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Gelsenkirchen, 08.12.2008

Testing and assessment with respect to wastewater

Reference: Fire extinguishing agent "FireAde 2000 - Fire Fighting Agent" (3%ig)"

Letters dated 19.06.2008, 18.08.2008 and 05.09.2008 and telecom. dated 01.08.2008

Within the scope of the above-mentioned contract award, the fire extinguishing agent "FireAde 2000 – Fire Fighting Agent" produced by the company Fire Service Plus, Inc., 180 Etowah Trace, Fayetteville, GA 30214, USA, was examined with respect to its behaviour on higher and lower aquatic organisms. With respect to the determination of fish toxicology the data of the test report (Report no. 424-222750/110675/2.000, Bestimmung der akuten Fischtoxizität, Prüfgegenstand: „FireAde 2000“) of TÜV Produkt und Umwelt GmbH, D-51105 Köln, Germany, were considered. The product discussed is an aqueous solution designed on the basis of surfactants, which is intended to be employed in a 3 % application concentration for extinguishing fires.

The analytical studies were performed according to the OECD Test Guidelines as well as the procedures laid down in the German Standard Methods for the Examination of Water, Wastewater and Sludge. The examination results are described below along with a short outline of the examination method used and the test conditions selected. The corresponding

examinations in our Institute were in all cases performed with the 3 % aqueous solution of the fire extinguishing agent.

1. Determination of bacterial toxicity

In order to be able to make a realistic assessment of possible toxicity of the product to be examined "FireAde 2000 - Fire Fighting Agent " (3 %) towards lower aquatic organisms a TTC test was performed. The method is based on the fact that the dehydrogenases of the living cells (activated sludge) reduce 2,3,5-triphenyl-tetrazolium chloride (TTC) to red formazan in quantitative dependence on the active cells in each case. In this manner, a direct statement about the toxicity of a substance that is introduced into a defined activated sludge/TTC suspension can be made by a quantitative determination of the amount of formazan formed if the results are compared with those of a parallel sample that does not contain this substance.

As the semi-logarithmic figure (cf. Annex) illustrates, initially the absolute value of formazan formation is above the blank value. The further course of the curve demonstrates that an increase in concentration of "FireAde 2000 - Fire Fighting Agent" (3 %) leads to a decrease in formazan formation, which reaches the blank value at 0.9 ml/10 ml of total solution.

2. Determination of fish toxicity

According to the examination results of the test report (Report no 424-222750/110675/2.000, dated.04.03.2002) of TÜV Produkt und Umwelt GmbH, D-51105 Köln, with respect to the determination of the acute fish toxicity of the product "FireAde 2000" the following EC values were determined for the original product:

EC-0	(48h):	20 mg/l
EC-50	(48h):	40 mg/l
EC-100	(48h):	80 mg/l

Taking into consideration the information of Fire Service Plus, INC., 180 Etowa Trace, Fayetteville, Georgia 30214, USA, dated 16. June 2008 with respect to the toxicological characteristics of the fire extinguishing agent "FireAde 2000" the above-mentioned examination results for the product "FireAde 2000 - Fire Fighting Agent" are in the same order of magnitude.

Based on the above-mentioned. information, the EC 50 can be estimated at approx. 1.330 mg/l for a 3 % solution of the fire extinguishing agent "FireAde 2000 - Fire Fighting Agent".

3. Determination of daphnia toxicity

Daphnia toxicity was determined according to the method described in OECD Test Guideline 202 ("Acute Immobilisation Test") with the test organism "Daphnia magna STRAUS". The effect is determined by measuring the stage of dilution of the water constituents at which a certain percentage of daphnia are still buoyant after expiry of the 48 hour test period (temperature: 20 ± 1 °C; no illumination).

The effects of the mass concentrations of the fire extinguishing agent "FireAde 2000 - Fire Fighting Agent" (3 %) tested on the buoyancy of the small crustacean Daphnia magna are compiled in the following table:

Concentration of the test substance in mg/l	4.000	10.000	20.000	40.000	100.000
Proportion of non-buoyant daphnia in %	0	0	10	95	100

Based on the above-mentioned test results, the effective concentration (EC 50 value) for the fire extinguishing agent "FireAde 2000 - Fire Fighting Agent" (3 %) can be determined as:

$$\text{EC-50 (48 h)} = 26.000\text{mg „FireAde 2000 - Fire Fighting Agent “ (3\%) / l}$$

4. Determination of algal toxicity:

Determination of the inhibitory effect on cell proliferation of green algae was performed according to OECD Test Guideline 201 ("Growth Inhibition Test"). In this test the green algae *Desmodesmus subspicatus* is cultivated with varying concentrations of the test solution in a nutrient solution for 72 hours under defined conditions (23 ± 2 °C; constant illumination at approx. 8000 lux) . At defined points of time (24, 48 and 72 h) the toxicity of the test material is to be checked by determination of the cell count.

The results of the cell proliferation inhibition test are listed below:

"Biomass yield" (0 – 72 h):

EC - 10:	4.880 mg „FireAde 2000 - Fire Fighting Agent “ (3%) / l
EC –20 :	7.840 mg „FireAde 2000 - Fire Fighting Agent “ (3%) / l
EC - 50:	19.330 mg „FireAde 2000 - Fire Fighting Agent “ (3%) / l

Growth rate (0 – 72 h):

EC - 10:	9.950 mg „FireAde 2000 - Fire Fighting Agent “ (3%) / l
EC - 20:	18.830 mg „FireAde 2000 - Fire Fighting Agent “ (3%) / l
EC - 50:	63.390 mg „FireAde 2000 - Fire Fighting Agent “ (3%) / l

5. Biodegradation behaviour

Biodegradation behaviour of the fire extinguishing agent "FireAde 2000 - Fire Fighting Agent" (3 %) was determined manometrically by means of the biochemical oxygen demand following the procedure OECD-301 c (MITI test). This last-mentioned test procedure not only gives a measure of the microbiological-oxidative degradation of the organic constituents, but also allows statements concerning degradation kinetics based on the corresponding course of the curve. The chemical oxygen demand (COD) experimentally determined by the dichromate method, which can be regarded as a measure of the complete mineralisation of the organic substance in the test liquid, serves as the reference value with respect to the degradation rate.

By using the chemical oxygen demand of 9.680 mgO₂/l determined for the fire extinguishing agent "FireAde 2000 - Fire Fighting Agent" (3 %) as the amount of oxygen needed for 100 % degradation, the biodegradation, expressed as BOD, is 1.920 mgO₂/l = 19,8 % after 5 days.

Under the test conditions selected, the microbiological degradation of the biochemically oxidisable constituents is approx. 87 % after 25 days, as can be seen from the graph attached (Annex), which shows the biochemical degradation kinetics determined manometrically.

Summary

With respect to discharge of the product "FireAde 2000 - Fire Fighting Agent" (3 %) into sewage treatment plants via the sewage system, the results of the TTC tests have established that no disadvantageous effects on the biologically active part of a wastewater treatment plant are to be expected if it is ensured that the fire extinguishing agent "FireAde 2000 - Fire Fighting Agent" (3 %) is diluted with other water, e. g. domestic

wastewater, in a ratio of at least 1 : 11 and the wastewater treatment plant is not overburdened by water containing the fire extinguishing agent.

Water containing the product "FireAde 2000 - Fire Fighting Agent" (3 %) should not be discharged into the receiving waters, since it would have a disadvantageous effect on the water quality on account of the determined aquatic toxicity.

Sincerely

Director of the Institute

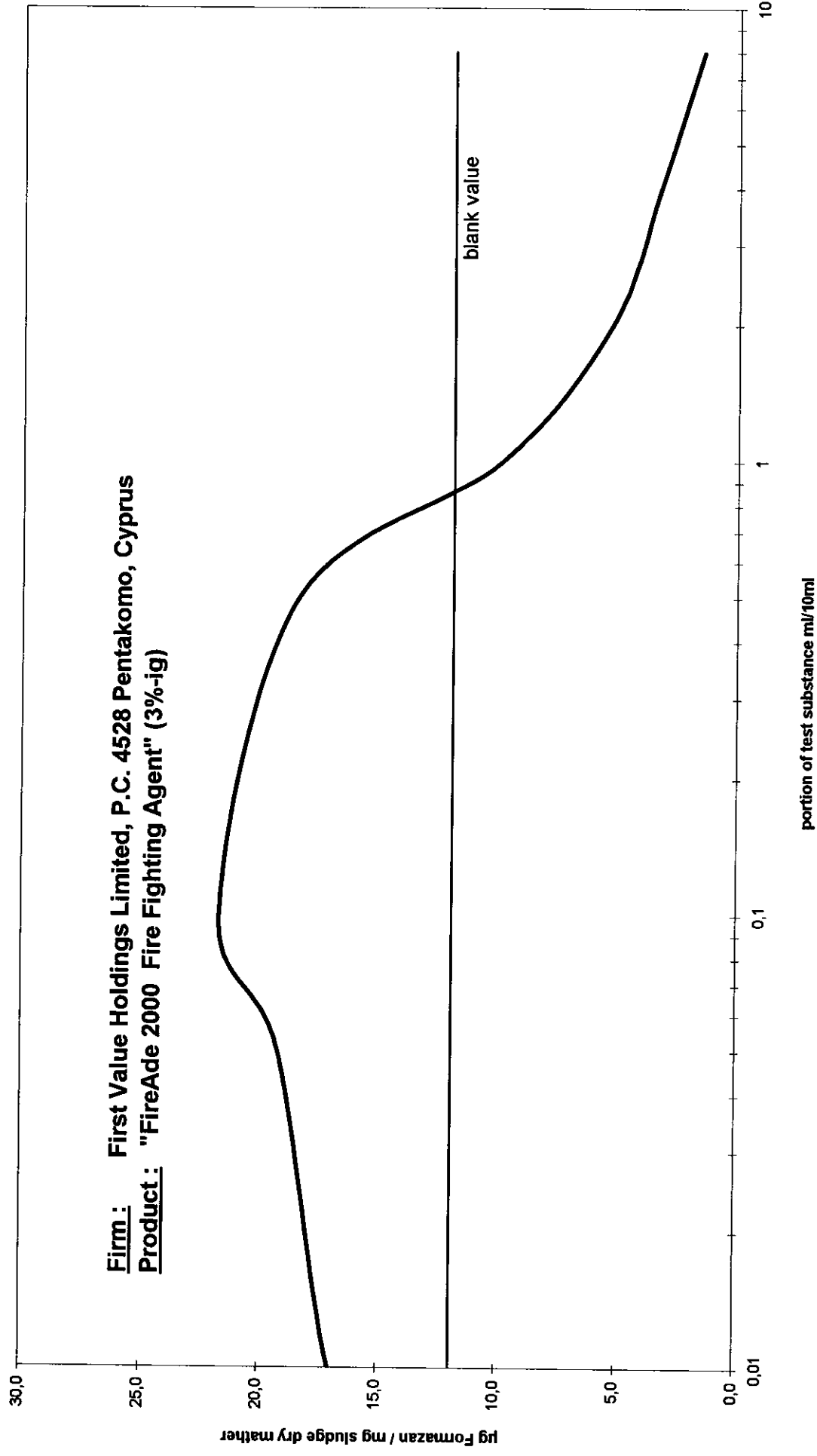
p.p.

Dipl.-Ing. Michael Sauerwald

Leiter der Abteilung
Abwasser-, Boden- und Lufthygiene

Dipl.-Biol. Roland Weiß

Determination of acute bacteria toxicity (TTC-Test)



Biodegradation behaviour

