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SOUND DAMPING COMPOSITION COMPRISING STYRENE-BUTADIENE-ACRYLIC ACID POLYMER

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This invention relates generally to sound insulation, and more particularly, to an improved composition for damping sound.

A major problem in acoustical design is to keep unwanted sound and vibrations from entering or leaving a given space. Sound transmitted from one space to another by vibration of an intervening structure, has been reduced, using various constructions which, in almost all cases, depend for their effectiveness on the use of resilient materials. Materials commonly used in sound insulation constructions include rubber, felt, cork, and spring steel. Compositions containing sound-damping fibrous materials are also widely used for coating surfaces to insulate them against sound. Such compositions are used to sound-dampen ceilings and roofs of buildings and as a base for delicate instruments which operate in a vibrant area and to dampen engine and traffic noise in commercial vehicles. These compositions usually comprise a sound-damping fibrous material, such as rag felt, and a binding material, such as asphalt, which binding material aids in the damping of sound.

Although these materials are effective for some applications, they are ineffective where a high sound-damping efficiency is required, such as, for example, coating of underwater craft, to prevent internal noises or vibrations from being transferred through the hull or shell to the surrounding water medium. Additionally, in the case of rubber or cork, and other analogous plastic materials, special installations must be made because these materials have a rather high bulk modulus of elasticity, which causes them to rapidly change shape.

The present invention provides a novel composition which is surprisingly capable of obtaining maximum sound-damping efficiency, and which is adaptable for installations on any type surface, either by spraying or troweling, or by preforming into sheets or tiles for adhering to a substrate by means of commercial adhesives.

The composition of our invention comprises a sound-damping fibrous material and a styrene-butadiene-acrylic acid emulsion. The emulsion material serves as an effective binder of superior sound-damping efficiency for sound-damping fibrous materials in the preparation of our sound-damping compositions. A typical composition may comprise a dispersion of short-fibred asbestos in a styrene-butadiene-acrylic acid emulsion. This dispersion is accomplished by blending the materials together in any suitable manner, for example, by saturating the asbestos with the styrene-butadiene-acrylic acid emulsion. The resulting composition provides an excellent material for use in damping of sound, particularly within the hull of ocean-going vessels. Moreover, this composition is flexible and may be bent through an angle of 180° without scoring. Usual ambient temperature variations have no effect on this material and, therefore, it can be used in warm, as well as in cold climates without chipping or cracking.

In general, the styrene-butadiene-acrylic acid emulsion comprises from 40% to 98% latex, 1% to 20% of a softener, and 1% to 10% of an emulsion stabilizer, such as isooctylphenyl ethylene oxide. Water may also be added to vary the texture of the final material.

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The styrene-butadiene-acrylic acid emulsion may contain from 40% to 60% styrene, 30% to 50% butadiene, and from .5% to 10% of acrylic acid without reducing the sound-damping efficiency of the final composition.

Typical softeners which may be used in this emulsion include butyl Cellosolve, butyl Carbitol, Cellosolve acetate, and the like.

The stabilizer may, in addition to isooctylphenyl ethylene oxide, include dioctyl sodium sulfosuccinate, and the like.

The latex preferred for use in preparing the emulsion, is composed of 60% styrene, 40% butadiene, and 1% acrylic acid emulsion. The emulsion base must contain at least 40% latex to provide enough binding power to hold the other materials in the emulsion.

Butyl Cellosolve softens the latex particles and also acts as coalescing agent during the final drying of the product. If the amount of softener in the base be greater than 20%, the emulsion may break because of the presence of too much solvent. If there be less than 1% softener, the latex may not be softened enough to permit complete particle cohesion during the drying of the final product.

To prevent the emulsion from breaking, as a result of dispersing, a stabilizer, such as isooctylphenyl ethylene oxide, is used. If the amount of stabilizer is greater than 10%, drying time of the final product will be increased, thereby increasing the water absorption which could result in the product re-emulsifying.

The sound-damping fibrous material which is dispersed in the emulsion, binds the latex particles together and also strengthens the final product. A sound-damping fibrous material which is advantageous in preparing superior sound-damping compositions, is a short-fibred asbestos. The short fibres prevent matting or strings from appearing in the final product. Other fillers, such as cork, ground glass fibres, mica, etc., can also be used. Good sound-damping results have been obtained, using amounts of fibrous material of from 2% to 60% of the emulsion.

Advantageously, the emulsion is prepared at room temperature but it may be prepared at any temperature between 32° F. and 200° F. If the emulsion is prepared below freezing, the emulsion will break, and if prepared above 200° F., the water in the emulsion will boil.

The sound-damping composition of our invention also is advantageous because it can be decoratively applied to any surface. A pigment can be added during the preparation of our material to successfully color the material to match any area or structure in which it is to be used. Pigments which are successful in coloring this composition, include those which are easily suspended in water solution, e.g., lamp black, chrome green, phthalocyanine blue, and the like.

As an example of the preparation of the emulsion useful in our composition, 3000 grams of a 50% styrene, 40% butadiene, and 1% acrylic acid latex, sold under the latex designation "K42," were added to a center shaft mixer with airplane-type mixing blades. The agitator was started and brought up to a speed of 150 r.p.m. for five minutes. After the addition of 150 grams of butyl Cellosolve, the mixing was continued for five more minutes. Ten grams of a 50% water solution of isooctylphenyl-ethylene oxide were added to the mixer and the mixer speed was then increased to 200 r.p.m. for ten minutes. The mixer speed was again reduced to 150 r.p.m. and 150 grams of water and 4 grams of lamp black pigment were then added and the mixing continued for ten minutes. This mixture had the appearance of a thin, emulsified latex. This emulsion can be stored indefinitely or used to prepare a final sound-damping product immediately.

To prepare the final sound-damping product, 1800 grams of the prepared stabilized emulsion latex was added to a blend-type mixer and 300 grams of asbestos fibre

were added slowly while mixing continued. When the total amount of the asbestos had been added, mixing continued for twenty minutes until the asbestos was completely dispersed through the emulsion. When measured by the Brabender Recording Viscometer using a speed of 52 r.p.m. heavy spring and 1/4 inch flag paddle, this composition had a consistency of 500. The composition without losing sound-damping efficiency, can vary from 100 to 900, depending on the proportion and character of ingredients used.

This product was then poured into three wooden molds 8" x 8" x 1/2". The molds were then placed into a forced-draft oven at 140° F., for twelve hours. The then dried sound-damping materials were removed from the molds, trimmed, and adhered to a steel substrate by means of a rubber base commercial tile cement.

The proportion of emulsion used in the composition will depend on the nature of the filler material and the intended use of the final product. The emulsion may contain added water, or it may be devoid of added water. The compositions containing added water will, of course, be of a thin consistency, making them more capable of spraying.

To measure sound damping efficiency, a number of methods are employed. One method is to drop a steel ball from a considerable height and measure the degree of rebound from the surface of the sound-damping material. A perfect material will entirely absorb the energy of the falling ball. The sound-damping material will distort under the impact of the falling object and will immediately recover by the dissipation of the energy within itself and not impart by reflection to the falling object, causing it to rebound.

For a comparative demonstration of the sound-damping efficiency of the material prepared in the foregoing example, a 2 pound steel ball was allowed to drop 8 feet on a 1/2" thick section of natural rubber and a 1/2" thick section of cork, and a 1/2" thick section of the material of this invention. The rebound of the steel ball from each of these materials was measured, and the results are shown in Table 1.

Table 1

Sound-Damping Material	Falling Object	Weight of Object, pounds	Distance Dropped, feet	Rebound, inches
Rubber 1/2" thick	steel ball	2	8	6
Cork	do	2	8	5-6
Styrene-Butadiene-Acrylic emulsion with filler.	do	2	8	.2

A second method of measuring sound-damping efficiency used, was to vibrate a 1/2" thick steel plate by means of a mechanical device at the steel plate's natural frequency while the steel plate is mounted on the sound-damping material. The source of vibration is then removed and the rate at which the vibration ceases, is measured. For purposes of this example, a decibel meter was used to measure the decay rate of the sound produced by the vibrating plate mounted on the six sound-damping

materials. As in the previous test, 1/2" samples of material were used. The results of the decibel meter readings are shown in Table 2.

Table 2

Material	Thickness, inches	Decay Rate (decibels)
Rubber	1/2	8-10/sec./sec.
Cork	1/2	8-12/sec./sec.
Felt	1/2	8-10/sec./sec.
Foam Polystyrene	1/2	10-12/sec./sec.
Styrene-Butadiene-Acrylic Acid Emulsion with filler.	1/2	240/sec./sec.
Foam Polyurethane	1/2	8-12/sec./sec.

It is obvious from these results that the sound-damping material of our invention is far superior to conventional sound-damping materials in use today. Many different areas of application are available for such efficient sound-damping material. In the aircraft industry, ceilings and rear side panels of jets can be coated with this material to markedly reduce the noise in the airplane cabin. In the building industry, walls could be reduced in thickness by the use of such a sound-damping material. Naval vessels have great need for such a sound-damping material, particularly submarines, and in sonar rooms of other vessels, to prevent the transmission of sound to the surrounding water medium, thus avoiding detection by other vessels operating in the same area.

What is claimed is:

1. A sound damping composition comprising:
an aqueous emulsion having from 40-98 percent by weight of a material formed by the copolymerization of
40 to 60 %styrene,
30 to 50% butadiene, and
from 0.5 to 10% of acrylic acid, and having added thereto,
from 1 to 20% by weight of said emulsion of a softener selected from the class consisting of 2-ethoxyethyl acetate, 2-butoxyethanol and 2-[(2-butoxy)ethoxy]-ethanol, and
from 1 to 10% by weight of said emulsion of an emulsion stabilizer selected from the class consisting of isooctylphenyl ethylene oxide, and dioctyl sodium sulfosuccinate, and the addition of from 0.2 to 60% based on the weight of the emulsion of a sound damping fibrous material selected from the group consisting of sort fibered asbestos, cork, ground glass fibers, and mica.
2. The composition of claim 1 including pigments to color the composition.

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