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A research work (Project Ref: P07-0224) was requested by EKKO HK Ltd. and conducted by Water and Waste Laboratory at Hong Kong Polytechnic University by Dr. W. Chu and Dr. K. H. Chan. The purpose of this work is to verify the performance of a bioagent, Devoroil, in degrading crude oil in soil.

For a 50% soil contamination level, it was found that the Devoroil can remove 71% of crude oil within 4 weeks of time.

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Report of DEVOROIL in Reducing Crude Oil in Soil

Hong Kong Polytechnic University

Dr. W. Chu and Dr. K. H. Chan

This work (Project Ref: P07-0224) was requested by EKKO HK Ltd. (the Client) and conducted by Water and Waste Laboratory at Hong Kong Polytechnic University (the Lab) by Dr. W. Chu and Dr. K. H. Chan. The purpose of this work is to verify the performance of a bioagent, Devoroil, in degrading crude oil in soil.

The Concepts in Designing Practical Reaction Conditions

The general test conditions followed the instructions indicated by the client as stated in their product website <http://www.sitistroi.ru/en/page455183> and several pre-test discussions between the Client and the Lab. Some specific test conditions were summarized as bellows:

1. The dosages of Devoroil used for the test were:
Soil test: 77 mg of Devoroil was added to 50% contaminated soil (i.e. spiking 5 g of crude oil into 5 g of soil - total 10 g of contaminated soil). The dose of Devoroil depends on the density of the oil used (0.79 in this study). It was determined by the calculator as founded in <http://www.sitistroi.ru/en/calculator>.
2. The tests were conducted for 4 weeks in batch type reactors (see photo). In addition, the oil removal performance was tested and compared to blank samples (without using Devoroil) every week by using Standard Method 5520 B/D/E (APHA 18th edition) as the performance index.
3. Small amount of water and nutrients (using common plant nutrient purchased from market: nitrogen, phosphorus and potassium) were mixed into the soil samples twice a week to maintain the humidity and biogenic elements for bacterium growth in the soil samples. The test was conducted in an open environment to simulate the real application.
4. The working temperature condition of Devoroil is between 20 and 37 °C.

Methodology

The laboratory procedure adopted for conducting the soil test is outlined as follows:

1. Totally 4 batches (2 samples in each batch) of tests were prepared for the 4-weeks

duration (i.e., 1 batch per week)

2. Soil samples were prepared in watch dishes which contained 5 g unrefined crude oil and 5 g soil (through 0.06/0.30 mm sieving). This results in a 50% oil pollution condition. The pH of soil was 7.
3. Among the samples, 4 of them were dosed with 77 mg Devoroil. Thus, each week's samples contained samples with and without the involvement of Devoroil, the latter were used as blank.
4. All the samples were kept in a fume-cupboard with good ventilation until the batch tests had finished. The test temperature was kept at 22 °C.
5. One dosed and one un-dosed samples were taken out for conducting the laboratory experiment each week.
6. The oil content in the soil samples was determined at the laboratory experiments. The experiments were referred to APHA 5520-B,D,E (Standard Methods for the Examination of Water and Wastewater).
7. To extract the oil out of the soil, the soil sample was placed into a thimble first and then setup at the solvent extraction system (Soxhlet method). The oil content in the soil was then extracted by hexane solvent after a cycle of reflux washing operation at the extraction system. After the extraction (3 hrs), the extracted solution was examined by the partition-gravimetric process as indicated in the water sample analysis. Thus, the oil content in the soil sample would be determined by weighting the final solution after the distillation process.

Results

The results of soil sample analysis were summarized in the following Table 1. The Devoroil itself can remove 41% and 27% of crude oil in 4 weeks of time. If the natural evaporation was also included for practical consideration, the removal rates increased to 71% and 28%, respectively.

According to our observations together with the previous test results offered by the client, it is suggested that the performance of Devoroil in the field largely depends on environmental factors. These factors may include temperature, wind, sunlight, wave, crude oil properties, water quality, and soil properties.

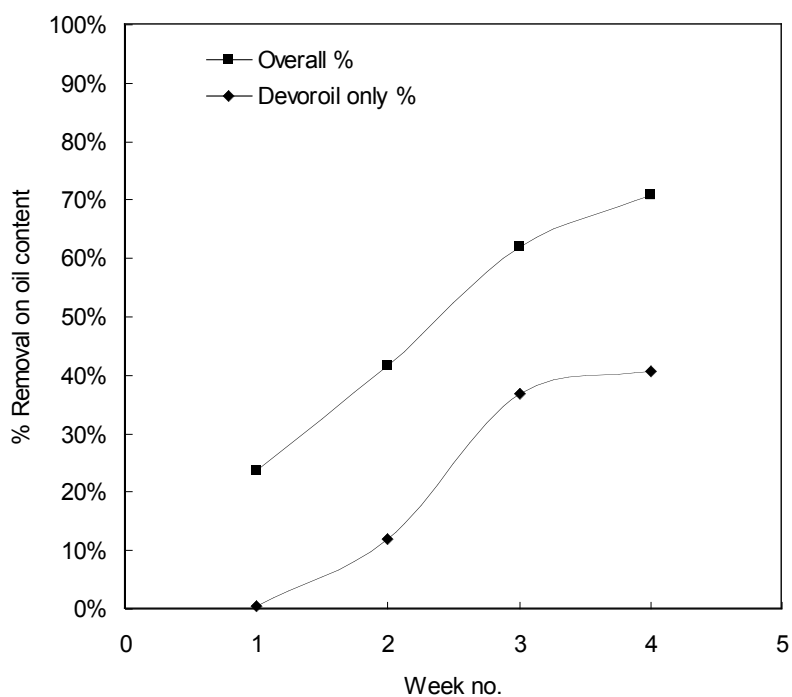
Conclusion

It was found that the Devoroil is useful and can accelerate the crude oil degradation in soil environment.

Table 1 Data of Soil Phase Test

week no.	Removal oil content	
	Devoroil only %	Overall %
1	0.51%	23.68%
2	11.89%	41.53%
3	36.72%	61.99%
4	40.56%	70.80%

Figure 1 The removal of crude oil by Devoroil in soil test.



Appendix Photo collection of this study

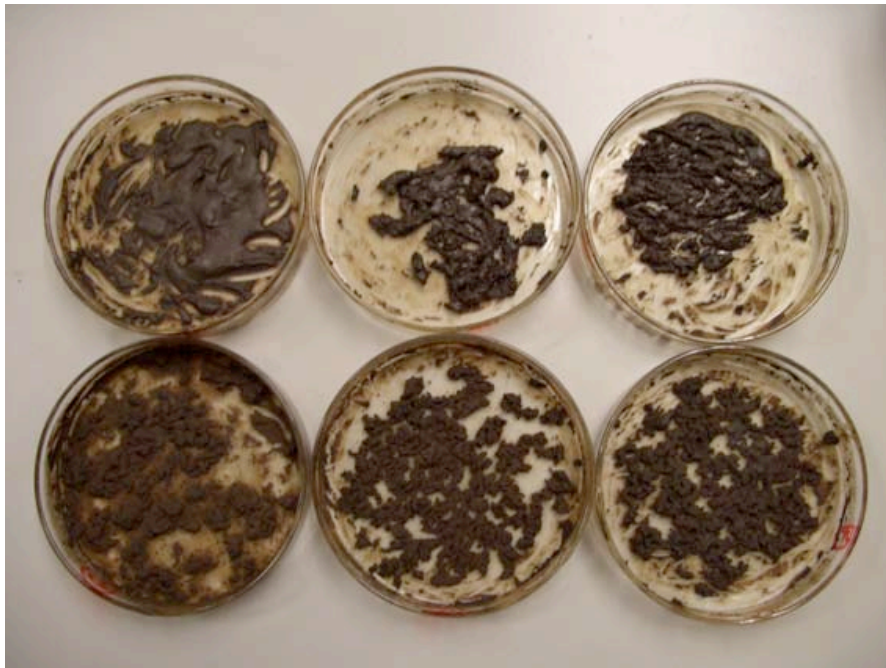


Photo The prepared soil samples; (Top) blank samples without Deovoroil, and (Bottom) soil samples without Deovoroil.



Photo The solvent extraction system (Soxhlet method).



Photo The solvent distilled/recovery apparatus.



Photo The soil test before (left) and after (right) the Devoroil treatment after 4 weeks.