



A Preliminary Study on the Sublethal Effect of Greases Used in Oil Drilling Wells with Earthworms Assay

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Abstract: As a result of the world's dependence on oil, as well as the impact this production chain has on some producing countries. There is a certain carelessness when the objective is to reduce the impacts that the activity produces on the environment. Thus, investigations on chemical compounds used and produced by this industry are necessary and relevant. In order to identify possible toxic effects on organisms from terrestrial environments, this study analyzed the effects of Kendex OCTG and Jet Lube® Korr-Guard™ thread compounds on *Eisenia andrei* (earthworms). Standard NBR ISO 17512-1 - Soil Quality - Leakage test to assess soil quality and effects of chemical substances on behavior Part 1: Assay with earthworms (*Eisenia fetida* and *Eisenia andrei*) was used. In the earthworm escape, test only Kendex OCTG showed a sublethal effect similar to the reference compound, boric acid, while the tested worms Jet Lube® Korr-Guard™ showed attraction behavior. The ecotoxicological approaches showed that, regarding the sublethality parameter, no ecotoxicological risk was demonstrated in the Jet Lube® Korr-Guard™ dope, while the Kendex OCTG thread compound showed a sublethal to *Eisenia andrei*, representing this risk form for terrestrial organisms. We suggest further studies with other parameters (genotoxicity, neurotoxicity and cytotoxicity, for example) that may add more ecotoxicological information to these products.

Keywords: Terrestrial Ecotoxicology, Earthworm, Oil Production Chain, Avoidance Test

1. Introduction

The oil industry is responsible for generating different types of impacts on the environment [1]. Analyzing the entire production chain, including the numerous stages that combine actions in different modalities, it is possible to understand the grandeur of the processes and their consequences, as well as their effects on the environment [2]. A high demand for products, materials and fuels is part of the

essential inputs for the maintenance of the sector.

When it comes specifically to the drilling of oil wells, the lining of the formation walls is essential for the safety and feasibility of interventions in the reservoir.

Gouveia [3] discusses the complexity of operations at this stage, given the impossibility of reaching the target depth with a single piece due to the risks associated with assembling columns through pipe connections in a risky environment. These wells must resist to internal (related to drilling fluids), external (related to rock formations and fluids

surrounding the casing) and axial (related to the weight of the casing string) actions.

In order to facilitate the understanding, casing tubes can be understood as tubular elements equipped with pin and box connections at their ends, which allows a union between them through the application of specific torque. Koehler [4] portrays relevant, primordial and usual operational details, and therefore mentions the application of greases in connections (popularly called threads) and their main functions.

In the oil industry in Brazil, there is a need to use coatings in all types of wells and most need to apply grease both for the conservation of steel during the storage period and for the lubrication and stabilization of parameters during maritime operations (offshore). In the field, the investigation of the potential toxic effects of these products (known as thread compounds) became an object of study [5].

The greases used by the industry are chemical compounds that, by their very nature, are not naturally expected by organisms and animals that may come into contact [6]. Gomes [7] considers that the situation is detailed in this case, both with regard to both legal provisions that allow disposal and indicates the possibility of due to malpractice, recklessness or negligence.

Baptista et al. [8] calls attention to the risks in the onshore environment and highlight the demand for contingency plans that can be activated in the event of an undesired event. Aslan et al. [9] highlights the importance of a questioning attitude in face of practices that involve risk to the environment, even if implicit in processes where criticality is more evident.

A tool that can produce important information about the toxicity of these compounds is Ecotoxicology. According to Zagatto [10] interprets ecotoxicology as “a science that can provide important information to environmental managers regarding environmental monitoring, pollution control and the prediction of impacts for different compartments (air, water, soil and sediment).”

Cunha [11] highlights that “the purpose of ecotoxicological analysis is to know if, and to what extent, chemical substances, isolated or in the form of mixtures, are harmful, and how and where they manifest their effects”. Therefore, the advantages arising from ecotoxicology products are numerous, including the variety of possible applications of the practices adopted in this science. The investigation of potential substances harmful to the environment also demands experiments aimed at knowing the reaction of terrestrial organisms [12]. Among so many existing preventive actions, the leak test is presented as a tool that is relatively simple to use and that quickly generates results. Widely used in research involving pesticides, they allow the identification of the spontaneous behavior of earthworms through exposure to soils contaminated with chemical products whose harmful potential is desired to be known [13, 14, 15].

In this work, the escape test aiming to investigate the reaction of *Eisenia andrei* earthworms to contact with soil intentionally contaminated with Kendex OCTG greases and API Modified Jet Lube® Korr-Guard™ was carried out and

culminated in a result with the potential to encourage further studies with products widely used and whose public records of studies were not located until the issuance of this record.

2. Method

2.1. Applied Method

The research was quantitative, applied, descriptive and experimental, regarding, respectively, the approach, nature, objective and procedure, according to the classification registered by Gerhardt and Silveira [16].

In the study, a methodology standardized by Brazilian Association of Technical Standards (ABNT) was used. The performance of test, by ABNT NBR ISO 17512-1 - Soil Quality - avoidance test to evaluate the quality of soils and effects of chemical substances on behavior Part 1: Test with earthworms (*Eisenia fetida* and *Eisenia andrei*) for terrestrial environment [17].

The grease samples were obtained by donation (from oil companies that routinely stock such products, due to the frequency of use).

2.2. Avoidance Test with Earthworms

The leak test was carried out in accordance with ABNT NBR ISO 17512-1 - Soil Quality - Avoidance test to evaluate soil quality and effects of chemical substances on behavior Part 1: Test with earthworms (*Eisenia fetida* and *Eisenia andrei*).

Latosol collection was carried out in Bairro Rasa - Armação de Búzios/RJ. The soil was sieved as determined by the standard. Earthworms were made available at the Laboratory of Ecotoxicology and Environmental Microbiology - LEMAM (Instituto Federal Fluminense - Campus Cabo Frio) and were not fed during the test.

Cleaning the material, sorting the worms, concentrating the grease and the reference substance (boric acid) were based on the standard cited above.

The exposure of earthworms allowed the observation of the behavior of the *Eisenia andrei* species through contact with control soil (hydrated with distilled water), Jet Lube® Korr-Guard™ and Kendex OCTG greases at a concentration of 100mg/kg of oxisol. The containers were divided into sections A (test) and B (control). Four replicas with 10 earthworms each were distributed in 1.5-liter containers, divided into two sections. The earthworms were submitted to an acclimatization period of 24 hours, were not fed during the test and remained at 21°C of environment temperature, light and dark photoperiod of 12/12 hours for 48 hours. Boric acid (750 mg.Kg⁻¹) was used as a reference toxic substance.

The results were obtained according to the formula expressed in ABNT 17512-1, where “the average number of earthworms in the test soil is compared with the average number of earthworms in the control soil [negative responses (= earthworms prefer the test soil) are considered as 0% leakage] according to Equation”:

$$x = \frac{nc - nt}{N} \times 100$$

"Where: x is the leak, expressed as a percentage; nc is the number of earthworms in the control soil (both per test container and in the control soil of all replicates added together); nt is the number of worms in the test soil (both per test container and for all replicates); N is the total number of earthworms (usually 10; both per test container and in the control soil of all replicates added together)".

3. Results and Discussion

Despite the operational characteristics that range from the promotion of lubrication and anticorrosive protection to the stabilization of parameters that determine acceptance criteria during the process of using the products, it is clear that greases used in tubes applied in oil wells are responsible for the contamination and the generation of waste [18]. In this test, the two products used to lubricate pipes in oil wells were tested for soil toxicity. Table 1 presents in detail the behavior of *Eisenia andrei* (earthworms) through exposures during the escape bioassay.

Table 1. Distribution of samples in the escape assay with *Eisenia andrei* (earthworms) after 48 hours.

Type	Samples	Section A (Test)	Section B (Control)
Control	1	3	5
	2	0	10
	3	2	8
Kendex OCTG	1	2	8
	2	3	8
	3	2	8
	4	0	10
Jet Lube Korr-Guard™	1	9	1
	2	7	3
	3	7	3
	4	7	3

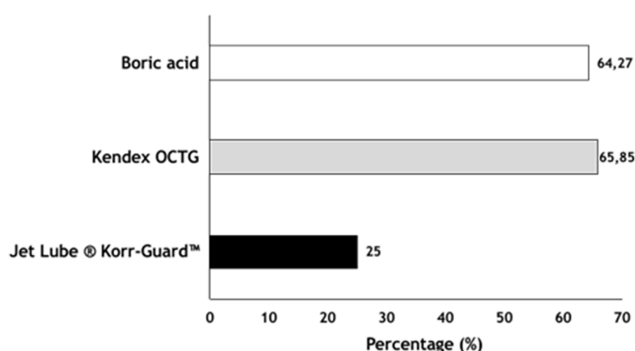


Figure 1. The escape behavior of earthworms after exposure to soils contaminated with Kendex OCTG and Jet Lube ® Korr-Guard™ greases.

The test with *Eisenia andrei* proved to be very suitable for researching the toxicity effects of petroleum products [19]. Lubricating oils have significant toxicity for *Eisenia andrei* [20]. And even after bioremediation processes, soils that have been contaminated with lubricating oils may still show toxicity [21]. In this study, Kendex OCTG grease had a leakage percentage of 65.85%, similar to that of boric acid

used as a toxic reference substance, with a leakage percentage of 64.27% (Figure 1).

In this case, it suggests that this compound has a sublethal effect on terrestrial organisms, and therefore containment and monitoring measures in onshore activities should be considered. In the test with Jet Lube® Korr-Guard™ grease, the earthworms did not show any escape behavior. These results showed that the sublethal toxic effects of greases on *Eisenia andrei* earthworms used in the study can vary. The leakage behavior of Kendex grease is similar to that of other lubricating oils. However, the result with Jet Lube® Korr-Guard™ grease was controversial, given the observation that the worms did not have any escape behavior. Conversely, earthworms exposed to Jet Lube grease showed attraction to the chemical.

4. Conclusion

The soil toxicity test, represented in this study by the *Eisenia andrei* leak test, showed a sublethal result for Kendex OCTG grease. The attraction of earthworms by the soil contaminated with Jet Lube® Korr-Guard™ grease, indicated that this product was not able to present sublethality in the test performed.

More research aimed at understanding the environmental impacts inherent to the practices adopted by the oil and gas segment should be carried out and encouraged from this study. Other parameters that could complement the sublethality assays would be necessary, such as: genotoxicity, neurotoxicity and cytotoxicity. These parameters should be investigated in order to elucidate possible initial impacts at molecular and cellular biological levels. Finally, it became evident that although this productive sector needs to act more in aquatic than terrestrial environments, it is necessary to develop ecotoxicological assessment practices that also involve this environment.

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