Survey of Methyl Tertiary Butyl Ether (MTBE) toxicity using bioassay on *Daphnia magna*

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In this study, the toxicity of MTBE on the crustacean Daphnia magna (Cladocera) has been studied. At the beginning, for finding the range of sensitivity of D. magna to MTBE, a test had been conducted at 24h. The initial and final tests with synthetic MTBE has been done with solutions containing of water accommodated fractions (WAFs) periods of 24 and 48h and then static bioassay was calculated in two phases of tests and the data were obtained and analyzed by SPSS 13 by using probit analysis. In 24h, lc₁₀, lc₅₀ and lc₉₀ for MTBE on D. magna were 345, 646 and 941mg/l and for 48h, they were 361, 476 and 893mg/l, respectively. Also, the maximum allowable concentration (MAC) of MTBE (WAFs) on D. magna was determined in 24 and 48h, 64.6 and 47.6mg/l, respectively. Results indicated that D. magna could be used for toxicity tracing MTBE in surface and ground

water, because these Crustaceans have perfect resistance against pollution of MTBE. It is also concluded that after 24 and 48h exposure time, there was no significant difference observed in the activity and mortality of *D. magna*.

Since Methyl Tertiary Butyl Ether (MTBE) was used widespread as a fuel oxygenated in gasoline, it commonly contaminates ground water, drinking water, coastal waters, and other aquatic (Werner al., bodies et 2001). Ecotoxicologic studies of MTBE were mainly performed in freshwater ecosystem and reported the concentration of acute toxicity, ranging from 136 to 1000mg/L which varied according to organism Therefore. toxicological species. the studies mixture of chemicals is growing (Hernondo et al., 2002). The main goal of this study was to evaluate toxic effects of MTBE using Crustacean (D. magna). The second goal of this research included

assigning of (MAC) of MTBE and 10% concentration of this material in water.

Static bioassay was calculated in two phases of examination and the data obtained were analyzed by SPSS 13 using probit analysis.

In this stage, the toxicity test has been done on D. magna using water accommodated fractions prepared in the laboratory in 24 and 48h. The results showed that in 24h, mortality of D. magna begun with concentration of 310mg/L and in 48h mortality ended with concentration of 30mg/L and 497mg/L. The results indicated in which concentrations the was zero mortality and in concentrations mortality was 100 percent. At the end. entering by these concentrations into SPSS software, data were analyses in probit model. The analyzation of data was preformed by using ANOVA and effect values of MTBE on D. magna with use of variance ratio (F), chi-square (x^2) and values regression coefficient (Tables 1 to 4).

Data on toxicity of MTBE suggest that this compound has a low toxicity towards aquatic organisms. Acceptable data on the toxicity of MTBE to freshwater organisms were available for three species of fish, six species of aquatic invertebrates, and three species of plants. For example concentrations of 388-2600mg/l, MTBE is toxic vertebrates (Rousch Sommerfeld, 1998). Acute toxicity values LC_{50}) for the rainbow (96h trout (Oncorhynchus mykiss) (Hocket, 1997) bluegill sunfish and (Lepomis macrochirus) ranged from 887mg/l to 1054mg/l (Hocket, 1999). The 96h LC₅₀ estimate for juvenile fathead minnows (Pimephales promelas) was 980mg/l. Also

the toxicity value of MTBE on trout fish had been studied and the obtained results showed that 96h Lc₅₀ value for this fish was 752mg/l (Beigy, 2006). On the other hand, MTBE in water and soil of gasoil which pumps around Tehran had also been studied by Ardalani (2003).

Acute toxicity values for invertebrates, ranged from 340mg/l (48h LC₅₀) for Ceriodaphnia dabia (Hocket, 1997) to 1742mg/l (48h E50 survival) Chironomus tentans (Hocket, Depending on the time of exposure, MTBE is a toxic to invertebrates at a concentration of 57 to >1000mg/l (Werner et al., 2001). EC₅₀ values of 7.4-41.8mg/l have been reported for acute toxicity of **MTBE** towards bacteria such as Salmonella tyhimurium and Photobacterium phosphoreum (Kado et al., 1998). In microalgae, MTBE is toxic at the concentration of 184-4800mg/l, when tested with species such as Selenastrum capricornutum and Synechococus leopoliensis (Werner al., 2001). et MTBE's toxicity D. on magna (EC₅₀=720mg/l) is content with a reported 96h EC30 measurement of 681mg/l (Hernando et al., 2002). Other researchers have claimed that MTBE is not toxic to D. magna at the concentration of 1-1000mg/l in exposures up to 48h (Gupta & Lin, 1995). These results, obtained with the static mode of the D. magna assay are explicable by volatilization of MTBE. Volatilization can greatly reduce the concentration of MTBE seen by the test organisms over duration of the assay (Hernando et al., 2002). In conclusion, MTBE alone is toxic to the tested species at concentrations that are significantly greater than the levels of pollutants

commonly detected in the environment (Hernondo *et al.*, 2002).

In this research, we used standard Checkousluaky (No. 46 6807) (Asobeda & Ukuosa, 1995) (Table 9) in limitation between 100 to 1000 which showed MTBE had low toxicity on *D. magna* and also MTBE did not have significant effects on the organism's mortality. These crustaceans have perfect resistance against pollution of MTBE and the results indicated that *D. magna* could be used for toxicity tracing MTBE in surface and ground water. Therefore, MTBE that was determined after 48h exposure (according to standard of Checkousluaky) had a low toxicity.

On the whole, the animals are sensitive to pollution in all seasons and this depends on metabolic activities and physiological manners of them. So, different species have different sensitivities regarding water accommodated fractions (WAFs) (Shahlapour, 1992). Therefore, MTBE and concentration of pollution in certain times of the year may cause mortality for a species of animals and does not have any effect on the others. Generally circular forms forms Shows more toxicity to chain forms (Piri and Falahi, 1998). The other case is toxicity of some refined since we can't generalize the results yield of finding with the MTBE to other oil products at all.

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References

- Asobeda, Z. and Ukuosa, B., 1995.

 Diagnosis, prevention and illness remedy and fish toxicities. M Multication assistance publication and fisheries development office of total of education and promotion. Own publication, pp1-256.
- Ardalani, E., 2003. [Detection of MTBE in gasoline station around Tehran and health recommendation]. MS. thesis, Islamic Azad University, Tehran. pp.1-106. (in Persian).
- **APHA, AWAH, WEF, 1998.** Standard methods for the examination of water and wastewater. 20th Edition, Part 8000, Toxicity part 7000 70000. pp.8–740.
- Beigy, A., 2006. [Survey of toxicity of Metyl Tertiary Butyl Eether (MTBE) and Arsenic on the trout fish]. MS. Thesis, Faculty of Health, University of Medicine Science, Tehran. 152P. (in Persian).
- Gupta, G. and Lin, Y., 1995. Toxicity of Methyl tertiary butyl ether to *Daphnia magna* and *Photobacterium phosphoreum*. Bulletin of Environmental Contamision Toxicology, **55**, 618-620.
- **Kikuchi, M., Sasaki, Y. and Wakabayashi, M., 2000.** Screening of organophosphate insecticide pollution in water by using *Daphnia magna*. Ecotoxicology Environment Safety, 47, 239-245.
- Kado, N, Y., Kuzmicky, P. A., Joarcapina,G., Mumtaz, M. M., 1998. Cenotoxicity tension of MTBE in the salmonella micro-suspension assay

- and mouse bone marrow micronuleus test. Mutat Research, 412, 131-138.
- Mezcua, M., Aguera, A., Hernando, M. D., Piedra, J., Fernandez–Alba, A., 2003. Determination of Methyl-tert-butyl ether alcoholin seawater samples using purge and trap enrichment coupled to gas chromatography with atomic emission and mass spectrometric detection. Journal of Chromatography A, 999(1-2)81-90.
- **OECD** (Guidelines for the testing of chemicals), 1999. *Daphnia* sp. Acute Immobillisution, Test, 1(2.2)1-25.
- **OECD** (Environmental Health and Safety **Publications Series** on **Testing** and Assessment No.23), 2000. Guidance document on aquatic toxicity testing of difficult substances and mixtures. Environment Directorate organization for Economic Co-operation and Development. Paris, France. September ENV/JM/Mon, (2000)6. pp1-51.
- Piri, M. and Falahi, M., 1998. Effect of Detergents on feeding of *Daphnia magna*. Iranian Scientific Fisheries Journal, Vol. 7, pp.55-6.
- Rousch, J. M. And Sommerfeld, M. R., 1998. liquid gas partitioning of the gasoline oxygenate MTBE under laboratory conditions and its effect of the growth of selected algae.

- Environment contamition Toxicology, 34, 6-11.
- Rausina, C. A., Wong, D. C. L., Arnold, W. R., Mancini, E. R. and Steen, AE., 2002. Toxiciy of Methyl-tert-butyl ether to marine organisms: Ambient water quality criteria calculation. Chemosphere, 47(5) 525–534.
- Shahlapour, S., 1992. [Evaluation of toxicity of crude oil on pearl oyster *Pinetada radiata* and its effects of free amino acids in their homolymph]. MSc. thesis, Department Fisheries, East Guilan Islamic Azad University. 179P. (in Persian).
- 23-USEPA, 2002. Methods for measuring the acute toxicity of effluents to fresh water and marine organisms, W.G. Peltier and C.I. Weber (eds). U.S. Environmental Protection Agency Report EPA/600/4-85/013, Cincinnati, Ohio. USA.
- Werner, I., Koger, C. S., Deanovic, J. A. and Hinton, D. E., 2001. Toxicity of methyl-tert-butyl ether to freshwater organisms. Environmental Pollution, 111, 80-83.

Table 1: ANOVA for data of logarithmic (11) in 24h

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	14,826	1	14,826	1,793	,189
Residual	281,174	34	8,270	-	-
Total	296,000	35	-	-	-

Table 2: ANOVA for data five treat in 48h

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	1,342	1	1,342	,351	,562
Residual	61,158	16	3,822	-	-
Total	62,500	17	-	-	-

Table 3: Coefficient for data of logarithmic (11) in 24h

	Unstandardized Coefficients		Standardized Coefficients		
Model	-		-	T	sig
-	В	Std. Error	Beta	-	-
Case Sequence	,062	,046	,224	1,339	,189
(Constant)	,190	,979	-	,195	,847

Table 4: Coefficients for data of five treat in 48h

Model	Unstandardized Coefficients		Standardized Coefficients	Т	Sig.
-	В	Std. Error	Beta	1	-
Case Sequence	,053	,089	,147	,593	,562
(Constant)	,667	,961	-	,693	,498