

[54] **EXOTHERMIC HOT TOPPING COMPOSITION**

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[57] **ABSTRACT**

Minimized smoke evolution and controlled reaction of exothermic hot topping compositions are obtained by a mixture of an oxidizer and a fuel together with bulk or modifying constituents. The improved properties are achieved by control of composition and particle size of ingredients and in certain instances agglomerating the mixture into a pelletized form.

**2 Claims, No Drawings**

## EXOTHERMIC HOT TOPPING COMPOSITION

### BACKGROUND OF THE INVENTION

Highly exothermic hot topping compositions are widely used in primary metal production and in the foundry. These products are applied to the hot top of a cast ingot or the riser of a foundry casting to cause remelting of the hot top or riser. Examples of highly successful commercial products are those sold by Exomet, Incorporated under the trademarks RISOTHERM and INGOTHERM. Such compositions and their usage are disclosed for example in U.S. Pat. Nos. 2,514,793; 2,791,816; 3,132,061; and 3,198,640.

All of the presently used exothermic products share a common fault. As a result of the reaction and the liberation of heat there is also a large volume of smoke evolved. The density of the smoke is such that it usually envelopes the entire pouring or casting area obliterating safe walkways and the ingots or molds from the view of cranemen and other foundry workers. In some instances, particularly in a closed foundry, the smoke is so dense the workers leave the casting area after application of the exothermic material and do not return until the smoke has abated.

Another problem with prior riser materials has been the inability to delay the ignition time on large ingots and risers, the known exothermic materials tending to ignite immediately on contact with the molten metal and start reacting before a complete addition can be made. This results in a safety hazard and aggravates the smoke problem, because of the need for repeated additions of the risering material.

### BRIEF DESCRIPTION OF THE INVENTION

In order to avoid the above mentioned problems, it has been found that the composition of the powdered exothermic material must be carefully controlled to keep the reaction temperature near 3,500°F and the size of the constituents must fall within certain limits. It is preferred to keep the temperature below 3,500°F. As an alternative the composition can be agglomerated into nuggets or pellets so as to achieve both reduced dense smoke emission and delayed reaction for prolonged heating.

Therefore, it is the primary object of this invention to provide an exothermic product in particulate form that minimizes or eliminates dense smoke evolution upon reaction with a substantially molten metal.

It is a further object of this invention to provide an exothermic riser product that is capable of delayed ignition and prolonged heat generation.

It is still a further object of this invention to provide an exothermic riser product of prolonged reaction with little or no smoke evolution during the reaction.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Most of the commercial highly exothermic hot topping compositions consist of a mixture of an oxidizer such as iron oxide, a source of fuel such as aluminum or other readily oxidizable metal, and slag modifying ingredients or bulk fillers. These components react to liberate a large amount of heat and at the same time evolve a large amount of dense smoke.

I have found that the large volume of smoke is directly related to the reaction of aluminum to form  $Al_2O_3$  above 3,500°F. It is believed that at this temperature the aluminum reacts to form a sub-oxide gas such as  $Al_2O$  which condenses back to  $Al_2O_3$  when exposed to the atmosphere. This condensed  $Al_2O_3$  forms large amounts of dense white smoke.

One successful method of controlling the temperature and hence smoke has been by replacing the slag modifying constituents with either steel punchings or a bulk filler such as ground fire clay, more commonly referred to as grog. The broad compositional range was found to be:

|                 | % by weight |
|-----------------|-------------|
| Iron Oxide      | 50-80       |
| Aluminum        | 14-22       |
| Steel punchings | 0-25        |
| Filler          | 0-25        |

The preferred composition for the powdered riser material is:

|                 | % by weight |
|-----------------|-------------|
| Iron oxide      | 50-70       |
| Aluminum        | 15-20       |
| Steel punchings | 4-16        |

In the foregoing formula steel punchings is taken to mean nail whiskers from nail making operations or plate perforations from structural fabrication operations or from washer manufacturing. In the latter case the perforations should be from plate no thicker than one-eighth inch or larger than one-fourth inch in diameter.

It has further been established that if the particle size of the reactants, e.g., iron oxide and aluminum is controlled to within the range set forth below the evolution of dense smoke is minimized and the product reacts at a uniform rate over a longer time span. The following screen analyses were conducted using Standard Tyler Sieve Equipment:

### IRON OXIDE BEFORE BLENDING

| Particle Size | Nominal | Range |
|---------------|---------|-------|
| 10 mesh       | 0       | 0-2   |
| 20 mesh       | 22      | 5-30  |
| 50 mesh       | 60      | 30-90 |
| 150 mesh      | 13      | 5-20  |
| -150 mesh     | 5       | 0-30  |

### ALUMINUM BEFORE BLENDING

| Particle Size | Nominal | Range |
|---------------|---------|-------|
| 30 mesh       | 18      | 2-35  |
| 40 mesh       | 44      | 12-60 |
| 100 mesh      | 26      | 15-85 |
| -100 mesh     | 12      | 0-20  |

In view of the foregoing screen analyses and further tests, it is preferable that before blending 80 percent by weight of the iron oxide is of a particle size that will pass a 10 mesh screen but will be retained on a 150 mesh screen. It is also preferable that about 85 percent by weight of the aluminum pass a 30 mesh screen and be retained on a 100 mesh screen. Within the above ranges the reaction time can be varied by varying the particle size depending upon the size of the riser or hot top to which the product is to be applied.

Several components were blended and tested on a 5 inch diameter riser with the result that for each mixture smoke evolution was minimal. The mixtures are set forth in Table I.

TABLE I

Test Sample Number

|                  | 21 | 3        | 45       | 6    |
|------------------|----|----------|----------|------|
| Iron oxide       | 50 | 58.058.0 | 66.977.1 | 66.5 |
| Aluminum powder  | 15 | 16.516.5 | 18.018.0 | 18.5 |
| Steel punchings  | 10 | 15.025.5 | 4.9      | 15.0 |
| Ground fire clay | 25 | 10.5     | 15.1     |      |

In the foregoing table, sample number 1 exhibited as incomplete burn after two minutes elapsed time, sample 2 reacted for 45 seconds, samples 3 and 4 for 35 seconds, sample 5 for 20 seconds, and sample 6 for 25 seconds. The particle size of the reactants in each of the above samples was within the ranges set out above.

It has also been discovered that minimized dense smoke evolution and even more prolonged reaction time can be achieved by forming pellets or nuggets of the riser composition according to the following Table II wherein the range and preferred composition are set out.

TABLE II

| Component       | Preferred Range<br>(% by weight) | Range<br>(% by weight) |
|-----------------|----------------------------------|------------------------|
| Iron oxide      | 55-62                            | 50-65                  |
| Aluminum powder | 14-17                            | 12-19                  |
| Silicon metal   |                                  |                        |
| powder          | 1-2                              | 0-8                    |
| Binder          | 1-2                              | 0-5                    |
| Sand            | 16-25                            | 5-30                   |
| Lubricant       | 0.5-1.5                          | 0-5                    |
| Inhibitor       | 0.1-1.0                          | 0-3                    |
| Moisture        | 0.2-0.7                          | 0-4                    |
| Slag modifiers  | 0-5                              | 0-10                   |

In the above composition the iron oxide acts as the oxidizer. If a more rapid reaction is desired, manganese dioxide could be used with or without various grades of quality iron ore. The aluminum powder is the fuel; aluminum foil can be substituted for the powder which during compaction tends to wipe the oxide particles and decrease the reaction time. If available, other readily oxidizable metals such as titanium grindings or grindings of aluminum-magnesium alloys, silicon, and on a partial replacement basis magnesium can be used as fuel. The binders can be dextrine, starches, clays, evaporated liquor of hydrolized wood, fire clay, bentonites, core oils, sodium silicates, phenolic resin, molasses and lime, urea resin, polyvinyl alcohol, and other known binders normally used in the foundry. Dextrine is preferred because of its ease in handling.

In the above compositions, sand is added to retard the reaction. Ground fire clay or other retardants can be freely substituted without affecting the overall effectiveness of the composition. The lubricants can be siliceous volcanic rock containing 70 to 80 percent silica commonly called perlite, foliated micaceous minerals such as vermiculite, diatomaceous earth or that are sold under the tradename Sil-O-Cell. The lubricant is chosen to make the mixture flowable and prevent sticking or cleaving of the pellets during compaction.

The preferred inhibitor is potassium dichromate to prevent deterioration of the fuel.

The retained moisture aids in briquetting and in activating the binder.

Mixtures within the above ranges have been formulated and briquetted using Komarek-Greaves 5 Briquetting Machine with approximately 20 tons pressure on the rolls. The resulting briquettes are approximately five-eighths inches by 1 inch in size, easy to handle and can be placed directly in containers for shipment without fear of breakage during transit. A minimum pressure of five tons is needed to assure adequate compaction.

Set forth in Table III are examples of briquetted riser compositions according to the invention.

TABLE IV

| Component            | Sample No.<br>1 | 2    | 3    |
|----------------------|-----------------|------|------|
| Iron oxide           | 56.3            | 61.6 | 53.8 |
| Aluminum             | 14.6            | 16.0 | 14.7 |
| Silicon metal        | 1.5             | 1.6  |      |
| Dextrin              | 2.0             | 2.0  | 2.6  |
| Sand                 | 24.3            | 17.5 | 19.6 |
| Perlite              | 1.0             | 1.0  |      |
| Potassium dichromate | 0.3             | 0.3  | 0.3  |
| Moisture             | 0.4             | 0.5  | 0.6  |
| Slag modifiers       |                 |      | 8.2  |

In the above Table, sample 1 represents a mixture formulated for use on very large risers that ignited slowly and burned slowly. Sample 2 represent a faster burning mixture that is suitable for medium size risers. Sample 3 was formulated to increase the fluidity of the resultant slag. In this mixture the silicon metal was replaced with a mixture of 3 calcium-silicon" (e.g., CAL-SIL) and sodium carbonate to lower the melting point of the slag and hence increase its fluidity.

It is preferred that before blending the particle size of dry aluminum powder and iron oxide will fall within the size distribution as set forth in Table V. Distribution of particle sizes was determined using a Standard Tyler Sieve Series.

TABLE V SCREEN ANALYSIS

| Tyler Screen | Aluminum Powder<br>Typical Range | Iron Oxide<br>Typical Range |
|--------------|----------------------------------|-----------------------------|
| 10           | 0                                | 12                          |
| 20           | 0                                | 18                          |
| 30           | 22                               | 3-35                        |
| 40           | 48                               | 13-60                       |
| 50           |                                  | 23                          |
| 100          | 29                               | 18                          |
| -100         | 1                                | 1-9                         |
| 150          |                                  | 8                           |
| 325          |                                  | 15                          |
| -325         |                                  | 6                           |

In actual use the casting is poured and when the metal rises in the riser or hot top it is covered with a layer of rice hulls or a hot topping composition such as disclosed in my copending application Ser. No. 89,026 filed Nov. 12, 1970 to prolong solidification of the riser. When the riser or hot top is 1/2 to 3/4 solidified the exothermic briquettes or powder is applied to generate the necessary heat to remelt the riser and feed the shrink cavity in the casting. If desired a layer of rice hulls covered with a layer of sand can be added on top of the briquettes to further insulate and filter smoke.

With the briquettes it has been possible to delay start of reaction from one to eight minutes and have an overall reaction time of 24 minutes on a 12 inch diameter riser. The delay in ignition prevents flashing and therefore minimizes the danger of serious burns to

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foundry workers from this operation. In addition the prolonged reaction keeps dense smoke evolution to a minimum. Using the product of sample 3 in Table V it is possible to have a second application of the briquettes because of the fluidity of the slag.

What is claimed is:

1. A highly exothermic hot topping composition consisting essentially of: 50 to 80 per cent by weight oxidizer in the form of iron oxide having a particle size so that approximately 80 per cent by weight will pass a 10 mesh screen and be retained on a 150 mesh screen; 14 to 22 per cent by weight fuel in the form of a readily oxidizable metal in finely divided form selected from the group consisting of aluminum, titanium, magnesium, silicon, and alloys thereof, said readily oxidizable metal having a particle size so that approximately 85 percent by weight of said metal will pass a 30 mesh screen and be retained on a 100 mesh screen; 5 to 26 per cent by weight retardant selected from the groups consisting of

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ground fire clay, sand, foliated micaceous minerals, and siliceous volcanic rock containing 70 to 80 percent by weight silica for controlling the temperature of reaction of said oxidizer and said fuel so that said reaction takes place at or below 3,500°F; whereby, dense smoke evolution from said reaction is minimized by controlling particle size of said reactants and temperature of reaction.

2. A composition according to claim 1 wherein the oxidizer is iron oxide in an amount of between 55 to 70 per cent by weight, the fuel is finely divided aluminum in an amount of between 15 to 20 per cent by weight, the retardant for controlling reaction temperature consists of steel punchings in an amount of between 4 and 16 per cent by weight together with a refractory filler present in an amount of between 0 to 16 percent by weight.

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