * (30/3) = 350 * 10 = Rs.3500/-
If the proposed treatment plant is installed and used, at least 50% of the water is recycled and reused. So, tanker water once bought can be used for six days.
Therefore, the cost saved per month = 3500/2 = Rs.1750/-
The total cost for installation of treatment plant = Rs.10920/-, nearly Rs.11000/-.
Due to savings in cost, the installation cost will be recovered in 6 or 7 months, i.e., (11000/1750)
After 6 or 7 months, because of recycling and reusing of car wash water, profits can be achieved.

III. CONCLUSION

The following findings were obtained based on the current research. Improvements in washing technology improve the quality of the wash, but they also increase the amount of water used. As a result, high-quality vehicle wash reclamation systems are in high demand. With water prices always rising, it makes sense to recycle as much as possible. Water recycling at a vehicle wash results in improved water quality reused in the washing operation, reduced fresh water consumption, and lower sewer discharge costs, which lessens the pressure on sewage treatment facilities and preserves the environment from pollution.
Water conservation should be combined with energy conservation to make the car wash operation more efficient for both the operator and the environment. Because the proposed treatment plant has a lower installation cost, this project will be extremely cost effective because advantages may be realised as early as the eighth month following installation, and maintenance expenses are very low in comparison to profits.
Water treatment also decreases pollutants. As a result, the suggestion for a treatment plant at vehicle wash facilities is advantageous not only economically, but also environmentally.

IV. REFERENCES

[1]. Anonimus, City of Huston: "Water Conservation Program", (http://www.publicworks.cityofhouston.gov/utilities/conservation/newsletter/page9.html).
[2]. Bartkiwicz B (2002), "cleaning of industrial sewage" (oczyszczanie scieknow). PWN, Warszawa PP. 280-281,
[3]. Brown.C (July 2002), "Water Conservation in the Professional Car Wash Industry". A report presented at International Carwash Association Meeting, Concord, North Carolina, 17.
[4]. Boussu (2007), " Separation and Purification Technology"

[5]. Burton.F.L,(1991) "Wastewater engineering, Treatment, disposal and reuse". McGraw-Holl Publishing Company, London, pp. 66, 757-758, 1140,.
[6]. Danish Epa, "Guidelines to Statutory Order on the Licensing of Waste Water Discharges". Environmental Guidelines 501, 1.
[7]. Hansen.J, (2002) "Cleaning up the dirty words of car washing, Modern Car Care 4(1)", 1.
[8]. Madwar.K, Tarasi.H (2002), "Desalination techniques for industrial wastewater reuse", Desalination 152, 325.
[9]. Nordic Ecolabelling Board, (October 2000 – October 2007) "Ecolabelling of vehicle wash installations. Criteria Document" 074/1.
[10]. Norland.J, Norland.E, (2001),"Prestigious Market Creates Unique Challenges". Auto Laundry News 12, 1.
[11]. Reith.C, Birkenhead.B, (1998), "Membranes enabling affordable and cost effective reuse of wastewater as an alternative water source", Desalination 117, 203.
[12]. Williams.E, (2003), "Drying Systems", Auto Laundry News 4, 1.
[13]. Zaneti.R.N, Etchepare.R and Rubio.J, (2012), "Applicability of nanofiltration in the carwash industry", Water Science & Technology, 67(1):82-8.

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