New Products

Eco-Friendly Foam Extinguishing Agents for Class A Fires

1. DEVELOPMENT NEEDS

Since Japan is blessed with comparatively abundant water resources, we rely solely on water to extinguish Class A fires in buildings etc. Nations with more limited water resources, however, in order to extinguish such fires effectively using smaller amounts of water, have long been engaged in research and development of water additives such as foam extinguishing agents, consisting mainly of surfactants. In the United States there are even areas where virtually all fire-fighting actions involve the use of foam extinguishing agents for Class A fires.

In recent years many countries have used extinguishing foams for Class A fires, and Japan has gradually begun to adopt fire-fighting strategies using them. At the present time, however, most of the foams for Class A fires available on the market are not produced domestically but are imported, mostly from Western countries.

An ecosystem risk assessment for foam extinguishing agents carried out in 1994 by the Forest Service of the USDA found that when direct run-off into rivers and streams occurs, there is a high risk to aquatic life, due primarily to residues of synthetic surfactant constituents, and that consideration must be given to preventing it entering the water system. Similarly in Japan, the 2003 Report on Investigation and Studies Relating to Measures against Forest Fires from the Fire and Disaster Management Agency and the Forestry Agency raises concerns about the direct and indirect effects on the environment of the application of fire extinguishing agents.

Accordingly Furukawa Techno Material has focused its attention not on synthetic surfactants but on soap, the constituents of which break down readily in the natural environment, and by developing a surfactant having soap as the primary constituent, has made possible the realization of an extinguishing foam that causes less damage to the environment. We believe that this extinguishing agent is responsive to environmental needs, and have begun work on product development.

2. R&D PROGRAM

Based on these considerations, therefore, in 2001 Furukawa Techno Material, together with Shabondama Sekken K.K., known for its manufacture of natural soaps, and the Kita-Kyushu City Fire Department, formed a joint development project team. In fiscal 2003, after a 2-year basic research period, a new member was added--Kita-Kyushu Municipal University, Faculty of International Environmental Engineering--in a new project combining private industry, academia and government, and we have begun this R&D work anew based on the new organizational structure. Figure 2 shows the interaction of these R&D entities.

3. PHYSICAL PROPERTIES OF PRODUCT DEVELOPED

The basic constituents are fatty acids extracted from plants that Shabondama Sekken uses in its own products. The complete product developed here (hereinafter referred to as "soap-based extinguishing agent") has the properties listed below, and is suitable for use for fire-fighters actually on the front line.

- Main constituent: Organic surfactant (soap constituent)
- Mixing ratio with water: 1%
- Specific gravity: 1.137 (at 20°C)
- Flow point: -32.5°C
- Ignition point: 100°C or more
- Dynamic viscosity: 49 cSt (at 20°C)

Figure 1 Spraying of water with foam during a Class A fire.

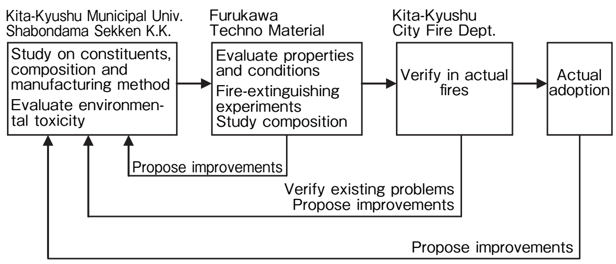

Figure 2 Organization of R&D system.

4. FIRE-EXTINGUISHING PERFORMANCE

Within Japan, where foam extinguishing agents for Class A fires are not widely used, performance standards have not been clearly set forth. Furukawa Techno Materials therefore proposes an experimental model for extinguishing wood fires.

Based on repeated in-house evaluation, a small-scale model was adopted for the fire-extinguishing experiments, and once a clear expectation regarding the desired performance was reached, it was put into practice using the Integrated Experimental Fire-Extinguishing Experiment Building belonging to the National Research Institute of Fire and Disaster, an independent administrative entity, using an A-2 model of the same standard as those used during examination of the performance of fire extinguishers and using 144 pieces of wood of equivalent size (900 x 35 x 30 mm).

As a result of the experiments, as shown in Figures 3 and 4, it was found that repeated spraying using water alone did not result in extinguishment and led to damage and collapse, whereas, in spraying with the soap-based agent under development, the fire was substantially put out by the third spraying. In this way it was confirmed that on an experimental scale we could put out the fire using a smaller amount of water than with water alone. We also confirmed a fire extinguishing performance equivalent to that of existing synthetic surfactant-based foam.

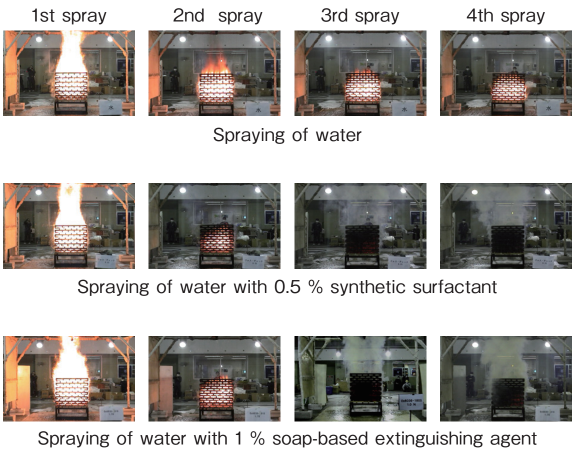

Figure 3 Photos comparing fire-extinguishing experiments.

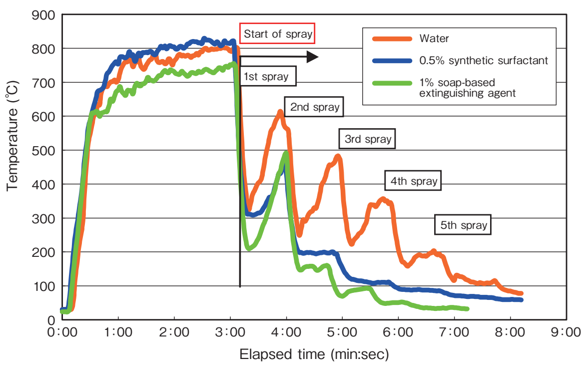

Figure 4 Graph comparing the temperatures at nozzle in experiment for extinguishing wood fires.

5. ENVIRONMENTAL EVALUATION

The soap-based extinguishing agent uses natural oils as the surfactant that is its principal constituent, and therefore aims at reducing the impact on the natural environment by increasing biodegradability.

With respect to impact on the environment, on the assumption that the liquid used in actual fire-fighting actions will flow along the ground and through rainwater drains into streams and rivers and eventually into the ocean, environmental toxicity evaluations on living organisms (Paramecium caudata, green paramecium, and Oryzias latipes (himedaka) were carried out using tap water, river water and brackish water (the water formed by the mixing of river water and sea water in river estuaries).

In evaluations involving Paramecium caudata, the soap-based extinguishing agent was found, as shown in Figure 5 and Table 1, to be from 10 to 200 times lower in toxicity

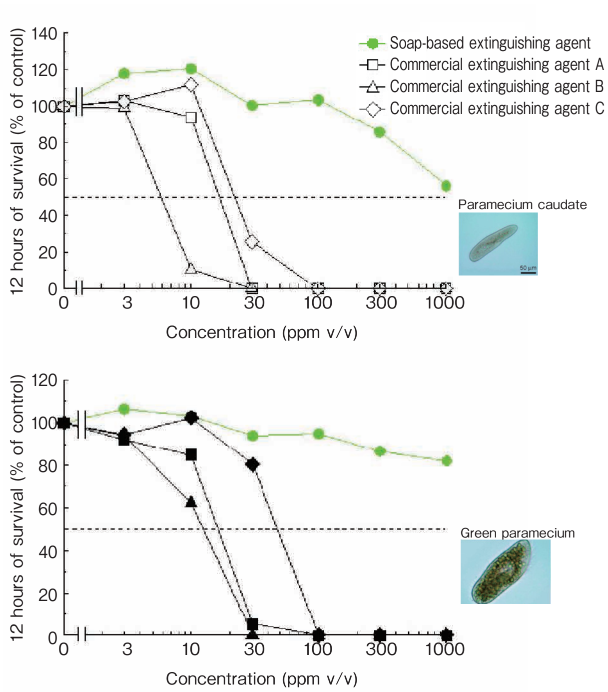

Figure 5 Tests of toxicity to Paramecium caudata and green paramecium.

Table 1 LD_{50} values for Paramecium caudata and green paramecium.

Tap water (boiled)	Paramecium caudata	Green paramecium
Soap-based extinguishing agent	980~1200 ppm	1500~1800 ppm
Commercial extinguishing agent A	17 ppm	17 ppm
Commercial extinguishing agent B	5.8 ppm	13 ppm
Commercial extinguishing agent C	23 ppm	28 ppm
Commercial extinguishing agent D	55 ppm	56 ppm
Commercial extinguishing agent E	50 ppm	51 ppm

than commercially available extinguishing agents.

In fish toxicity evaluations using Oryzias latipes (himedaka), as shown in Figure 6 and Table 2, it was confirmed that as water flowed from a river to its estuary, its toxicity tended to decrease. This is because the soap that is the main constituent of the soap-based agent reacts with minerals in the water (Ca, Mg, etc.) to form metallic soaps, and as a result its surfactancy decreases.

6. VERIFICATION IN ACTUAL FIRES

In parallel with the various evaluations described above, from fiscal 2005 into 2007 ten foam fire trucks of the Kita-Kyushu City Fire Department were supplied with the product being developed here, and were used in fighting actual fires, allowing us to evaluate front-line performance and make improvements in problem areas.

During this period, in addition to improving its temperature characteristics for winter and summer, etc., the firefighters who actually used the soap-based extinguishing agent were asked about their impressions and needs to elicit its advantages. The most prominent one given was the ease with which the foam dissipated. The foam of existing synthetic surfactant-based extinguishing agents persists as much as half a day or more after spraying, interfering with investigations of the cause of the fire and resulting in the danger of poor footing during the fire-fighting operation, and this has been presented as a real concern in fire-fighting manuals from other countries. With the product developed here, on the other hand, the foam dissipates quickly, about 30 minutes after spraying, and it was widely praised for this characteristic, not found in the existing products.

In addition, in fiscal 2006, a full-scale fire-fighting experiment was carried out using municipal housing scheduled for demolition. The building used in the test was an old-style council flat block of quasi-fire-resistant construction (plan: two rooms plus kitchen, area: 26.9 m^2) with a combustion load, including wood, tatami mats, paper sliding doors, etc. of 35 kg/m^2, and recreated an actual multi-unit housing fire. The fire engine used was one specifically intended as for foam fire-extinguishing agents (CAFS) developed by Morita Corporation, a participant in this project since fiscal 2005.

Figure 7 shows the conditions of the fire-extinguishing experiment.

As a result of this it was confirmed that using a 0.5 % mixture, the fire was extinguished by spraying 480 liters (approximately 17.8 l/m^2). According to statistical data from the city of Yokohama, the amount sprayed when extinguishing fires in medium- and high-rise buildings using water was 309 l/m^2. Comparing the data from this experiment, it is confirmed that the fire was extinguished with about 1/17th as much liquid, verifying that the soap-based extinguishing agent developed here enables fires to be extinguished effectively with less liquid sprayed.

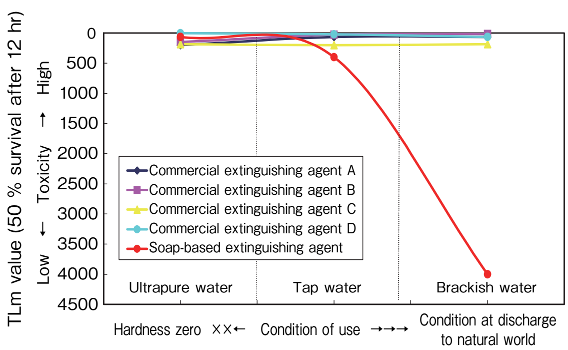

Figure 6 Graph of tests of toxicity to Oryzias latipes (himedaka).

Table 2 Tests of toxicity to Oryzias latipes (himedaka) (50 % survival level).

Tap water	TLm12	TLm24	TLm48
Soap-based extinguishing agent	400 ppm	200 ppm	200 ppm
Commercial extinguishing agent A	25 ppm	25 ppm	25 ppm
Commercial extinguishing agent B	20 ppm	20 ppm	18.5 ppm
Commercial extinguishing agent C	65 ppm	65 ppm	65 ppm
Commercial extinguishing agent D	200 ppm	200 ppm	200 ppm
Brackish water (25% sea water)	TLm12	TLm24	TLm48
Soap-based extinguishing agent	4000 ppm	1330 ppm	650 ppm
Commercial extinguishing agent A	15 ppm	7.5 ppm	7.5 ppm
Commercial extinguishing agent B	65 ppm	55 ppm	20 ppm
Commercial extinguishing agent C	65 ppm	20 ppm	20 ppm
Commercial extinguishing agent D	185 ppm	133 ppm	73 ppm

7. CONCLUSION

As we have seen above, close cooperation of private industry, academia and government has resulted in development of a fire-extinguishing agent that meets the needs of the environment, and has contributed to the development of fire-fighting strategies that represent a radical change from what went before. This fire-extinguishing agent is scheduled to go on the market in the latter part of fiscal 2007.

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Figure 7 Conditions of fire-extinguishing experiment.