

FOAMABLE FIRE RESISTANT COATING COMPOSITION

TECHNICAL FIELD

5 **[0001]** The present disclosure relates to a foamable fire resistant coating composition.

BACKGROUND

10 **[0002]** Temperatures tend to rapidly rise up to about 945°C within a very short time, e.g., 5 minutes, in the event of oil-related fire, which frequently takes place in marine structures or plants. In areas where there is a probability of the outbreak of oil-related fire, curable epoxy-based fire resistant coatings are usually used as fire resistant coatings. However, existing fire resistant coatings are disadvantageous in that a large amount of harmful gases are released during coating expansion.

15 **[0003]** The following three U.S. patents disclose fundamental technology of epoxy-based fire resistant coatings.

20 **[0004]** U.S. Patent No. 4,529,467 proposed a solvent-free, epoxy-based fire resistant coating, which can improve insulation performance and adhesion of the coating to a substrate by forming a foam layer having a small-celled structure in a char using zinc (Zn) when the coating swells in the event of fire. However, when zinc (Zn) is used in excess, the coating may not expand, thereby undesirably lowering insulation performance.

25 **[0005]** U.S. Patent No. 5,108,832 proposed a highly flexible, epoxy-based, fire-resistant coating composition by synthesizing an epoxy resin having superior flexibility. In the proposed patent, an epoxy resin was synthesized using an epoxy monomer having a chain structure, and a fire-resistant coating composition was prepared using the synthesized epoxy resin. The flexibility of the epoxy-based fire resistant coating was predicted by a cold cycle test.

[0006] U.S. Patent No. 6,096,812 proposed a fire resistive coating which can reduce a density of the coating by employing hydrophobic fumed silica, thereby attaining fire resistance while lowering the amount of a coating composition used.

[0007] All of the three U.S. Patents disclose foaming mechanism of a fire resistant coating composition using boric acid and ammonium polyphosphate. Boric acid releases gases at about 170°C while being dehydrated, thereby allowing the coating to be swollen.

According to the foaming mechanisms of the disclosed patents, however, harmful gases can be released, which is problematic.

[0008] Meanwhile, U.S. Patent Application No. 1997-999536 discloses a fire resistant coating, which can demonstrate fire resistance while reducing the amount of coating used, by reducing the density of a coating using hydrophobic fumed silica based on epoxy resin. However, a phosphorus-based flame retardant disclosed in this patent contains triphenyl phosphate (TPP) in an amount of 21 wt% or more and has a pyrolysis temperature below 250°C. Due to low molecular weight, TPP can be vaporized at a lower temperature than the cured epoxy resin, thus an initial foaming rate can be increased. However, when a large quantity of TPP is contained, gas toxicity may be undesirably increased and long-term fire resistance may be lowered.

[0009] There still is a need, therefore, for a foamable fire resistant coating composition, which can reduce the gas toxicity and can improve long-term fire resistance by reducing the amount of TPP contained in the phosphorus-based flame retardant.

DETAILED DESCRIPTION OF DISCLOSURE

PROBLEMS TO BE SOLVED

[00010] The present disclosure is contemplated to provide a foamable fire resistant coating composition, which comprises an epoxy resin, a curing agent, a flame retardant, a foaming agent, an acid catalyst and fiber, wherein the flame retardant contains 20 wt% or less of triphenyl phosphate and has a pyrolysis temperature of 250°C or higher, thereby reducing the gas toxicity, imparting flexibility to a foam layer, and preventing cracks from occurring on a carbonization layer, ultimately improving long-term fire resistance.

MEANS TO SOLVE THE PROBLEMS

[00011] A foamable fire resistant coating composition according to the present disclosure includes 10 to 25% by weight of an epoxy resin, 10 to 15% by weight of a curing agent, 10

to 20% by weight of a flame retardant, 3 to 10% by weight of a foaming agent, 20 to 40% by weight of an acid catalyst and 3 to 10% by weight of fiber, based on the total weight of the composition, wherein the flame retardant contains 20% or less by weight of triphenyl phosphate and has a pyrolysis temperature of 250°C or higher.

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EFFECTS OF DISCLOSURE

[00012] Since the foamable fire resistant coating composition according to the present disclosure has a small amount of TPP, the gas toxicity can be reduced. In addition, since the foamable fire resistant coating composition according to the present disclosure has a relatively high pyrolysis temperature of 250°C or higher, flexibility can be imparted to a foam layer. Further, long-term fire resistance can be improved by preventing cracks from occurring on a carbonized layer. When the gas toxicity is evaluated using a KSF 2271 testing method, the foamable fire resistant coating composition according to the present disclosure demonstrates 12 minutes or more. In addition, when fire resistance is evaluated using a UL 1709 testing method, the foamable fire resistant coating composition according to the present disclosure demonstrates fire resistance of 3 hours or more even without using an additional reinforcement material (mesh).

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BEST MODE FOR CARRYING OUT THE INVENTION

[00013] Hereinafter, the present disclosure will be described in more detail.

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[00014] The foamable fire resistant coating composition according to the present disclosure includes 10 to 25% by weight of an epoxy resin, 10 to 15% by weight of a curing agent, 10 to 20% by weight of a flame retardant, 3 to 10% by weight of a foaming agent, 20 to 40% by weight of an acid catalyst and 3 to 10% by weight of fiber, based on the total weight of the composition. Here, the flame retardant contains 20 wt% or less of triphenyl phosphate, and a pyrolysis temperature is 250°C or higher.

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[00015] The epoxy resin used for the composition of the present disclosure allows a coating to be adhered to a substrate to be coated, and the coating, when cured, demonstrates durability at room temperature. In addition, when the coating is exposed to high-temperature heat in the event of fire, it can be transformed into a fluidized phase to

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expand appropriately when gases are released, and functions as a skeleton of a foamed carbonized layer.

5 [00016] Examples of the epoxy resin include, but not limited to, bisphenol A-type epoxy resin, bisphenol F-type epoxy resin, flame retardant epoxy resin, novolak type epoxy resin, multifunctional amine epoxy resin and cycloaliphatic epoxy resin. Preferably, at least one selected from bisphenol A-type epoxy resins and bisphenol F-type epoxy resins can be used as the epoxy resin.

10 [00017] The epoxy resin can have a weight average molecular weight of 150 to 900, preferably of 200 to 800, and an equivalent weight of 75 to 450 g/eq, preferably of 100 to 400 g/eq.

15 [00018] The foamable fire resistant coating composition according to the present disclosure may include 10 to 25%, e.g., 15 to 23%, by weight of an epoxy resin. If the content of the epoxy resin is less than 10% by weight, the shortage of the epoxy resin may deteriorate adhesion of the coating. If the content of the epoxy resin is greater than 25% by weight, the excess of the epoxy resin may reduce the foaming rate of the coating in the event of fire, so that sufficient fire resistance cannot be demonstrated.

20 [00019] In the composition of the present disclosure, the curing agent is used to cure the epoxy resin. Examples of the curing agent include, but not specifically limited to, amides or amidoamine resins having a viscosity of 200 to 800 cps, an amine value of 300 to 600 mgKOH/g and an active hydrogen equivalent weight of 50 to 200 g/eq, and obtained by polymerizing polyethylene amine, fatty acid dimer and fatty acid monomer.

25 [00020] The curing agent can be synthesized in the following manner. First, a mixture of polyethylene amine, fatty acid dimer and fatty acid monomer is heated to 200°C. A condensation reaction is proceeded until an acid value of the reactant reaches 1 to 5. Preferably, at this stage, the reaction is carried out such that an amine/acid molar ratio ranges from 1.2 to 2.0. If the molar ratio is less than 1.2, the viscosity is too high to be applied to a coating, and if the molar ratio is greater than 2.0, unreacted amines may remain, making it difficult to achieve desired physical properties when applied to a coating.

30 [00021] More specifically, examples of the polyethylene amine include one selected from the group consisting of ethylene diamine, diethylene triamine, triethylene tetraamine,

tetraethylene pentaamine or mixtures thereof. In addition, examples of the fatty acid dimer and monomer include monomers and dimers selected from the group consisting of soybean oil fatty acid, tall oil fatty acid, castor oil fatty acid, rice bran oil fatty acid, linseed oil fatty acid, coconut oil fatty acid, lauryl acid, linoleic acid or mixtures thereof. Tall oil fatty acid monomer and dimer can be preferably used as the fatty acid dimer and monomer.

[00022] When the acid value of the reactant reaches 1 to 5, the heating is terminated to produce an amide or amidoamine resin. Preferably, the produced curing agent has a viscosity of 200 to 800 cps, an amine value of 300 to 600 mgKOH/g, and an active hydrogen equivalent weight of 50 to 200 g/eq. When curing agent has physical properties falling within the ranges stated above, the curing performance can be maximized.

[00023] The foamable fire resistant coating composition according to the present disclosure may include 10 to 15%, e.g., 11 to 14%, by weight of a curing agent. If the content of the curing agent is less than 10% by weight, the shortage of the curing agent may deteriorate adhesion of the coating. If the content of the curing agent is greater than 15% by weight, the excess of the curing agent may cause coating defects, such as amine brushing, etc.

[00024] The phosphorus-based flame retardant used for the composition of the present disclosure functions to impart flexibility to a foamed carbonized layer at an initial stage by adjusting the rate of pyrolysis of a cured coating. TPP was contained in a phosphorus-based flame retardant used for the conventional foamable fire resistant coating composition in an amount of equal to or greater than 21% by weight, and the pyrolysis temperature was below 250°C . When the phosphorus-based flame retardant is used, TPP, a low molecular weight material, is vaporized at a lower temperature than the cured epoxy resin, thereby initial foaming can be increased. However, when a large quantity of TPP is contained, gas toxicity may be increased and long-term fire resistance may be lowered. Therefore, the amount of phosphorus-based flame retardant used in the present disclosure can be reduced to half of the amount of conventional phosphorus-based flame retardant, that is, the content of TPP can be reduced, thereby decreasing the gas toxicity. In addition, the rate of pyrolysis of the cured coating can be lowered by additionally using a phosphorus-based flame retardant having a pyrolysis temperature of 250°C or higher (that

is, less than 5% in loss on heating at 250°C), and cracks can be prevented from occurring on the carbonized layer by imparting flexibility to the foam layer, thereby attaining long-term fire resistance even without using a reinforcement material (mesh).

5 [00025] The phosphorus-based flame retardant in the foamable fire resistant coating composition according to the present disclosure contains triphenyl phosphate (TPP) in an amount of less than or equal to 20% by weight, and the pyrolysis temperature is 250°C or higher (that is, less than 5% in loss on heating at 250°C).

10 [00026] More specifically, the phosphorus-based flame retardant used in the present disclosure may include at least one selected from the group consisting of aryl phosphates, such as triphenyl phosphate (TPP), isopropylated triphenyl phosphate, tricresyl phosphate, butylated triphenyl phosphate, cresyl diphenyl phosphate or isopropyl phenyl diphenyl phosphate; and bisphosphates, such as resorcinol bis(diphenyl phosphate) (RDP) or bisphenol-A bis(diphenyl phosphate) (BDP).

15 [00027] In a specific example, isopropylated triphenyl phosphate containing TPP in an amount of 5 to 10% by weight can be used as the aryl phosphate, and RDP (Resorcinol bis(diphenyl phosphate)) or BDP (Bisphenol-A bis(diphenyl phosphate)) containing TPP in an amount of less than 5% by weight can be used as the bisphosphate.

20 [00028] The phosphorus-based flame retardant used in the present disclosure is preferably a mixture of aryl phosphate and bisphosphate, which are mixed in a weight ratio of 1:0.5 to 1:3, preferably of 1:0.5 to 1:1.5, but aspects of the present disclosure are not limited thereto.

25 [00029] The foamable fire resistant coating composition according to the present disclosure may include 10 to 20%, e.g., 13 to 18%, by weight of a flame retardant. If the content of the flame retardant is less than 10% by weight, the shortage of the flame retardant may result in insufficient flame retardancy of the coating, making the coating readily burned. If the content of the flame retardant is greater than 20% by weight, the excess of the flame retardant may decrease a melting viscosity of the coating, resulting in excessive foaming. Thus, the carbonized layer may be easily broken, so that insulation performance cannot be properly demonstrated. In addition, since the content of TPP is

increased, desired levels of gas toxicity reducing effect and fire resistance cannot be attained.

[00030] When the cured coating is exposed to high-temperature heat to then be softened/liquefied and the carbonized layer is formed, the foaming agent used in the composition of the present disclosure is decomposed to generate a large amount of gases, making the carbonized layer have micro pores, leading to swelling (foaming), and thereby demonstrating insulation performance. The foaming agent includes, but not limited to, any one selected from the group consisting of melamine, urea, glycine and combinations thereof.

[00031] The foamable fire resistant coating composition according to the present disclosure may include 3 to 10%, e.g., 5 to 10%, by weight of a foaming agent. If the content of the foaming agent is less than 3% by weight, the coating may not expand, thereby undesirably lowering insulation performance. If the content of the foaming agent is greater than 10% by weight, the coating may excessively expand, so that cracks occur on the carbonized layer, resulting in poor mechanical strength, thereby lowering insulation performance.

[00032] The acid catalyst used in the composition of the present disclosure is decomposed when the cured coating is softened due to exposure to high-temperature heat, thereby allowing the carbonized layer to be swollen (to be foamed) due to gases released during the decomposition while facilitating formation of the carbonized layer. The acid catalyst may include, but not limited to, any one selected from the group consisting of ammonium phosphate, melamine polyphosphate, melamine monophosphate, melamine bisphosphate and combinations thereof.

[00033] The foamable fire resistant coating composition according to the present disclosure may include 20 to 40%, e.g., 27 to 35%, by weight of an acid catalyst. If the content of the acid catalyst is less than 20% by weight, the carbonized layer may be insufficiently formed, making it difficult to attain fire resistance. If the content of the acid catalyst is greater than 40% by weight, excessive foaming may occur, so that the carbonized layer may be easily broken, thereby lowering insulation performance.

[00034] The fiber used in the composition of the present disclosure has the following advantages. First, the fiber has a relatively high specific surface area, which gives a thixotropic property to a coating, thereby preventing the coating from flowing during a coating process. Second, since the fiber evenly distributed in a cured coating is thin and long, it can serve as a reinforcement material, thereby preventing cracks from occurring at ordinary times. Third, when the cured coating is softened and foamed by heat in the event of fire, a foaming rate can be controlled and occurrence of cracks can be prevented by compensating for the strength of the foamed carbonized layer by reacting with an acid catalyst. Owing to these advantages, the fiber used in the composition of the present disclosure is capable of maintaining insulation performance even at high temperatures.

[00035] Examples of the fiber include, but not specifically limited to, ceramic fiber, mineral wool, carbon fiber, Kevlar and combinations thereof. Aluminosilicate fiber or magnesium silicate fiber can be used as the ceramic fiber, synthetic vitreous (silicate) fiber can be used as the mineral wool, PAN based carbon fiber can be used as the carbon fiber, and para-aramid synthetic fiber can be used as the Kevlar.

[00036] The foamable fire resistant coating composition according to the present disclosure may include 3 to 10%, e.g., 3 to 8%, by weight of fiber. If the content of the fiber is less than 3% by weight, the proportion of the fiber is too low to demonstrate an effect of preventing cracks from occurring on the carbonized layer. If the content of the fiber is greater than 10% by weight, the excess of the fiber may degrade coating workability due to an increase of the viscosity, and the coating may not expand well, thereby lowering insulation performance.

[00037] To obtain an optimal coating and enhanced coating performance, the foamable fire resistant coating composition according to the present disclosure may further include one or more additives selected from the group consisting of a dispersant, a defoamer, a coloring agent, a thickener, a pigment and a curing catalyst.

[00038] The foamable fire resistant coating composition according to the present disclosure may include 5 to 15% by weight of additives. If the content of the additives is less than 5% by weight, the coating may not be well dispersed, so that there is a probability

of generating bubbles in the coating. If the content of the additives is greater than 15% by weight, adhesion of the coating may be lowered.

[00039] When the gas toxicity is evaluated using a KSF 2271 testing method, the foamable fire resistant coating composition according to the present disclosure

5 demonstrates 12 minutes or more. In addition, when fire resistance is evaluated using a UL 1709 testing method, the foamable fire resistant coating composition according to the present disclosure demonstrates fire resistance of 3 hours or more even without using an additional reinforcement material (mesh). Accordingly, it is possible to reduce the risk of chocking by reducing harmful gases released during coating expansion in the event of fire.

10 Therefore, the foamable fire resistant coating composition according to the present disclosure can be effectively used as a fire resistant coating material for a closed space, such as a tunnel or a basement, as well as equipment for handling oil or gas, such as marine structures or plants.

[00040]

15 **[00041]** Hereinafter, the present disclosure will be described in more detail through Examples. However, these embodiments are provided only for the purpose of illustrating the present disclosure but the present disclosure is not to be construed as being limited to these examples.

[00042]

20 **[00043]**

EXAMPLES

[00044] The foamable fire resistant coating compositions of Examples 1 to 3 and Comparative Examples 1 to 3 were prepared using the compositions shown in Table 1 and fire resistance and gas toxicity were evaluated.

25 **[00045]**

Table 1

(Unit: wt%)

Ingredient		Ex.1	Ex.2	Ex.3	Comp. Ex.1	Comp. Ex.2	Comp. Ex.3
Epoxy resin		20.0	20.5	20.4	20.0	20.0	20.1
Curing agent		13.0	12.5	13.2	13.1	13.0	13.1
Foaming agent		8.0	7.0	8.0	8.0	8.1	5
Acid catalyst		30.0	31.0	30.0	30.1	30.0	28
Phosphorus-based flame retardant	#1	-	-	-	15.0	7.5	-
	#2	7.8	8.0	9.5	-	-	10.5
	#3	7.8	8.0	5.5	-	7.5	10.5
Fiber #1		0.9	0.85	0.9	0.9	0.9	0.9
Fiber #2		0.9	0.85	0.9	0.9	0.9	1.4
Fiber #3		2.0	2.1	2.0	2.0	2.0	1.5
Fiber #4		0.9	0.85	0.9	0.9	0.9	0.9
Curing catalyst		1.5	1.6	1.5	1.5	1.6	1.5
Pigment		6.0	5.5	6.0	6.0	6.0	5.5
Thickener		0.6	0.65	0.6	1.0	1.0	0.5
Dispersant		0.5	0.5	0.5	0.5	0.5	0.5
Defoamer		0.1	0.1	0.1	0.1	0.1	0.1
Total		100	100	100	100	100	100
Fire resistance (UL1709)	Average	below 538° C			below 538° C	below 538° C	higher than 538° C
	Highest	below 649° C			higher than 649° C	below 649° C	higher than 649° C
Gas toxicity (Mouse activity stop time, min)		12 min. 50 sec. or more		10 min. or more	less than 9 min.	less than 9 min.	less than 9 min.

- 5 **[00046]** Epoxy resin: Bisphenol A-type resin having 182 to 192 g/eq in equivalent weight, 11,000 to 14,000 cps in viscosity, Max.25 APHA in color, max. 300 ppm in hydrolyzable chlorine content and 100 to 400 in weight average molecular weight
- [00047]** Curing agent: Amide resin having 300 to 600 cps in viscosity, Max.11 in color (#G), 400 to 500 mgKOH/g in amine value and 50 to 150 g/eq in active hydrogen equivalent weight

[00048] Foaming agent: Melamine

[00049] Acid catalyst: Ammonium polyphosphate

[00050] Phosphorus-based flame retardant #1 (Liquid): Isopropylated triphenyl phosphate (greater than 21 wt% in TPP content, below 250°C in pyrolysis temperature (5% or less in TGA loss on heating)

[00051] Phosphorus-based flame retardant #2 (Liquid): Isopropylated triphenyl phosphate (10 wt% or less in TPP content, 250°C or higher in pyrolysis temperature (5% or less in TGA loss on heating) and 60 to 80 cps in viscosity)

[00052] Phosphorus-based flame retardant #3 (Liquid): RDP (less than 5 wt% in TPP content, 250°C or higher in pyrolysis temperature (5% or less in TGA loss on heating) and 600 cps in viscosity)

[00053] Fiber #1: Aluminosilicate fiber (1 to 2.5 μm in diameter, about 5,000 μm in length and 1,760°C in melting point)

[00054] Fiber #2: Magnesium silicate fiber (2 to 3 μm in diameter and 1,500 to 1,550°C in melting point)

[00055] Fiber #3: Mineral wool (6 μm in (number average) diameter, 650 $\pm$ 150 μm in length and 1,000°C in melting point)

[00056] Fiber #4: Carbon fiber (7 μm in diameter, 3 mm in length and 1.8 in specific weight)

[00057] Curing catalyst: tris-(dimethylaminomethyl) phenol

[00058] Pigment: Titanium dioxide

[00059] Thickener: Alkyl quaternary ammonium clay

[00060] Dispersant: Unsaturated polyamine amide salt-acidic polyester solution

[00061] Defoamer: Polymethylalkylsiloxane

[00062]

[00063] - Evaluation of fire resistance (UL1709)

[00064] Fire resistance was evaluated using UL1709 standards (Rapid Rise Fire Tests of Protection Materials for Structural Steel) simulating the rise in temperatures of structural steel exposed to oil-related fire environments. The time-temperature curve shows the temperature rises up to 1,093°C within 5 minutes and complies with the international

oil-related fire test standards for structural steel. If an average temperature of section of each test specimen was below 538°C and the highest temperature for each sensor was below 649°C when the test was terminated, fire resisting performance of the test specimen for use in a fire resistant structure can be secured. Fire resisting performances of test specimens coated with mesh-free coating without using a reinforcement material (W10X49, ANSI Designation) were evaluated and comparison results thereof are listed in Table 1.

[00065]

[00066] - Evaluation of gas toxicity (Mouse activity stop time, min)

[00067] Gas toxicity was tested in accordance with the KSF 2271 testing method. Major features of the gas toxicity test include the followings. Heat was applied to test specimens coated with fire resistant coatings for burning the test specimens, and smoke generated from the burnt test specimens was collected and then transferred to an experimental chamber with mice to be subjected to smoke exposure. Then, the average activity stop time of mice was measured as an index of the gas toxicity. If the toxicity of gases is reduced, the average activity stop time can be extended. The evaluation criterion for the average activity stop time is 9 minutes or more.

[00068]

[00069] As confirmed from Table 1, in Examples 1 to 3, liquid phosphorus-based flame retardants each containing less than or equal to 20% by weight of TPP and having a pyrolysis temperature of 250°C or higher were used, and the foamable fire resistant coating compositions according to the present disclosure demonstrated superior gas toxicity indexes while satisfying the fire resistance standards even without using a reinforcement material (mesh). However, in Comparative Examples 1 and 2 in which phosphorus-based flame retardants each containing greater than or equal to 21% by weight of TPP were used, the fire resistance was poor or the gas toxicity index was less than 9 minutes. In addition, like in Comparative Example 3, when the content of a liquid phosphorus-based flame retardant containing less than or equal to 20% by weight of TPP and having a pyrolysis temperature of 250°C or higher, was greater than 20% by weight, the fire resistance and gas toxicity index were poorer than in Examples 1 and 2.

CLAIMS

WHAT IS CLAIMED IS:

1. A foamable fire resistant coating composition comprising:
10 to 25% by weight of an epoxy resin,
5 10 to 15% by weight of a curing agent,
10 to 20% by weight of a flame retardant,
3 to 10% by weight of a foaming agent,
20 to 40% by weight of an acid catalyst and
3 to 10% by weight of fiber, based on the total weight of the composition,
10 wherein the flame retardant contains 20% or less by weight of triphenyl phosphate
and has a pyrolysis temperature of 250°C or higher.
2. The foamable fire resistant coating composition of claim 1, wherein the epoxy
resin has a weight average molecular weight of 150 to 900 and an equivalent weight of 75
15 to 450 g/eq, and is selected from the group consisting of bisphenol A-type epoxy resin,
bisphenol F-type epoxy resin, flame retardant epoxy resin, novolak type epoxy resin,
multifunctional amine epoxy resin, cycloaliphatic epoxy resin and combinations thereof.
3. The foamable fire resistant coating composition of claim 1, wherein the curing
20 agent is an amide or amidoamine resin having a viscosity of 200 to 800 cps, an amine value
of 300 to 600 mgKOH/g and an active hydrogen equivalent weight of 50 to 200 g/eq, and
obtained by polymerizing polyethylene amine, fatty acid dimer and fatty acid monomer.
4. The foamable fire resistant coating composition of claim 1, wherein the flame
25 retardant is selected from the group consisting of triphenyl phosphate (TPP), isopropylated
triphenyl phosphate, tricresyl phosphate, butylated triphenyl phosphate, cresyl diphenyl
phosphate, isopropyl phenyl diphenyl phosphate, resorcinol bis(diphenyl phosphate) (RDP),
bisphenol-A bis(diphenylphosphate) (BDP) and combinations thereof.

5. The foamable fire resistant coating composition of claim 1, wherein the flame retardant is aryl phosphate and bisphosphate mixed in a weight ratio of 1:0.5 to 1:3.