

EUROPEAN PATENT SPECIFICATION

- (45) Date of publication of patent specification: **26.08.87** (51) Int. Cl.⁴: **H 01 B 7/34**
(21) Application number: **84303739.1**
(22) Date of filing: **04.06.84**

(54) **Flexible fibrous endothermic sheet material for fire protection.**

- | | |
|---|---|
| (30) Priority: 21.07.83 US 515768 | (73) Proprietor: MINNESOTA MINING AND MANUFACTURING COMPANY
3M Center, P.O. Box 33427
St. Paul, Minnesota 55133-3427 (US) |
| (43) Date of publication of application:
13.02.85 Bulletin 85/07 | (72) Inventor: Langer, Roger Leon
Minnesota Mining and Manf. Comp.
2501 Hudson Road P.O. Box 33427
St. Paul Minnesota 51333 (US) |
| (45) Publication of the grant of the patent:
26.08.87 Bulletin 87/35 | (74) Representative: Baillie, Iain Cameron et al
c/o Ladas & Parry Isartorplatz 5
D-8000 München 2 (DE) |
| (84) Designated Contracting States:
DE FR GB SE | |
| (56) References cited:
DE-A-2 530 388
DE-A-2 844 693
FR-A-2 257 555
US-A-3 772 455
US-A-3 928 210 | |

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European patent convention).

Description

TECHNICAL FIELD

This invention is in the field of fire protection materials. Specifically, it relates to fire barrier sheet materials useful in protecting electrical systems during a fire.

BACKGROUND

Fire protection in areas with high concentrations of instrument, communication and power transmission wires and cables is very important, especially in such installations as large buildings and power plants. Such wires and cables are constructed with electrically insulating coverings which are combustible and can provide a pathway by which fire might spread. Fire protection for such wires and cables is critical when power supply is necessary for the maintenance controls, for example, in aircraft or factories.

Intumescent sheets for fire protection are disclosed in U.S. Patent 4,273,879. These particular sheets have a significant content of organic materials (binder and char forming resin). During combustion, these organic materials can cause exothermic reactions increasing the temperature of the fire.

There are other fire protection materials which may be produced in a sheet form and which are designed to retard the spread of fire and heat by an endothermic reaction. See, for example, U.S. Patent 4,315,075 describing a neoprene foam containing hydrated alumina.

Alumina trihydrate ($\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$) has 34.6% chemically combined water of hydration. This water is liberated beginning at about 230°C with complete dehydration at about 600°C. This endothermic dehydration is known to have a cooling effect in compositions of which alumina trihydrate is a component. The water vapor given off also dilutes the combustible gases which may be present during a fire to help arrest combustion. Alumina trihydrate (ATH) is a known fire retardant filler in the plastics industry.

Inorganic materials in the form of fibre blankets have been used for the protection of conduits and cable trays. One such fibre blanket is prepared from alumino-silicate glass fibres and marketed under the trademark Kaowool by the Babcock & Wilcox Company. In order to have one hour fire protection, the alumino-silicate fibre blankets are wrapped around cable trays in a thickness of usually two inches or more. This blanket insulation has low thermal conductivity and, therefore, not only insulates from the effects of fire but also retains in the conduit the heat generated by the current carried through electrical cables under normal conditions. With the dissipation of normal heat generated by the line resistance thus retarded, the cables in trays or conduit must be derated. That is, the amount of current which they are rated to carry (ampacity or amp capacity) must be decreased.

It is desired to provide a sheet which gives good fire protection to cable trays and conduits with a minimum reduction in the ampacity rating of the electrical cables in them.

DE-AS-2,530,388 discloses fire-resistant, electrically and thermally insulating mouldings composed of a combination of polyester resin, glass or asbestos fibres, and aluminium hydroxide. The publication discloses a composition comprising 100 parts by weight polyester resin, 5 to 200 parts by weight aluminium hydroxide, and 5 to 200 parts by weight asbestos fibre. Mouldings formed from this composition are stated to be useful as self-supporting insulating elements in electrical installations, particularly as cell partitions in switchgear. Glass fibre incorporated within the moulding is stated to provide mechanical support.

The present invention provides a sheet of an endothermic composition comprising:

- a) a refractory inorganic fibre;
- b) an organic polymer binder; and
- c) an inorganic, endothermic filler which undergoes an endothermic reaction between 100°C and 600°C,

the weight ratio of said inorganic, endothermic filler to said refractory inorganic fibre being in the range 0.5 to 5.0, characterised in that said sheet is a pliable fibrous sheet having a weight ratio of organic to inorganic constituents of less than 0.15.

The sheets of this invention have a composition which minimizes the fuel source organic content while still maintaining the necessary strength and physical integrity required of fire protection application methods. The low ratio of organic binder to inorganic material of this invention maximises utilisation of the endothermic and cooling vapour retention aspects of the inorganics (ie retention of the water vapour given off in the interstices of the inorganic fibre). This low ratio minimizes fuel contribution to any fire, and therefore minimizes smoke and harmful gases from combustion.

It has been found that although the organic binder content is very low, relatively high sheet densities are maintained, eg 0.70—1.0 g/cc as compared to 0.1—0.3 g/cc for fibre blanket type systems. The more dense sheet is advantageous because it provides an increased thermal conductivity and therefore, better heat dissipation for cables in normal service. Furthermore, the sheet of this invention provides a more compact wrap to protect such items as cables, cable trays and conduits, of particular importance in areas of limited space such as airframe structures.

It is believed that the stability of the inorganic materials in the sheet composition will provide superior aging qualities over the fire barrier materials of the prior art which contain larger quantities of organic materials.

Sheets in accordance with the invention do not rely on inorganic binders (such as clays, colloidal silica or cementitious materials) or on the insulative effect of a fibrous matrix. They rely on the porosity and mechanical entanglement of the fibers, and the materials remain flexible while the useful proportionality of endothermic powders to fiber can be quite high.

5 The inorganic fiber is chosen from materials which can withstand very high temperatures without significant changes in physical properties, such as refractory alumino-silicate fibers.

The sheets of this invention are preferably formed by standard paper-making techniques, either hand laid or machine laid on a Fourdrinier or cylinder type paper machine.

10 DETAILED DESCRIPTION

The inorganic fibers used in the protective material of this invention are refractory materials which combine high strength, good thermal resistance and the ability to retain relatively high levels of high density endothermic filler. Examples of useful inorganic fibers include graphite, silica, alumina-silica, calcium oxide-silica, asbestos, and glass fibers. Alumino-silicate fibers are preferred and are available
15 commercially under the trademarks Fiberfrax SK—2600 from the Carborundum Company, Cerafiber from Manville Corporation and Kaowool from Babcock and Wilcox. The fiber diameter is usually less than about 6 micrometers, preferably 3 micrometers. Larger fiber diameters result in a material with a lower number of fibers for a given mass, yielding sheets of lower tensile strength, and are usually more difficult to handle on paper making machinery. The physical properties of a preferred inorganic fiber (Fiberfrax) are: continuous
20 use limit 1260°C; melting point 1790°C; normal packing density 96—192kg/m³; fiber lengths up to 102 mm; specific gravity 2.73 and fiber strength of 2.76×10^9 N/m².

The amount of organic binder is preferably 2—6 weight percent of the total, more preferably about 5%. Suitable binders can include various polymers and elastomers in latex form, for example, natural rubber latex, styrene-butadiene latices, butadiene acrylonitrile latices, and latices of acrylate and methacrylate
25 polymers and copolymers (e.g., polymethyl acrylate, polyethyl acrylate, and polymethyl methacrylate). It is preferred to use halogen-free polymers to avoid decomposition and release of noxious and corrosive halogen gases during a fire. Acrylic polymers are preferred because of their excellent heat resistance, aging properties, and noncorrosive combustion products.

The inorganic, endothermic filler raw material is preferably a powder, having a mean particle size less
30 than about 60 micrometers, even more preferably about 8 micrometers. Larger filler particles tend to separate the inorganic fibers during processing, resulting in a sheet of lower tensile strength. Preferably, the weight ratio of endothermic filler to inorganic fibers is in the range of about 1.5 to 3.0.

Typical fillers would be hydrated metal oxides and borates. The filler should be relatively insoluble in water, chemically inert, and should not require a synergist. Alumina trihydrate, magnesium hydroxide
35 (hydrated magnesia), and zinc borate possess these properties. Alumina trihydrate is preferred. The preferred particle size for the filler is about 8 micrometers. As particle size decreases below that, the dewatering of the slurry in the manufacturing process can be adversely affected. The use of larger particles (greater than 60 micrometers) can reduce the tensile strength of the sheet.

The flexible, fibrous, endothermic sheets of this invention are made by mixing the ingredients together
40 with water to form a slurry. The latex is coagulated, and the resulting floc suspension flows to a head box and from there onto the Fourdrinier wire screen. The dewatered floc will drain readily and knit together to yield a homogeneous mass in which the inorganic fibers are mechanically interlocked and bound together by the polymer binder, and the endothermic filler occupies the interstices between the fibers. Larger flocs are preferred for thicker sheets, to give good drainage necessary in the process. The green sheet from the
45 Fourdrinier machine is densified by calendering and dried by passing through heated drying rolls.

One alternative embodiment of the invention involves adding a backing to the sheet material already described. A suitable backing material is aluminum foil having a thickness of about 0.08 mm and a pressure-sensitive adhesive coated on one side. The backing is adhered to the protective sheet by means of
50 the adhesive. Such backing can give an added degree of strength to sheet material which must be bent around sharp corners or small radii.

The fibrous sheets of this invention may be held in position around conduits and cable trays by being wrapped with ceramic fiber cord, wire cloth or other high temperature resistant material. It is desirable to have the wrapping restrain the sheet, holding it tightly around the cables being protected particularly when
55 exposed to open fire. A suitable ceramic fiber cord can be made from the fibers described in U.S. Patents 3,709,705, 3,795,524 and 4,047,965. One commercially available suitable cord is sold under the trademark Nextel brand ceramic fiber cord by Minnesota Mining and Manufacturing Company.

This invention will be further clarified by a consideration of the following examples, which are intended to be purely exemplary. In these examples, two ASTM tests have been used to evaluate the inventive materials. ASTM test D3286—73 measures the gross calorific value of a fuel in an isothermal-jacket bomb
60 calorimeter. The purpose of these tests is to determine how much the fire barrier material might actually contribute as fuel to a fire. ASTM test E119—78 is a standard fire test for building and construction materials.

Example I

In order to produce large quantities of the fire protective sheet of this invention, a 26 inch (66 cm) wide
65 Fourdrinier paper machine was used. 122 pounds (55.3 kg) of alumino-silicate fibers were added to 1000

gallons (3785 l) of water in a Mordon slush maker which agitated the mixture for three minutes to produce a slurry. This slurry was pumped to a 2000 gallon (7570 l) stock chest and diluted with an additional 265 gallons (1000 l) of water. 53 pounds (24 kg) of acrylic latex obtained as Rhoplex HA—8 latex containing about 46% solids by weight from Rohm & Haas Company and varying amounts and sizes of alumina trihydrate obtained from Great Lakes Minerals Company were added to the fiber slurry as shown in Table 1 below.

TABLE 1
Alumina Trihydrate Used (in Kg) Subdivided by Particle Size

Sample	1	2	3	4	5	6	7	8	9	10
Mean Particle Size of Fraction:										
4 micrometers	28.6	44.5	66.7	99.8	155.1	44.5	66.7	99.8		
8 micrometers									155.1	155.1
45 micrometers						55.3	88.4	99.8		
Total Used (Kg)	28.6	44.5	66.7	99.8	155.1	99.8	155.1	199.6	155.1	155.1

A dilute (about 25 weight percent) aqueous alum solution was then added to the latex-fiber-ATH slurry while it was being mixed, in sufficient amount to reduce the pH to between about 4.7 and 5.1 (preferably about 4.9) which coagulates the latex. The latex-fiber-ATH slurry was then pumped at controlled rates to a mixing tank where a flocculant or polyelectrolyte was added in dilute solution at about 50 ml per minute for particle retention and to aid in drainage. Suitable polyelectrolytes would be Bufloc 170 from Beckman Laboratory Inc., used in 0.2 percent solution (50 ml of polyelectrolyte solution per 50 gallons or 189 liters of slurry) or Lufax 295 cationic polyelectrolyte from Rohm & Haas Company.

The slurry flowed from the mixing tank to a headbox and on to the Fourdrinier wire to form a composite sheet up to 66 cm wide. The sheet, after being dewatered to about 50 weight percent water on the Fourdrinier machine, was calendered at about 0.06 N force to further dewater (less than about 30 percent water) and densify the sheet. The wet sheet is dried by passing it through heated drying rolls to reduce the moisture content to less than about three percent. It was then wound on to rolls. Several process parameters (the speed at which the sheet is transported through the paper-making machinery and the force used on the calender) may be varied to produce a sheet product of varied thickness and density. The final compositions of samples 1—10 are shown in Table 2.

TABLE 2
Endothermic Sheet Composition (weight percent)

Sample	1	2	3	4	5	6	7	8	9	10
Acrylic Resin	11.6	10.0	8.3	6.7	5.0	6.7	5.0	4.2	5.0	2.5
Alumino-Silicate Fibers	58.4	50.0	41.7	33.3	25.0	33.3	25.0	20.8	25.0*	25.6*
Alumina-Trihydrate	30	40.0	50.0	60.0	70.0	60.0	70.0	75.0	70.0	71.9
Sheet Density (g/cc)	0.47	0.52	0.61	0.72	0.87	0.58	0.69	0.79	0.82	0.78

* obtained as Fiberfrax SK2600, 2.5 micrometer mean fiber diameter. All other samples in Table 2 used Cerafibers VFS alumino-silicate having about a 3.5 micrometer mean fiber diameter.

Several examples of known fire protection materials were used for purposes of testing as controls against the experimental samples of this invention. Some of these were available in commercial form. Others were formulated from reference patents. Those which were not in sheet form were in the form of mastics or putties which were trowelled or pressed into sheet form for comparative testing. The control samples are shown in Table 3.

TABLE 3

Sample No.	Control Samples						
	C1	C2	C3	C4	C5	C6	C7
Type of material:	Intumescent insulating sheet	Intumescent char-forming sheet	Intumescent mastic	Endothermic sheet	Endothermic mastic	Endothermic mastic	Insulating Blanket
Reference:	3,916,057	4,273,879	Thomas-* Betts Co. FST—601	4,315,075	4,255,318 Example 1	4,255,318 Example 5	Babcock & Wilcox Kaowool
Composition (weight/percent):							
— Acrylic resin	7.0	—	—	—	—	—	—
— Alumina-Silica fibers	34.0	—	—	—	—	—	100
— Unexpanded vermiculite	59.0	—	—	—	—	—	—
— Polychloroprene	—	23.4	—	13.9	23.3	21.2	—
— Alumina trihydrate	—	—	—	79.5	69.7	63.8	—
— Glass fibers	—	—	—	—	7.0	6.4	—
— Asbestos fibers	—	—	—	—	—	2.2	—
— Bentonite clay	—	—	—	—	—	6.4	—
— Sodium silicate	—	52.5	—	—	—	—	—
— Dioctyl phthlate	—	8.2	—	5.8	—	—	—
— Phenolic resin	—	5.5	—	—	—	—	—
— Inorganic fillers	—	8.7	—	—	—	—	—
— Vulcanizing agents	—	1.7	—	0.8	—	—	—
Density (g/cc)**	0.62	1.5	0.74	1.45	1.0	1.0	0.13

* Commercial product — composition unknown

** All materials dried to less than 3 weight percent moisture

Inventive samples 1—10 and control samples C1—C6 were evaluated using ASTM test D3286. The gross calorific values of several of the materials are given below in Table 4.

TABLE 4
Gross Calorific Value Determined by ASTM D3286

	Inventive Sample	Heat Value (Joules/g)	Control Sample	Heat Value (Joules/g)
5				
10	1	2790	C1	2,080
	2	2560	C2	11,160
	3	2410	C3	5,580
15	4	1280	C4	6,050
	9	1190	C5	6,050
20	10	580	C6	5,580

The comparative test data in Table 4 show the calorific value of the control materials to be substantially greater than the composition of this invention in all but one case. These higher values result from the greater organic content. It is preferred to select compositions of the present invention having a calorific value of no more than about 2400 Joules/g, more preferably less than about 2000 Joules/g.

Example II

In order to maintain the integrity and flexible nature of the inventive sheet system during the covering or wrapping operation, several thinner layers are applied separately to achieve the necessary total thickness. Preferably a metal foil (0.08 mm thick) is laminated to one side of each such layer to provide a flexible yet tough sheet that can be conveniently taped with metal foil tape at abutting sheet edges of the wrap covering. A final wrap of high temperature ceramic fiber cords (alumina borosilicate fiber such as Nextel 4/5 cord) or stainless steel wires may be placed around the fire protective sheet, spaced at about 20 cm intervals or in a spiral fashion to ensure the maintainance of complete coverage and prevent the unwinding of the protective sheet, particularly under fire conditions.

Fire tests in accordance with ASTM E119—78 were conducted on specimens of 2.5 cm diameter conduits and 10.2 by 30.5 cm cable trays wrapped by the above-described procedure. The quantity of sheet material used is measured by: (a) the number of layers, (b) the total thickness, and (c) by weight. The preferred method measures the weight of protective sheet material per linear distance in kilograms per meter covering the conduit or cable tray. The test specimens were heated inside furnaces fueled with natural or propane gas, and the heating rate of the furnace interiors were in conformance with ASTM E119—78. The furnace hot zone lengths for the conduit and cable tray tests were 61 cm and 245 cm respectively. The time required for the surface temperature of the conduit and cable tray under the fire protective sheet wrap to reach 315°C was used to compare the samples. 315°C is the temperature at which electrical cables are often observed to begin to deteriorate and short circuit. This comparison is shown in Table 5 below.

TABLE 5
ASTM E119—78 Flame Test of 2.54 cm Conduit

5		Inventive Sample No.				
		6	8	9	9	
	Time to 315°C (min)	46	72	57	67	
10	Material wt. (Kg/m)	2.2	3.9	3.0	3.7	
		Control Example No.				
		C1	C1	C2	C4	
15	Time to 315°C (min)	35	44	9	57	
	Material wt. (Kg/m)	2.4	3.9	3.0	4.0	
20	ASTM E119—78 Flame Test of 10.2 × 30.5 cm Cable Tray					
		Inventive Example No.		Control Example No.		
		9	C1	C2	C7	
25	Time to 315°C (min)	61	54	40	39	
	Material wt. (Kg/m)	12.7	12.1	21.0	8.2	
30						

These fire tests show that the composition of the inventive sheets extends the fire exposure times substantially over known materials. It should be noted that the putties or mastics of comparative control samples numbers C3, C5 and C6 could not be applied in a uniform thickness. Adhesion to the conduit and cable tray surfaces was also a problem; therefore, these materials could not be tested in this manner. Only the sheet materials were fire tested.

In the case of the intumescent sheet materials of control samples C1 and C2, special precautions for designing the wrapping configuration were required. Radial cracks occur in the intumesced fire protective materials around the perimeter of the conduit or at the corners of the cable tray which allows direct heat exposure to the metal surface. A loose, eye-shaped or corrugated wrap with a wire mesh overaly for containment was employed to limit the material intumescence and control such cracking in order to obtain a meaningful test. More details on wrapping intumescent fire protective sheeting around conduits can be found in commonly assigned patent application U.S. Serial Number 501,887 filed June 7, 1983. The sheets of the present invention remained tightly and neatly wrapped on the conduit or cable tray. Compared to the intumescent materials which undergo a significant volume increase during heat exposure, there was essentially no physical change in the inventive sheet dimensions during heat exposure.

Example III

The following flame test was performed on the inventive material and on the controls in the form of putty or mastic. The test specimens were cut or formed to 23 by 28 cm rectangles and glued or formed to one side of a metal sheet 0.3 mm thick. The test specimen weight and thickness was recorded. A thermocouple was attached to the surface in the center of the metal sheet to measure the cold side surface temperature. The test sheet was placed vertically and centered in front of a flame source generated by a propane fueled exhaust gas simulator (from Maremont Company) which provided a hot side surface temperature of 1,050 to 1,100°C. The rate of temperature rise on the cold side surface was then recorded. The results obtained are shown in Table 6 below.

TABLE 6

		Inventive Sample 9	Control Sample No.	
			C3	C5
5	Specimen Weight (Kg):	0.54	0.59	0.77
	Specimen Thickness mm	11.0	10.2	11.4
10	Time (minutes):	Cold Side Temperature (°C)		
	Start	23	23	23
15	5	87	99	114
	10	133	123	167
	15	163	213	198
20	20	177	262	207
	25	182	279	208
25	30	182	290	226
	35	183	298	228
	40	183	309	238
30	45	183	—	245
	50	182	—	256
35	55	183	—	—
	60	186	—	—

40 The inventive sheet sample maintained a much lower temperature for a significantly longer time than either of the control sample mastics.

Example IV

45 An ampacity study of fire barrier protected electrical conduits was conducted. The fire barrier sheets used in the study included: the inventive sheet; commercially available intumescent mats comprising acrylic resin, alumina-silica fibers and unexpanded vermiculite (control sample C1); and Kaowool blankets available from Babcock and Wilcox Company. The lengths of intumescent mat were 457 mm for the first layer, 572 mm for the second, and 635 mm for the third. The lengths of the inventive mat were 394 mm for the first layer, 445 mm for the second, and 500 mm for the third. The lengths of Kaowool blankets used were 610 mm for the first layer, and 749 mm for the second. The Kaowool blankets were applied by completely wrapping around the conduit and overlapping at least 76 mm. In these tests, Scotch 33 tape, a black electrical vinyl tape, was wrapped in a helical fashion around the outside of the test specimen to provide a black surface solely to raise the surface emissivity in some tests. In each case, the length of wrapped conduit under test was about 2.45 meters.

50 All the ampacity derating factors were calculated with respect to the case of bare conduit with unaltered surface. The equation used was

$$55 \text{ percent derating} = (1 - (T_1/T_2)^{1/2}) \times 100$$

where T₁ is the conductor temperature rise above ambient in the bare conduit case and T₂ is the conductor temperature rise above ambient for the protected conduit.

60 The conduit tested was a 4 inch (10.2 cm) internal diameter electrical grade schedule 40 steel containing four 500 MCM 600 volt XLPE insulated copper conductor cables. The thicknesses of each fire barrier layer were: for the inventive sheets about 5 mm; for the intumescent mat about 5 mm; and for the Kaowool blanket about 25 mm. The conductor temperatures measured for bare steel at 190, 300 and 400 amps were 39.7°C, 61.2°C, and 85.1°C respectively and for steel conduit covered with black tape 37.1°C, 54.2°C, and 76.2°C at the same respective currents. Ambient temperature ranged between about 22 and 65 26°C for these tests. The results are shown in Table 7 below:

TABLE 7

Current (amperes)	Number of Fire Barrier Layers	Average Conductor Temperature (°C)				Percent Ampacity Derating		
		Outermost Surface	C1 Intume- scent Mat	C7 Kaowool	Sample 5 Inventive Sheet	C1 Intume- scent Mat	C7 Kaowool*	Inventive Sheet (Sample 5)
190	1	aluminum	46.5	48.8	42.6	19.2	23.3	8.7
300	1	aluminum	78.1	90.0	65.5	18.0	25.6	6.2
400	1	aluminum	118.1	146.8	94.0	19.8	29.6	6.8
190	1	tape	43.2		39.3	10.7		0.3
300	1	tape	71.4		58.0	12.1		- 4.9
400	1	tape	108.4		81.9	15.3		- 2.8
190	2	aluminum	48.0	58.0	42.9	24.1	34.9	10.6
300	2	aluminum	87.0	115.7	70.0	24.8	37.1	10.5
400	2	aluminum	136.5	209.9**	103.0	27.2	43.0**	11.9
190	2	tape	47.1		40.6	21.0		4.8
300	2	tape	80.8		59.6	20.7		0.4
400	2	tape	128.0		87.3	24.5		3.3
190	3	aluminum	51.4		43.4	26.8		13.4
300	3	aluminum	91.8		69.7	26.9		10.7
400	3	aluminum	151.3		107.8	31.1		14.9
190	3	tape	48.8		40.3	22.7		7.2
300	3	tape	89.0		65.2	25.2		6.2
400	3	tape	142.2		98.7	28.4		9.8

Footnote to Table 7:

* Aluminum outer layer not used on Kaowool blanket

** Estimated by computer. Test at 400 amps with two layers of Kaowool blanket was not run because the expected conductor temperature could damage the cable.

A comparison of the samples having the same number of fire barrier layers reveals that the ampacity derating required by the inventive sheet is significantly less than that required with either Kaowool blankets or the intumescent mat material. The air space between the fire barrier and conduit necessitated by the loose eye-shaped or corrugated wrap for the intumescent mat (see discussion after Table 5) is believed to be detrimental to ampacity rating. Even the inventive samples having 3 fire barrier layers compare favorably to the control materials having only two layers. Thus, the current carrying capacity of the cables in conduit does not suffer a great deal as a result of achieving adequate fire protection.

In addition, it can be noted that the addition of black tape to the outside helps to decrease the percent ampacity derating.

Claims

1. A sheet of an endothermic composition comprising:

- a) a refractory inorganic fibre;
- b) an organic polymer binder; and
- c) an inorganic, endothermic filler which undergoes an endothermic reaction between 100°C and 600°C, the weight ratio of said inorganic, endothermic filler to said refractory inorganic fibre being in the range 0.5 to 5.0, characterised in that said sheet is a pliable fibrous sheet having a weight ratio of organic to inorganic constituents of less than 0.15.

2. A sheet as claimed in claim 1 wherein the inorganic endothermic filler of part (c) is selected from the group consisting of alumina trihydrate and magnesium hydroxide.

3. A sheet as claimed in claim 1 or claim 2 wherein the weight ratio of organic to inorganic constituents is less than 0.08.

4. A sheet as claimed in any preceding claim having a density in the range 0.70 to 1.0 grams per cubic centimeter.

5. A sheet as claimed in any preceding claim wherein the mean particle size of the inorganic endothermic filler is less than 60 micrometers.

6. A sheet as claimed in any preceding claim wherein the inorganic fibre of part (a) is selected from the group consisting of silica, aluminosilicate, asbestos and glass fibres.

7. A sheet as claimed in any preceding claim wherein said inorganic fibre of part (a) is aluminosilicate fibre.

8. A sheet as claimed in any preceding claim wherein said organic polymer binder of part (b) is derived from a latex of a polymer selected from natural rubber, styrene-butadiene rubber, butadiene acrylonitrile polymer, and acrylate and methacrylate polymers and co-polymers.

9. A sheet as claimed in any preceding claim, having a metal foil backing.

10. Use of a sheet as claimed in any preceding claim, to be wrapped around a cable tray or conduit.

Patentansprüche

1. Blatt aus einer eindothermen Zusammensetzung mit

- a) einem feuerfesten anorganischen Fasermaterial;
 - b) einem Bindemittel aus einem organischen Polymer; und
 - c) einem anorganischen eindothermen Füllstoff, der zwischen 100°C und 600°C ein endotherme Reaktion erfährt,
- wobei das Gewichtsverhältnis des anorganischen eindothermen Füllstoffes zu dem feuerfesten anorganischen Fasermaterial im Bereich von 0,5 bis 5,0 liegt, dadurch gekennzeichnet, daß das Blatt ein biegsames Fasermaterialblatt ist, in dem das Gewichtsverhältnis der organischen zu den anorganischen Bestandteilen kleiner ist als 0,15.

2. Blatt nach Anspruch 1, dadurch gekennzeichnet, daß der anorganische endotherme Füllstoff des Teils (c) aus der Gruppe ausgewählt ist, die aus dem Aluminiumoxidtrihydrat und dem Magnesiumhydroxid besteht.

3. Blatt nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß das Gewichtsverhältnis der organischen zu den anorganischen Bestandteilen kleiner ist als 0,08.

4. Blatt nach einem der vorhergehenden Ansprüche mit einer Dichte im Bereich von 0,70 bis 1,0 g/cm³.

5. Blatt nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die mittlere Korngröße des anorganischen eindothermen Füllstoffes kleiner ist als 60 µm.

6. Blatt nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der anorganische Füllstoff des Teils (a) aus der Gruppe ausgewählt ist, die aus Siliciumdioxid, Aluminiumsilikat, Asbest und Faserglas besteht.

7. Blatt nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß das anorganische Fastermaterial des Teils (a) aus Aluminiumsilikatfasern besteht.

8. Blatt nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß das aus einem organischen Polymer bestehende Bindemittel des Teils (b) aus einem Latex eines Polymers hergestellt ist, das ausgewählt ist aus Naturkautschuk, Styrol-Butadien-Kautschuk, Butadienacrylnitrilpolymer und den Acrylat- und Methacrylat-Polymeren und -Copolymeren.

9. Blatt nach einem der vorhergehenden Ansprüche mit einer Tragschicht aus einer Metallfolie.

10. Die Verwendung eines Blattes nach einem der vorhergehenden Ansprüche zum Umwickeln einer Kabelrinne oder eines Kabelrohrs.

Revendications

1. Feuille d'une composition endothermique comprenant:

a) des fibres minérales réfractaires;

b) un liant polymère organique; et

c) une charge minérale endothermique qui subit une réaction endothermique entre 100°C et 600°C, le rapport pondéral de ladite charge minérale endothermique aux dites fibres réfractaires minérales étant situé dans la gamme allant de 0,5 à 5,0, ladite feuille étant caractérisée en ce qu'elle est une feuille fibreuse souple ayant un rapport pondéral des constituants organiques aux constituants minéraux inférieur à 0,15.

2. Feuille suivant la revendication 1, dans laquelle la charge minérale endothermique de la partie (c) est choisie parmi l'ensemble constitué par l'alumine trihydratée et l'hydroxyde de magnésium.

3. Feuille suivant la revendication 1 ou la revendication 2, dans laquelle le rapport pondéral des constituants organiques aux constituants minéraux est inférieur à 0,08.

4. Feuille suivant l'une quelconque des revendications précédentes, ayant une masse volumique se situant dans la gamme allant de 0,70 à 1,0 g/cm³.

5. Feuille suivant l'une quelconque des revendications précédentes, dans laquelle la taille moyenne des particules de la charge minérale endothermique est inférieure à 60 micromètres.

6. Feuille suivant l'une quelconque des revendications précédentes, dans laquelle les fibres minérales de la partie (a) sont choisies parmi l'ensemble constitué par les fibres de silice, d'aluminosilicate, d'amiante et de verre.

7. Feuille suivant l'une quelconque des revendications précédentes, dans laquelle lesdites fibres minérales de la partie (a) sont des fibres d'aluminosilicate.

8. Feuille suivant l'une quelconque des revendications précédentes, dans laquelle le liant organique polymère de la partie (b) dérive d'un latex d'un polymère choisi parmi le caoutchouc naturel, le caoutchouc de styrène-butadiène, le polymère de butadiène-acrylonitrile et les polymères et copolymères d'acrylate et de méthacrylate.

9. Feuille suivant l'une quelconque des revendications précédentes ayant une doublure en pellicule métallique.

10. Utilisation d'une feuille suivant l'une quelconque des revendications précédentes pour envelopper une tablette à câbles ou une canalisation.