Introduction

The Favuseal Fire Barrier System (FFBS) was introduced in 1988 for the protection of glass fiber reinforced epoxy (GRE) piping in the offshore industry, and up to date numerous oil installations all over the world are fire protected by FFBS. The system is based mainly on the Favuseal technology that was developed in the early 80's. A series of tests on FFBS protected GRE pipes have demonstrated the system's excellent properties as a fire barrier. Tests have been made in ovens and under "jet fire" conditions. The results, particularly those for "jet fire" conditions, are convincing. An important fact is that Favuseal is halogen free and does not generate corrosive gasses in fire. Furthermore, Favuseal burns with very low smoke emission. Favuseal AS is the sole marketing and material supplier of the FFBS system. Favuseal AS also provides technical support such as dimensioning of the barrier and an installation manual. For these calculations a well-proven mathematical model is developed.

The Company

Favuseal AS (Norway) is the continuation of the former companies Norsk Safetech AS and PSP Safetech AS. Norsk Safetech AS was originally founded to develop and market products based on the Favuseal technology. This work was later taken over by PSP Safetech AS. In 2005, all activities in PSP Safetech AS were taken over and continued in Favuseal AS.

Today, Favuseal AS concentrates all its resources around the production and marketing of fire protection products and systems based on the Favuseal technology. Favuseal AS possesses considerable knowledge in the field of polymer technology and the mechanisms associated with Favuseal's performance. Favuseal AS can deliver FFBS and other Favuseal products in any quantity anywhere in the world on relatively short notice. Favuseal AS is owned by the Schlytter-Henrichsen family.

The Material

Favuseal is a highly filled thermoplastic compound with unique properties when subjected to high temperatures. The material consists of mineral fillers in a thermoplastic matrix. It is halogen free, has low smoke emission and does not produce corrosive gasses when subjected to high temperatures. When subjected to heat (for example fire), two phase transitions take place. The first phase takes place between 200 and 250°C and the second between 700 and 800°C.

At the first phase transition, crystal water is generated from the (O-H) groups in the fillers. The water evaporates and the reaction is strongly endothermic (heat absorbing). The temperature behind the barrier of Favuseal cannot exceed 250 - 300°C as long as this reaction takes place. The second phase transition is the oxidation of the minerals of the fillers resulting in the formation of the cellular ceramic material. This reaction is also endothermic, although to a lesser extent. The thermal conductivity of this cellular ceramic is however very low, 0,07 W/m°K. The ceramic is stable to temperatures up to 1500°C.

Tests have shown that the total reaction time is dependent upon the temperature and the thickness of the Favuseal test specimen.
The following reaction times will occur in a H-C fire, with temperature of 1150°C:

- Good thermal conductivity in the virgin state 5 mm of Favuseal: 15 minutes
- Good thermal conductivity in the virgin state 10 mm of Favuseal: 30 minutes

Different testing (explosion, jet fire and oven) has been performed on pipes from major producers of GRE pipes. All tests were successful. Some of the test where witnessed by independent parties, such as Lloyds and DnV. The two transitions give Favuseal its unique properties, which can be utilized for fire protection and high temperature insulation. The material can be used alone or in combination with conventional material.

FAVUSEAL® Fire Protection

Data sheet Favuseal NKX-6174

Ceramic-forming thermoplastic compound

NKX-6174 is a thermoplastic compound containing inorganic fillers in a binder composed of an ethylene copolymer. Supplied in pellet form, the compounds may be processed by extrusion, compression-molding or injection-molding. This composition is transformed in a fire from a thermoplastic to cellular ceramic. Other characteristics are:

- Good thermal conductivity in the virgin state
- Good thermal insulation above 200°C
- Swells to approx. twice its original volume in a fire
- Good mechanical stability in its cellular ceramic form
- Acts as a flame barrier
- Halogen free
- Low smoke emission during combustion
- No corrosive gasses produced when burning

During exposure to flame, NKX-6174 goes through the following transformation:

90°C	Softening
200°C	Evolution of water, swelling
300°C	Pyrolysis of the polymeric binders
800°C	Formation of rigid cellular ceramic

Typical properties

	Test method	
Specific Gravity	D-792	1.776
Tensile Strenght, Mpa. 23°C	D-638	3.2
Elongation at break, %, 23°C	D-638	320
Melt Flow, g/10 min.	D-1238 D	2.1
Fire properties:		
Oxygen Index, %	D-2863	37
NBS Smoke Chamber		
Flaming Mode, Dmax	D-2843	407
Smoldering Mode, Dmax		335

Fire Protection of Glassfiber Reinforced Epoxy Pipes

Tests have shown that glass fiber reinforced epoxy pipes, GRE pipes, used in deluge systems will survive in a fire when filled with water. Empty pipes, however, will be damaged after a few minutes and must therefore be protected. In a fire in oil installations the flame temperature very soon reaches 11 50°C (H-C-curve) and the protection should prevent the surface temperature of the pipes exceeding approx. 250°C until the pipes are filled with water. The time until the critical temperature is reached depends upon the quality and dimensions of the protection. The fire impact of the pipes can therefore be divided in two phases.

Phase 1: Empty pipes

Phase 2: Pipes filled with circulating water.

The Favuseal Fire Barrier System (FFBS)

The FFBS is designed to give optimal protection to GRE pipes in a H-C fire. The system is halogen free, has low smoke emission and will not give off corrosive gases. The material is self-extinguishing with a limiting oxygen index (LOI) of 37%. Due to the unique properties of Favuseal, the total addition to the diameter of the GRE pipes is only 16 mm for a typical protection. The concept consists in principle of:

1: An inner layer of Combimat
2: One or more layers of Favuseal
3: An outer layer of glass fiber tape painted with epoxy

Improving the Impact Strength

The FFBS will contribute significantly to the impact of the GRE pipes. This is due to the plastic properties of Favuseal and the cushioning effect of the combimat.

The Physics of the FFBS

A GRE pipe subjected to fire will undergo two phases:

Phase 1:	During phase 1 of the fire, the heat of the flame will first cause Favuseal to swell (100%) and thereby increase the thermal insulation. When the temperatures of Favuseal reaches 250°C, the endothermic reactions starts and although the surface is hot, the temperature of the interior cannot exceed 250°C. Favuseal screens out higher temperatures as long as the reaction lasts. Tests have shown that in H-C fires the reaction of 5 mm thickness lasts approx. 15 minutes, i.e. the pipe insulated with the combimat, is subjected to a temperature of 250°C only during this period.
Phase 2:	When phase 2 of the fire commences, the pipes are filled with water. The endothermic reaction is soon finished and the residue of the burnt out Favuseal is cellular ceramic with twice the volume of the virgin material and with a thermal conductivity $\lambda = 0.07$ W / m°K. The pipes are then subjected to the full temperature but protected by the cellular ceramic and the combimat, both resistant to more than 1 500°C. The inner cooling by the water, combined with relatively good thermal conductivity of the combimat, protects the pipes against damage for hours