SUSTAINABLE DECONTAMINATION METHODS OF OIL CONTAMINATED RAILWAY BALLAST – MECHANICAL VERSUS BIOLOGICAL PROCESSES

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ABSTRACT

This work presents the decontamination methods tested and compares the results obtained through the mechanical and sustainable biological processes. The mechanical processes consist in a simulation of a washing method using a cement-mixer and non-biodegradable and biodegradable solvents applied in various concentrations. The sustainable biological processes consist in applying, by spraying, of mixtures/solutions that provide nutrients for the growing of bacteria culture made in the contaminated ballast, in pilot tests. Simultaneously, the same contaminated ballast was immersed in an aqueous preparation made purposely for increase the micro partition of oil molecules that can easily be digested by the microorganisms adapted and reproduced with appropriate nutrients, at laboratory scale. The biological process is optimized through the simultaneous action of the nutrients for the microorganisms, the biodegradable solvent and the hydrogen peroxide (H_2O_2).

1 - INTRODUTION

Most of rail transports are considered low-polluting means of transport to different extents, and therefore are designated as "friends" of the environment. However, there are several aspects of their operation which may constitute an environmental problem. Among these aspects, is to consider different types of contamination of the ballast and the soil in the platform of the railway and in the associated technical installations.

This work is a follow up of works presented previously by Afonso and Jorge (2010) and Afonso (2011), where were described the main ways of environmental contamination of the ballast of the railways that occur with the operation of railway developments.

2 - CONTAMINATION OF THE BALLAST RAILWAY

Environmental contamination by railway projects, essentially, consists in the presence of hydrocarbons and heavy metals. The hydrocarbons are mainly found in the fuels, lubricating oils and creosote.

The long carbon chains (C20 to C50), that compose lubricating oils used in rail projects, have a great persistency in the environment. Their strong adherence to the ballast also contributes to the difficulty in its natural degradation. This type of contamination is responsible for a very significant part of the hydrocarbons in railways.

3 - PROCEDURES FOR THE DECONTAMINATION OF RAILWAY BALLAST

In this work are approached two experimental methods for decontamination of ballast, with high potential for success in view of their cost and feasibility. Are also suggested some modifications to the traditional processes, result of the experiment inherent in this research process. This way new approaches are proposed to solve the problem of contaminated ballast from railroad, based on the methods of washing and sustainable bioremediation.

3.1 - Mechanical Process

The ballast washing occurred using a mixer, two solvents and water. The variables of this process are concentrations, the type of solvents and washing time (Table 1). The solvents were provided by LATECMA – Laboratórios Técnicos de Produtos de Manutenção e Segurança, Lda.

Table 1 – Concentration of solvents used in cleaning the ballast (VS/VA)*

LAT-SOLV.2 (%)	SOLV-LAT (%)	Cicle Time (min.)
10	4; 5; 10	15 washing – 5 rinsing

*VS – Solvent volume; VA – Water volume

The results can be seen in Figure 1.

Figure 1 – Comparison Between Ballast Before and After the Procedure Wash with SOLV-LAT 10%.

3.2 - Sustainable Biological Process

The biological process consists of three specific approaches. The two first based in pilot tests and the third that resulted from laboratory tests, which occurred simultaneously with the second approach. The experimental solutions were different for each experimental batch (the first approach used a different solution from second and third approach), but the essential were the lyophilized bacteria provided by EcoBactérias, representative in Portugal of the company Bio System Europe®.

For the pilot-tests, the real conditions in tunnel and outside railway track were simulated (Figure 2). In the first approach an initial solution with microorganisms (adapted and multiplied) was sprayed in the ballast (Table 2) and, after, daily a solution of water and nutrient was sprayed over the same, trying to simulate a treatment at full scale, during 40 days.

Figure 2 – Experimental Field.

Table 2 - Suggested dosages of EU 80 and water adopted by manufacturer

Quantity of ballast to treat (m^3)	EU 80 (g)	Water volume (L)
1,0	150,0*	30,0
1,0	225,0	45,0

In the second approach was experimented a different aqueous solution, with hydrogen peroxide. The same material subject to the first approach was treated, during 22 days, with the new aqueous solution. In this case, the application of LAT-SOLV.2 promotes the destruction of the carbon longer chains facilitating the action of U.S. 80, however, is hydrogen peroxide (H_2O_2) the great catalyst of this process to provide oxygen to microorganisms, speeding their action. The composition of aqueous solutions used in second and third approach is presents in Table 3.

For the second approach the procedure was: the water was mixed with a biological solvent and sprayed over the ballast. Then, 24 hours after was added water with the microorganisms and the nutrients. Two hours latter was added the peroxide for accelerating the effects of a traditional bioremediation process.

Table 3 – Quantities of decontamination products

H_2O_2 (mL)	LAT-SOLV.2 (mL)	EU 80 (mL)
500,0	500,0	500,0

In the third approach done in laboratory, the ballast was immersed in water with the biological solvent to promote micro partition of the oil molecules, so that these become more available to the microorganisms. Then, 24 hours after was added the microorganisms and the nutrients. Two hours latter was added the peroxide.

The joint action of a biodegradable solvent, a culture of bacteria and of hydrogen peroxide led to obtain satisfactory results in 15 days, as can being seen in Figure 3.

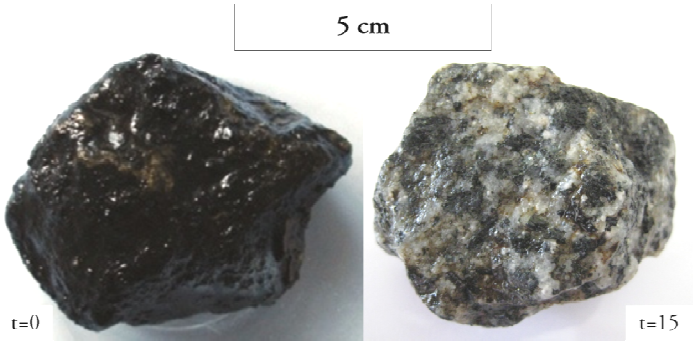

Figure 3 - Ballast Sample Before and After Treatment (time in days).

4 - PRESENTATION AND DISCUSSION OF RESULTS

In the case of mechanical process, the best result was obtained, as expected, with resorting to the use of the most aggressive solvent at the concentration recommended by the manufacturer. The destructive effects of this method were observed.

For the biological process, despite the good indications resulting from the work at the experimental field, the more expressive result has been obtained in the laboratory with the solution developed in one of the approaches.

REFERENCES

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