

1

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FIRE EXTINGUISHER COMPOSITIONS FOR
METAL FIRES

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This invention relates to powdered fire extinguishing compositions for use on light metal fires, such as fires of aluminum, zirconium, magnesium, potassium, sodium and their alloys and in particular, on fires of lithium and its alloys. More specifically, this invention relates to powdered dry fire extinguishing compositions which can be stored in a container and expelled therefrom by gas under pressure.

The light metals, such as magnesium, sodium and lithium and their alloys, especially when in finely divided form, such as turnings or powder, are readily oxidized and on occasion become ignited and burn with an intense hot flame. The ordinary fire-extinguishing fluids, of course, cannot be used, since they react with these metals, often with explosive violence.

Certain solid type fire-extinguishing agents have been shown to have potential for use on this type of fire, but none of them meets all the following requirements: storage for prolonged periods without deterioration, suitability for application under pressure from an extinguisher after storage, and ability to extinguish fires in all of the listed metals without reacting with the burning metal.

Carbon- or graphite-based extinguishing agents have been used with some success for metal fire hazards but most of these materials, such as those disclosed in U.S. Patents 2,346,627 and 2,385,500 because of their inherent properties, have had to be applied to the fire by scoop or shovel. Application from an extinguisher provides a number of advantages including greater range which affords some measure of protection to the operator, greater control which permits economy in the use of the agent which will accomplish extinguishment of a fire that might otherwise not be obtained because the agent was wasted, and discharge from an extinguisher allows application of extinguishing agents in areas which are otherwise inaccessible. However, when graphite-based extinguishing agents are stored in an extinguisher, the extinguisher must be inverted daily to overcome their caking tendencies, and even when this precaution is taken, frequent plugging of the hose and/or nozzle results when discharge under pressure is attempted.

Extinguishing agents based on sodium chloride can be stored and discharged satisfactorily, but this agent reacts with burning lithium and consequently when such an agent is used on a lithium fire, relatively enormous quantities are required to effect extinguishment and the metal remaining after extinguishment is contaminated with the reaction product and therefore is unfit for further use.

It is, therefore, an object of the present invention to provide a composition for extinguishing light metal fires, in particular lithium fires, which can be stored in an extinguisher for an indefinite period of time and when needed can satisfactorily be discharged under pressure from the extinguisher and which will not react with the burning metal when applied.

This object is attained according to the present invention by providing as the extinguishing agent the composition which consists of a ground carbon or graphite whose storage properties have been enhanced by the addition of a small quantity of anti-caking or anti-com-

2

pacting agent plus an agent to impart water repellency to the above mixture. By selecting a rather hard type of carbon or graphite and by controlling the particle size of the extinguishing composition, I provide an agent which can be reliably discharged from an extinguisher and which is more effective in extinguishing metal fires.

Particle size of the carbon used is critical and must be held within certain limits. I prefer to use a material which will pass 100% through a 20 mesh sieve, and no more than 20-25% through a 325 mesh sieve. Analysis of a typical graphite suitable for use in this composition is as follows: traces on 40 mesh, 46% on 100 mesh, 23% on 200 mesh, 11% on 325 mesh. In general, coarser particles than these are frequently difficult to discharge and a larger percentage of fines encourages caking.

The carbon or graphite should be sufficiently hard so that the particles will not crush or fracture when the extinguisher is pressurized. A preferred material is synthetic, high density electro-furnace graphite which has been ground to the desired particle size. It has an apparent density of about 1.62 and is similar in composition to the graphite used for moderator bars in uranium and plutonium piles.

One of the major drawbacks of graphite-based extinguishing agents previously available was their very marked tendency to cake upon storage. This tendency made extinguishers charged with these agents very unreliable in their operation. I have overcome this tendency by the addition of an anti-caking agent such as Attapulugus clay, which is anhydrous magnesium aluminum silicate. The particle size of this anti-caking agent should be approximately the same as that of the graphite employed, with special emphasis being placed on avoiding a large proportion of fines. A typical Attapulugus clay which I find satisfactory has the following sieve analysis: 4% on 80 mesh, 11% on 100 mesh, 55% on 200 mesh, 16% on 325 mesh and 12% through 325 mesh. Other materials which I find suitable for use as anti-caking agents are talc, adsorptive magnesium silicate, bentonite and diatomaceous earth. I prefer to use about 5 to 15% by weight of anti-caking agent.

As a practical matter, I have also found it desirable to incorporate a small percentage of a water-repellent agent such as magnesium stearate in amounts from about 0.25 to 5% by weight of the composition. The addition of the water-repelling agent is not absolutely essential, particularly if the extinguishing agent is definitely protected from exposure to moisture. Since this is not always the case and inadvertent exposure to moisture may occur, its use is advisable. Graphite has about 25% of its volume as pores or voids, which can adsorb water. If moisture adsorption should occur and this wet extinguishing agent were applied to a light metal fire, a serious explosion could result. Consequently, the use of a water-repelling agent is desirable. The agent I prefer is known as "bulky" magnesium stearate and has an apparent density of 110 grams or less per liter. Zinc or calcium stearates may also be used.

I have found it advantageous to select the particle size of all the components of my extinguishing agent so that all of it will pass through 20 mesh sieve and not more than 25% of it will pass through a 325 mesh sieve.

The extinguishing agent used in the following examples was prepared by mixing 93% by weight of graphite having the preferred particle size previously referred to, 5% anti-caking agent (Attapulugus clay having the preferred particle size previously referred to) and 2% water-repelling agent ("bulky" magnesium stearate as previously described). These were combined by blending for 30 minutes in a ribbon mixer. All of this composition

passed through a 20 mesh sieve and 20% passed through a 325 mesh sieve.

Example 1

A 2.25 square foot pan, 8 inches high was filled to a depth of $\frac{1}{2}$ " with molten sodium. This was heated with a propane torch from 0 time to 0+8 min. 45 sec. It was allowed to burn until 0+9 min. 5 sec., when the graphite-based extinguishing agent was applied from a dry chemical type fire extinguisher. By 0+11 min. 20 sec. the fire was well under control. At 0+13 min. 30 sec. a few cracks appeared on the surface of the graphite, though they seemed to have no effect on the fire. At 0+25 min. the fire was examined and found to have been extinguished although the metal was still sufficiently hot that it would reignite upon contact with the air. 93.4% of the graphite was discharged from the extinguisher.

Example 2

The pan of Example 1 was emptied and refilled with $\frac{1}{4}$ " of molten lithium. Heat was applied with a propane torch until 0+15 min. 30 sec. At 0+15 min. 50 sec. graphite-based extinguishing agent was applied from a dry chemical type fire extinguisher. The fire was well under control by 0+17 min. 15 sec. Fire broke through the graphite once at 0+19 min. but was immediately recovered to extinguish the flames.

Example 3

Approximately 10 lbs. of magnesium turnings were placed in a pile about 27 in. in diameter of $2\frac{1}{2}$ " deep. They were heated for 30 sec. with a propane torch and allowed to burn until 0+2 min. 25 sec., at which time application of the graphite-based extinguishing agent was begun. By 0+4 min. 5 sec. the fire was completely covered, the extinguisher having discharged 95.2% of the graphite-based extinguishing agent. One hot spot remained in the center of the pile until 0+30 min. but was not given additional attention. When the fire was examined at 0+55 min. it was found to be completely extinguished.

Example 4

A mixture of zirconium chips and turnings as received contained 78.2% metal, 15.4% water and 6.4% oil. This material was arranged in a pile approximately 27" in diameter and 4 in. deep. It was heated with a propane torch until ignited and allowed to burn for 15 sec., at which time approximately 20% of the surface area was burning. The graphite-based extinguishing agent was applied from an extinguisher, control of the fire being obtained about 40 sec. after the start of the application. The pile of chips was covered over with a layer of extinguishing agent approximately $\frac{1}{2}$ in. deep. Five minutes after the start of the application, the pile was cool enough to touch, and when opened 10 min. after the application was found to have been completely extinguished. 80% of the zirconium chips and turnings remained unburned. $26\frac{1}{2}$ lbs. of extinguishing agent were required in this example.

Example 5

The dry chemical type fire extinguisher was filled with the graphite-based extinguishing agent and vibrated for 35 min., which caused the graphite mixture to settle 2 inches. The tests indicate the vibration treatment given the extinguisher in this example very nearly approximates the settling observed in extinguishers which have been in service on trucks, etc., for a protracted period of time. The extinguisher was then discharged, total discharge time being 42.8 sec., 91.9% of the agent being discharged.

The following examples will illustrate the effect of particle size on the discharge characteristics of this agent. The extinguisher used in these examples was a standard dry chemical type extinguisher.

Example 6

A graphite-based fire extinguishing agent was prepared which had the following sieve analysis: 84% on 40 mesh, 5.5% on 100 mesh, 6.3% on 200 mesh, 4.0% on 325 mesh and an undetermined amount through 325 mesh. This agent was placed in the extinguisher which was then pressurized and discharged. The hose on the extinguisher plugged when 6.3% of the agent had been discharged. On a duplicate test the hose plugged when 48.9% of the agent had been discharged.

Example 7

A graphite-based fire extinguishing agent was prepared which had the following sieve analysis: 0% on 40 mesh, 0.5% on 100 mesh, 3.5% on 200 mesh, 56.5% on 325 mesh and 39.5% through 325 mesh. This material was placed in an extinguisher which was then pressurized and discharged. On this test 58.2% of the dry chemical agent was discharged. On replicate determinations, as little as 38% of the material was discharged and as much as 62.8%. This lack of uniformity in performance is characteristic of graphite-based agents with extremely fine particles, and of course, this material is not suitable for use in pressurized fire extinguishers.

Example 8

When the procedure of Examples 6 and 7 was repeated using a graphite-based extinguishing agent of my preferred particle size, the following percentages were discharged on successive tests: 95.5, 95.0, 93.3, 95.0 and 94.7.

Example 9

A graphite-based fire extinguishing agent was prepared which had my preferred particle size but in which a soft amorphous graphite was substituted for my preferred granular type. On duplicate tests, 61.3% and 48.9% were discharged from a pressurized extinguisher.

I claim:

1. A powdered free-flowing fire extinguishing composition for extinguishing light metal fires and dischargeable as a stream from an extinguisher under pressure which comprises, by weight, 85 to 95 percent of an agent selected from the group consisting of powdered baked carbon and synthetic granular graphite and about 5 to 15 percent of an anti-caking agent which is a member selected from the group consisting of Attapulugus clay, talc, adsorptive magnesium silicate, bentonite and diatomaceous earth, the composition having a particle size range such that substantially all of it will pass through a 20 mesh sieve and not more than about 25 percent will pass through a 325 mesh sieve.

2. The fire extinguishing composition of claim 1 wherein the synthetic granular graphite is electro-furnace graphite which has an apparent density of about 1.62.

3. The fire extinguishing composition of claim 1 wherein the synthetic granular graphite is sufficiently hard so that the particles will not crush or fracture when the extinguisher is pressurized.

4. A powdered free-flowing composition for extinguishing light metal fires and dischargeable as a stream from an extinguisher under pressure, comprising, by weight, about 85 to 95 percent synthetic granular graphite; about 5 to 15 percent of an anti-caking agent which is a member selected from the group consisting of Attapulugus clay, talc, adsorptive magnesium silicate, bentonite, and diatomaceous earth; and about 0.25 to 5 percent of a water-repelling agent which is a member selected from the group consisting of magnesium, zinc, and calcium stearates; the composition having a particle size such that substantially all of it will pass through a 20 mesh sieve and not more than about 25 percent will pass through a 325 mesh sieve.

5. A method of extinguishing light metal fires which comprises discharging onto the fire a pressurized stream

5

of a dry powdered composition comprising, by weight, 85 to 95 percent of an agent selected from the group consisting of powdered baked carbon and synthetic granular graphite and about 5 to 15 percent of an anti-caking agent which is a member selected from the group consisting of Attapulugus clay, talc, adsorptive magnesium silicate, bentonite and diatomaceous earth, the composition having a particle size range such that substantially all of it will pass through a 20 mesh sieve and not more than about 25 percent will pass through a 325 mesh sieve.

6. A method of extinguishing light metal fires which comprises discharging onto the fire a pressurized stream of a dry powder composition comprising, by weight, about 85 to 95 percent synthetic granular graphite; about 5 to 15 percent of an anti-caking agent which is a member selected from the group consisting of Attapulugus clay, talc, adsorptive magnesium silicate, bentonite, and diatomaceous earth; and about 0.25 to 5 percent of a water-repelling agent which is a member selected from the group consisting of magnesium, zinc, and calcium stearates; the composition having a particle size such that substantially all of it will pass through a 20 mesh sieve and not

6

more than about 25 percent will pass through a 325 mesh sieve.

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