Australian Journal of Basic and Applied Sciences, 9(28) Special 2015, Pages: 150-154

ISSN:1991-8178

Australian Journal of Basic and Applied Sciences

Journal home page: www.ajbasweb.com

Acute Toxicities of Drilling Fluids towards Guppy Fishes and Ghost Shrimp

Abdul Razak Ismail, Wan Rosli Wan Sulaiman, Mohd Zaidi Jaafar, Shum Weng Yih and Nurul Jannah Ismail

University Technology Malaysia, Petroleum Engineering Dept., Faculty of Petroleum and Renewable Energy Engineering, 81310 Johor Bahru, Malaysia

ARTICLE INFO

Article history:
Received 23 June 2015
Accepted 25 July 2015
Available online 30 August 2015

Keywords:
Drilling fluid, palm oil ester, toxicity, lethal concentration, environment

ABSTRACT

Background: Environmental regulations are diverse, complex and have a tremendous impact on drilling operations, economically as well as logistically. As an alternative to conventional oil based drilling fluids, the oil and gas industries are trying to substitute these conventional oil based fluids with environmental friendly drilling fluids. **Objective:** In this study, sarapar-147 (commercially used synthetic oil based drilling fluid) and palm oil ester (newly formulated drilling fluid) have been used as comparison. The comparison was made based on the lethal concentration (LC50) for 96 hours of these drilling fluids towards guppy fishes, Poecilia reticulate and ghost shrimp, Palaemonetes sp. in a static condition. **Results:** Palm oil ester drilling fluid requires 20,000 ppm to kill 50% of guppy fishes in 96 hours compared to 7,000 ppm on synthetic oil based drilling fluids. Meanwhile, palm oil ester drilling fluid requires 3,100 ppm to kill 50% of ghost shrimp in 96 hours compared to 1,200 ppm on synthetic oil based drilling fluids. **Conclusion:** This study also revealed that ghost shrimp has high sensitivity towards exposure of both types of drilling fluids.

To Cite This Article: Abdul Razak Ismail, Wan Rosli Wan Sulaiman, Mohd Zaidi Jaafar, Shum Weng Yih and Nurul Jannah Ismail, Acute Toxicities of Drilling Fluids towards Guppy Fishes and Ghost Shrimp. ***Aust. J. Basic & Appl. Sci.,*** *9(28): 150-154, 2015*

INTRODUCTION

Oil based and synthetic based drilling fluids are increasingly being used in offshore drilling applications in the oil and gas industry. This is mainly due to their satisfactory performance in the drilling operation involving highly deviated or horizontal wells, high pressure and high temperature conditions and their performance characteristics (Dorn *et al*., 2011).

Previous study of drilling activities in offshore Brunei was conducted to evaluate the environmental effects of water based drilling fluid, oil based drilling fluid and ester based drilling fluid (Sayle *et al*., 2003). Sampling of biological abundance was performed at several wells with different drilling fluid systems being used.

Persistent toxic substances from drilling operation have been significantly reduced the Malay Basin ecosystem over the past 20 years and they continue to be present at levels that pose threats to human and wildlife health. Drilling fluids released within sea at Malaysia contribute to this ongoing problem (Evans and Young, 1994).

More recently, researchers have documented the loss of biological abundance due to disposal of different type of drilling fluid that being widely used nowadays. It was found that mortality of the marine life is closely related to the drilling fluid type that used at the well near the affected area (Akbari *et al*., 2009, Umejuru, 2007 and Wills, 2000). Therefore, formulation of drilling fluid must be chosen wisely so that its environmental impact can be minimized.

Hence, more information regarding toxicity effects of different drilling fluid type toward marine life is needed to aid the selection of drilling fluid formulation. In order to provide more necessary information, toxicity effect of oil based drilling fluid and ester based drilling fluid were being investigated in this study. LC50 value of both drilling fluids system were compared so that the severity of their acute effect can be determined.

The research is intended to investigate the toxicity of oil-based and ester-based drilling fluids in various concentrations toward living organisms. In order to achieve the objectives of the research, acute toxicity tests (median lethal concentration, LC50) were performed to investigate the effect of drilling fluid on living organisms. LC50 value is the concentration of toxicant that kills 50% of the tested organisms in 96 hours exposure time.

Corresponding Author: Abdul Razak Ismail, University Technology Malaysia, Petroleum Engineering Dept., Faculty of Petroleum and Renewable Energy Engineering, 81310 Johor Bahru, Malaysia

MATERIALS AND METHOD

Drilling fluid formulation:

Formulation of synthetic oil based drilling fluid and synthetic ester based drilling fluid are prepared using sarapar-147 and palm oil ester respectively with oil-water ratio of 85:15. The components of each drilling fluids are represented in Table 1.

Specimen preparation:

Guppy fishes and ghost shrimps (Figure 1) were acclimatized for at least 12 days before experiment. Each 10 units of the guppy fishes with average size of 4 cm and ghost shrimps with average size of 3.5 cm were put separately in the testing chambers (aquariums) for 12 days under the following conditions:

i. Light: 12 to 16 hours daily
ii. Temperature: 20-24 °C
iii. Oxygen concentration: 17 to 20 % of air saturation value
iv. Feeding: twice daily

Toxicity test procedure:

This research was conducted according to the guideline of The Organization for Economic Co-operation and Development (OEDC), 1992. Five batches of guppy fishes (10 units per batch) were tested under various concentrations of synthetic based drilling fluid and ester based drilling fluid respectively in different aquariums. Total volume of water and drilling fluid mixture was 2,000 ml. Mortality of the guppy fish were recorded at every 24 hours until 96 hours. Experiments were repeated by using ghost shrimp. Dissolved oxygen were recorded throughout the experiments to make sure that the specimens received enough air supply.

Results:

Static, non renewal toxicity tests were conducted for 96-hours and lethal concentration (LC50) value for each specimen were determined. The response of test organisms towards both synthetic based drilling fluid and ester based drilling fluid were recorded as shown in Figures 2 and 3 respectively. Figure 4 shows the value of LC50 for the guppy fishes on synthetic based drilling fluid was 7,000 ppm and 20,000 ppm on ester based drilling fluid.

The experiments were repeated by using ghost shrimp as a test organism. Figures 5 and 6 showed the response of these organisms toward both types of drilling fluids. Figure 7 shows the result of LC50 for ghost shrimp on synthetic based drilling fluid and ester based drilling fluid were 1,200ppm and 3,100 ppm respectively.

Discussions:

Effects of drilling fluid types on guppy fish mortality:

Figures 3 and 4 revealed that at the same drilling fluid concentration and the test period, the synthetic based drilling had caused higher mortality percentage of guppy fish compared to ester based drilling fluid. Synthetic based drilling fluid caused the death of 50% of guppy fish in 48 hours with drilling fluid concentration of 10,000 ppm. However, ester based drilling fluid took 72 hours to cause the death of 50% of guppy fish with the same condition.

The difference in toxicity is mainly due to the based oil used. The extra toxicity effect of synthetic based drilling fluid is mainly due to the based oil component which can rapidly penetrates into the species through gills and disturbs the body systems such as respiration, nervous system, blood formation and enzyme activity. The occurrence of this disturbance leads to a number of common symptoms in terms of behavioral change (Umejuru, 2007).

Effects of drilling fluid types on ghost shrimp mortality:

Acute toxicity test for ghost shrimp shows same trend with guppy fish as shown in Figure 7. The ghost shrimp LC50 value of synthetic based drilling fluid gives 1,200 ppm is compared to ester based drilling fluid which give 3,100 ppm. However, the LC50 value of ghost shrimp for both synthetic based drilling fluid and ester based drilling fluid is lower compare to the LC50 value of guppy fish for both types of drilling fluid. This condition is due to characteristics of ghost shrimps as benthic zone organisms whereas guppy fish are commonly live in the upper water level.

According to Wills (2000), drilling fluids are usually dispersed widely at the upper part of water column and also form suspended particle phase at the bottom. Water level organisms will have less exposed to drilling fluids long enough and at sufficiently high concentrations to elicit any acute or sub-lethal responses. Hence, the ghost shrimps are proven to be more sensitive toward the toxicity effect in this study.

Conclusions:

Ester based drilling fluid is less toxic compared to synthetic based drilling fluid. Organisms that live in the upper part of water level have less mortality when exposed to drilling fluids compared to those live in the benthic zone.

ACKNOWLEDGEMENT

The authors wish to thank Ministry of Higher Education, Malaysia and University Technology Malaysia for funding this project under Fundamental Research Grant Scheme (vote R.J130000.7842.4F437 and vote R.J130000.

7842.4F551) and Research University Grant (vote Q.J130000.2542.08H72). The authors also appreciate Scomi Oiltools Sdn. Bhd. for providing the chemicals and additives and field expert advice.

Table 1: Formulation of synthetic oil based drilling fluid and ester based drilling fluid

Synthetic based drilling fluid	Ester based drilling fluid	Function
Sarapar-147	Palm oil ester	Base fluid
Confi-mul p	Confi-mul p	Primary emulsifier
Confi-mul s	Confi-mul s	Secondary emulsifier
Water	Water	Drill water
Calcium chloride	Calcium chloride	Water phase salinity
Confi-gel	Confi-gel	Viscosifier
Confi-trol	Confi-trol	Fluid loss controller
Lime	Lime	Emulsion stability
Barite	Barite	Weighting agent

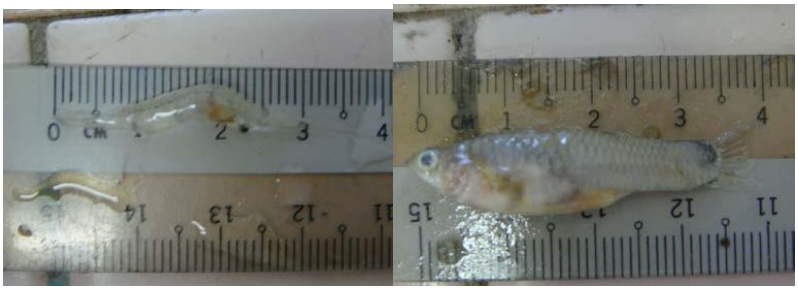

Fig. 1: Test specimens (guppy fish and ghost shrimps).

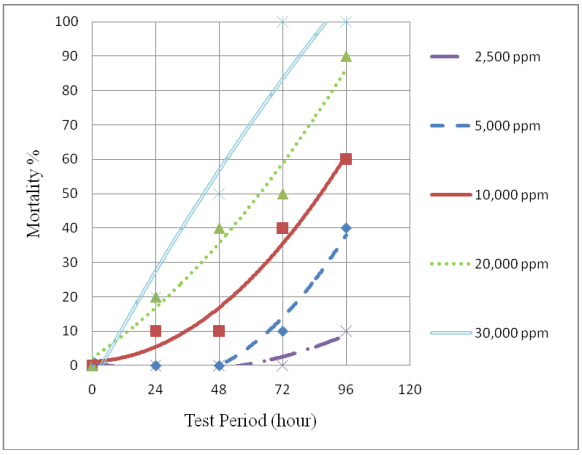

Fig. 2: Mortality rate of guppy fish within 96 hours exposure (synthetic based drilling fluid).

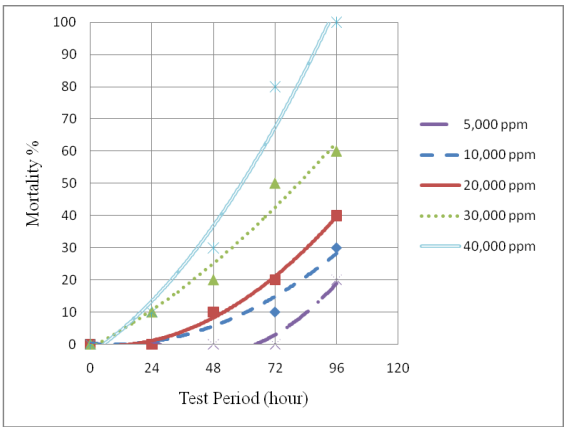

Fig. 3: Mortality rate of guppy fish within 96 hours exposure (ester based drilling fluid).

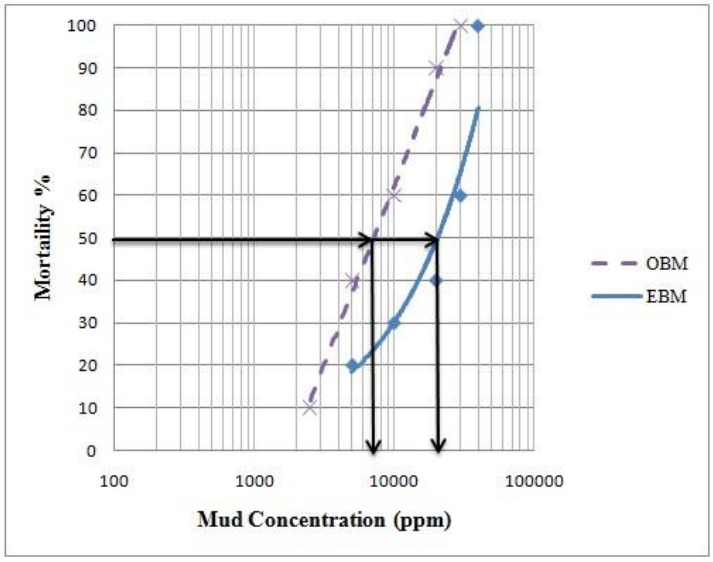

Fig. 4: Mortality of guppy fish after 96 hours exposure at different types of drilling fluid.

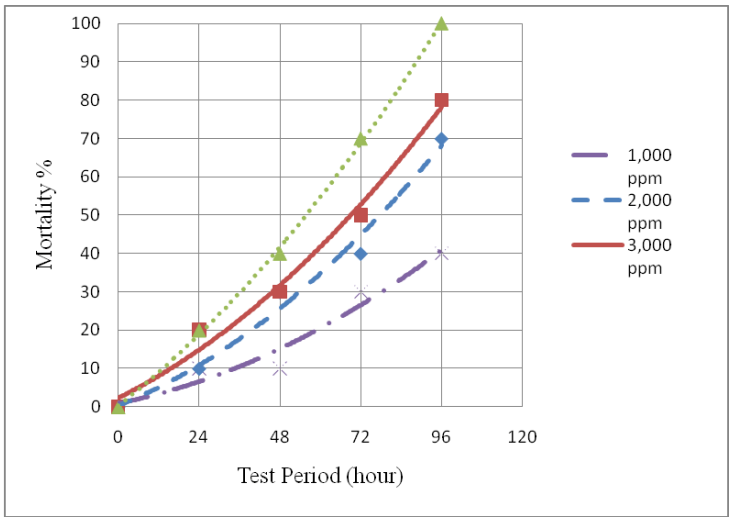

Fig. 5: Mortality rate of ghost shrimps within 96 hours exposure (synthetic based drilling fluid).

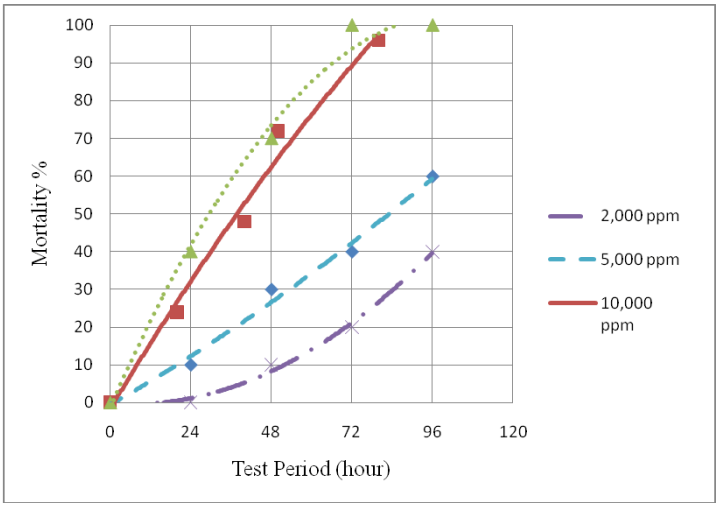

Fig. 6: Mortality rate of ghost shrimps within 96 hours exposure (ester based drilling fluid).

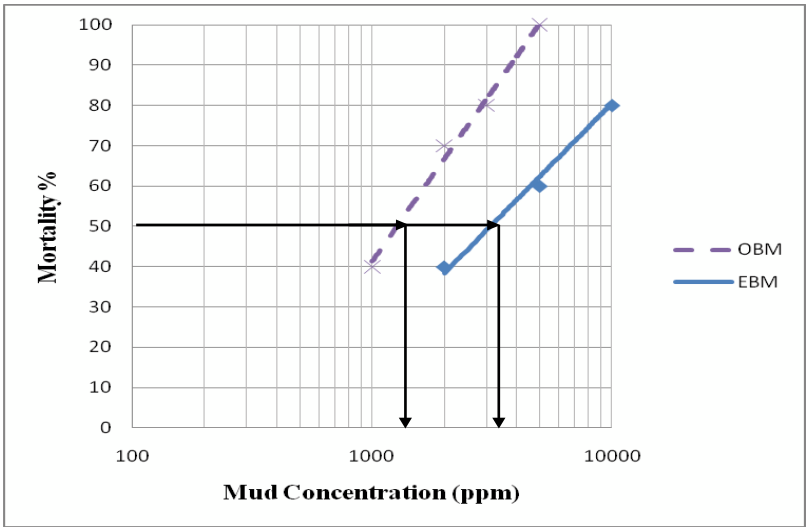

Fig. 7: Mortality of ghost shrimps after 96 hours exposure at different types of drilling fluid.

REFERENCES

Akbari, S., A.T. Law and M. Shariff, 2009. Toxicity of Water Soluble Fraction of Crude Oil to Fish, *Luthjanus Argentimaculatus* and shrimp, *Penaeus Monodon*. *Iranian Journal of Science & Technology*, 28*:* 169- 175. Shiraz University, Islamic Republic of Iran.

Dorn, P.B., D.C.L. Wong, J. Ye and V.A. Martin, 2011. Chemical Properties Affecting the Environmental Performance of Synthetic Based Drilling Fluids for the Gulf of Mexico. *SPE Americas E&P Health, Safety, Security, and Environmental Conference, pp:* 21-23. March 2011. Houston, Texas.

Evans, D.B. and E.F. Yang, 1994. Environmental Issues in Oil and Gas Development in Malaysia. Second International Conference on Health, Safety & Environment in Oil & Gas Exploration & Production, 25-27 Jan. 1994, Jakarta.

Sayle, S., M. Seymour and E. Hickey, 2003. Assessment of Environmental Impacts from Drilling Muds and Cuttings Disposal, Offshore Brunei. *SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production*, pp: 20-22. March 2003, Kuala Lumpur.

Umejuru, O., 2007. Juvnile Crawfish (Procambarus Clarkii) LC50 Mortality from South Louisiana Crude, Peanut and Mineral Oil. Master of Science, Louisiana State University.

The Organization for Economic Co-operation and Development – OEDC, 1992. ISSN: 2074-5761. Medmenham. The Organization for Economic Co-operation and Development.

Wills, J., 2000. A Survey of Offshore Oilfield Drilling Wastes and Disposal Techniques to Reduce the Ecological Impact of Sea Dumping. [Brochure] New York: Sakhalin Environment Watch.