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Colombian water sources polluted by car-wash-generated sludge

Abstract

The fact that Colombian hydric sources, despite their great importance, can contain microorganisms, led this study to categorize sludge from car wash, because this activity results inhigh volume of residual water that fluctuates, according to wash demand, between 0.5 and 1.0lt/sec. Detergents, fats, oil, fuels and sediment, among many others, produce very high pollution levels. A three-period experimental design carried out taking random samples of sludge found presence of *Salmonella*, somatic phages, helminth eggs and fecal coliforms coming from three car wash locations around metropolitan Bucaramanga, Colombia. Sludge analyzed was classifiedas category B, apt for different uses in forest plantations, as precursor material in production of construction materials, and energy-valorization processes.

Keywords: bio solids, fecal contamination, residual water, sanitary and bacteriological indicators

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Introduction

One very serious problem for water sources is contamination from car wash, discharged into streams, affecting their quality and potential use. Categorization of sludge, determining its microbiologic and physical-chemical composition parameters, was done to achieve productive use of sludge, potentially helping recovery of natural resources and contamination reduction. In Colombia, car makers treat residual water from car wash using, as work principle, systems or unitary processes like sand and grass traps, commonly used simultaneously to reach efficient water treatment. One characteristic of sludge is the possibility to make organic matter into methane and carbon dioxide, in the absence of oxygen, a process facilitated by interaction of microorganisms.[1] According to Colombia's Ministry of the Environment, year 2000, among the significant, adverse, or beneficial impacts of pump stations, at different stages, are: potential contamination of surface and underground water, soil contamination, alteration of landscape or natural setting, harm to adjacent infrastructure and population stemming from risk of fire or explosion, affected public space, especially along construction, closure and dismantling phases.[2] Colombia's failure to enforce regulation, and its lack of facilities and technology to handle residue, seriously worsen the situation, resulting in increased contamination of water sources by infiltration, sludge lixiviation, soil contamination, and harm to people in areas where the residue is discharged. Such is the reason to categorize sludge generated by Colombia's car wash stationsand its contaminating action of hydric sources, as well as the physical-chemical analysis of sludge from car wash shops in Bucaramanga city, including color, smell, texture, looks, pH, humidity[3] acidity, alkalinity, ashes, Biochemical Demand of Oxygen (DBO_5) and Chemical Demand of Oxygen (DQO)[4] and microbiological classification of sludge produced by the car wash industry, such as coliforms, *Salmonella* , and helminth eggs, viruses, to allow classificationas A, B, or C, taking into account Decree 1287 of 2014 issued by the Ministry of Housing, City and Territory of Colombia.[2]

Materials and methods

Research activities were conducted in three stations in the towns of Floridablanca, Girón, and Piedecuesta, of Bucaramanga City's metropolitan area; sterile 500ml Scotch bottles were used to collect sludge samples from the three car wash stations in six monitoring sessions for a total of 18samples, including duplicates. Data raised in the field and lab results were tabulated indicating their minimal, average and maximal values, so as to identify quantity and quality parameters at sampling place. The study type was experimental, and it consisted of categorization of sludge from some car wash stations in three Colombian cities, using 500ml samples to determine presence of microorganisms. Car wash shop 1 of 3 has a 10-year business trajectory, and is located in the municipality of Santander Piedecuesta, hiring around 30 specialized car cleaners providing high-quality services of car wash, cleaning, readying and decking on an area of around 800 square meters, taking care of around 70 SUVs, pick-up trucks, tourism vehicles with and without trailers, etc., with work on each vehicle lasting between 30 and 45 minutes, according to customer's needs. Car wash 2, in Floridablanca, Santander, with 7 car-cleaning and priming professionals, also offers mechanical and body-paint work on an area of around 200 square meters, servicing only around 50 tourism cars daily. Car wash 3, located in Girón, Santander, promotes itself as a pioneer in car wash services, cleans around 40 large vehicles like buses, and tourism on an area of around 100 square meters.

Sampling was conducted according to regulation NTC-ISO 5667-13 "guidelines for samplingsludge and sewage and water treatment", which sets standards for such sampling, taking into account the following physical-chemical sludge-categorization parameters:

Physical-chemical parameters:

a. Establish pH through SM4500 H+B method Establish DQO through SM 5220 C-034 method;

b. Establish DBO_5 though 5210 B ASTM D888-12 method;

c. Establish ashes and humidity through gravimetric method.[4]

Microbiological parameters:

a. *Salmonella*, through *Salmonella*. NTC 4574 horizontal detection method. Pre-enrichment, lasting 6 hours, was conducted by adding 25g to Scharlau® lactose broth; then, 1 mL of this culture

was planted in Rappaport broth, with isolates carried out through agar XLD (Scharlau®) and Hectoen (Scharlau®); culture was also planted in tubes to determine NMP.

b. Helminth eggs, through NOM–004–SEMARNAT–2002 Official Mexican Regulation, Environmental Protection, Sludge and Biosolids, maximal specifications and limits of pollutants permitted for availing and final disposal.

c. Total and fecal coliforms, through NOM-112-SSA1-1994, Official Mexican regulation, assets and services. Determining coliform bacteria[5] most-likely-number technique. Three series of 3 tubes were used to determine CT, including dilution 10-3, to enable interpretation of results exceeding maximum bacterial detection limit of 1,600 bacteria per 100 ml through the 3-series planting procedure mandated by this technique. Presumptive coliforms testing used Lauryl Tryptose Phosphate Broth (3); upon incubation at 35±1ºC for 48 hours, the material was transferred from the positive tubes into tubes containing bright (2) green Lactose bile 2%, incubated at 35±1ºC for 48 h, whose positive results confirmed NMP of CT.[6]

Results and discussion

The following are the results of the study of the total sludge samples from the three car wash workshops. Table 1 shows the average physical-chemical categorization of the total sludge samples and Table 2 shows the microbiological categorization of sludge, averaged over the totalsamples.[6]

Table 1 shows the physical-chemical average categorization of total sludge samples

Variable	Methods	Results	Units
pH	SM 4500 H*B	7.68	Unidad.pH
DQO	SM 5220 C	44337	mg O_2/L
DBO_5	SM 5210 B ASTM D888-12 Método C	21074	mg O_2/Ln
Ashes	Gravimetric	20,0	%
Humidity	Gravimetric	72,1	%

SIAMA Ltda Laboratory, certified by IDEAM Res. 0833 of 2016, Ext Resolution 0144 of 2018

Table 2 shows microbiological categorization of sludge, as an average for total samples

Variable	Method	Results	Units
Salmonella	Horizontal NTC4574	Absence	UFC/25 g
Helminth eggs	NOM-004 SEMARNAT-2002	<1,0	HH/4g
Fecal coliforms	Horizontal NTC 4458 12/12/2007	$<2x10^{-6}$	UFC/g

SIAMA Ltda laboratory, certified by IDEAM Res. 0833 de 2016, Ext Resolution 0144 of 2018

The results obtained from the sludge samples from the car wash workshops allow the certificationof *Salmonella*, absent; Helminth eggs <1.0HH/4g, and coliforms $<2x10^{-6}$CFU/g, since the sludge discharged from the biological treatment of wastewater is mainly composed of organic matter, with only a small part of solid matter[7] and could end up in the effluents of Colombia.The fact that *Salmonella* is a Gram negative bacterium, facultative aerobic, positive catalase, negative oxidase, facultative anaerobes, lactose fermenter, not sporulated, it has peritrichous flagella, its metabolism is fermentative and oxidative; can ferment glucose with the production ofhydrogen sulfide (H2S) and gas,[8] since it is a mesophilic organism whose optimal growth occurs between 35-43°C with a pH of 7 to 7.5 as a potential cause of absence of Salmonella by the present work, was because the sludge analyzed for this study was maintained at a temperature of 21 to 23°C; however the WHO in 2018 mentioned that Salmonella is one of the four main causes of diarrhea, highlighting that Salmonella is a resistant bacterium and can survive in a dry environment for many weeks and in water for months, in the same way detailed.[9]

Regarding the coliform bacteria found in the sampled sludge, E. *coli* stands out, causing outbreaksdue to consumption of contaminated food including water, the CDC in 2021 reported outbreaks caused by this microorganism that caused 22 sick people and 1 death;[10] Likewise, in Colombia many populations do not have drinking water and the outbreaks for this microorganism reported by the National Institute of Health mention poisonings due to consumption of contaminated water.[11] Results supported the categorization of sludge as category B, apt for agricultural use with sanitaryrestrictions, depending on type and location of soils or crops. EPA, the United States Environmental Protection Agency classifies category B sludge as: 1) bio-solids with concentration of contaminants, and 2) sludge with lower contaminant concentration than Category A, but with reduced type-B contaminants, and it must be used at the same site, as a treatment alternative for reduction of vectors.[12,13] Also, the samples comply with the microbiological and physical-chemical parameters set by Decree 1287 of 2014, meaning sludge is deemed as non-hazardous, usable in sanitary fill-ups, energy valorization in agriculture, cemetery parks, and road dividers, among others, to reach itsimpact on hydric sources.[2]

Conclusion

The sludge was generated by the car wash in Colombia, it causing water pollution, it has been categorized as type B sludge, an alternative for use in forest plantations, inputs in the manufactureof construction materials and energy recovery processes in exchange for expelling them to the water sources.

Acknowledgments

None.

Conflicts of interest

Authors declare that there is no conflict of interest.

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