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INHIBITED ALUMINUM-WATER COMPOSITION AND METHOD

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This invention relates to the stabilization of aqueous systems containing particulate aluminum.

In recent years aqueous slurry blasting explosives have been developed which contain one or more oxidizing agents, water, and particulate aluminum. Such blasting agents are inexpensive and safe to handle because of their relative insensitivity. They have found wide application because of their low cost and ease of handling, which merely involves pouring into a borehole and firing with a booster of high brisance. Such blasting agents cannot be stored and must be prepared and loaded into boreholes just prior to use, however. Upon storage, the particulate aluminum reacts with water to form hydrogen which, in the presence of oxidizing agents, constitutes an explosion hazard. The reaction between aluminum and water is exothermic, which in addition to the hazard involved evaporates water from the composition thereby drying out the composition and rendering it useless for its intended purposes and constituting a fire and explosion hazard.

The aluminum-water reaction also presents problems in other fields. For example, many dry, solid explosives contain particulate aluminum along with oxidizing agents and organic sensitizers. As is well known, such compositions may deteriorate upon storage and become unsafe for use. Accordingly, it is often desired to reclaim the ingredients from such compositions which have aged past a predetermined expiration date by leaching water soluble components therefrom. The aluminum-water reaction presents the same problems with regard to hazards in the reclaiming or reworking operation.

Accordingly, it is an object of the present invention to inhibit the aluminum-water reaction in such aqueous systems, including slurry blasting agents and the reclaiming of aluminum-containing explosive compositions.

A further object of this invention is to provide stable aluminum-containing aqueous slurry blasting agents which may be stored for extended periods without decomposition while minimizing explosion or fire hazards.

The method of this invention comprises the addition of a stabilizing amount of a phosphate selected from the group consisting of ammonium and alkali metal phosphates to an aqueous slurry containing particulate aluminum and an inorganic oxidizing agent containing a stabilizing amount of a phosphate selected from the group consisting of alkali metal and ammonium phosphate.

The preferred phosphate is diammonium hydrogen phosphate. Other phosphates utilizable in the invention include the tribasic, dibasic, or monobasic phosphates of ammonium or alkali metals such as sodium or potassium.

It has been found that from 0.1% to 2% by weight of the phosphate inhibitor is effective in slurry blasting agents containing about 10% to 15% water and 8% to 20% aluminum. Amounts larger than 2% phosphate in such compositions may be used but no apparent added benefit appears to result. With test mixtures consisting solely of 20 parts aluminum and 25 parts water by weight, 0.1% to 2% of phosphate were also effective to inhibit gas evolution.

The phosphate inhibitors of the invention are effective in slurry blasting agents which contain additional fuels or sensitizers in addition to aluminum and oxidizing agents.

Such additional ingredients may include sulfur, ferrophosphorus, TNT, smokeless powder, alcohols, glycols, and the like. In uninhibited mixtures containing ammonium nitrate, the evolved gas often contains considerable ammonia. In mixtures containing sulfur, the odor of hydrogen sulfide is apparent in the evolved gases. The inhibitors of the invention also prevent such side reactions.

The following examples illustrate the invention. All parts and percentages are by weight.

Example I

A control mixture consisting of 5 parts ammonium nitrate and 25 parts water was placed in a flask and maintained at 81° C. The volume of gas evolved after 6 hours from such composition was measured and found to be consistently 165 to 175 ml. The quantity measured in such control system was due to thermal expansion, degassing of water, and ammonium nitrate, and the vapor pressure of the water. A test mix was then prepared consisting of 5 parts ammonium nitrate, 25 parts water, and 20 parts 20 mesh aluminum. Identical quantities of this mixture were subjected to the above accelerated gassing test both with and without diammonium hydrogen phosphate as an inhibitor in various amounts. The quantity of gas evolved after six hours was measured as above and also the temperature rise in the mixture, if any. The results are set forth in the following table:

Mixture	Gas Evolved, ml.	Temp. Rise, ° C.
Control (no aluminum)	165	
Uninhibited with Al	455	15
Al + 0.5 inhibitor	160	
Al + 0.25 inhibitor	170	
Al + 0.1 inhibitor	170	

It is thus apparent that 0.2 to 1% diammonium hydrogen phosphate completely inhibited the aluminum-water reaction.

Example II

The following slurry blasting agents were prepared:

	(1)	(2)	(3)	(4)
Ammonium Nitrate 20 mesh	55	60	45	51
Sodium Nitrate 20 mesh	10	5	6	12
Aluminum 20 mesh	8	12	17	12
Ferrophosphorus 20 mesh				8
TNT 10-14 mesh			18	
Sulfur				2
Smokeless Power 10-14 mesh	12	8		
Ethylene Glycol				4
Guar Gum (Thickener)	0.4	0.3	0.4	0.4
Water	14.4	14.5	13.3	10.4

All of the above slurries showed excessive gassing after storage at room temperature for two weeks. To each of otherwise identical slurries was added diammonium hydrogen phosphate, sodium dihydrogen phosphate, trisodium phosphate, dipotassium hydrogen phosphate, and monoammonium dihydrogen phosphate in amounts of 0.2 part, 0.4 part, and 1 part. The resulting inhibited slurries were stored for three months without evidence of gassing. The stored slurries were fired in six inch boreholes with 160 gram pentolite boosters. All charges fired satisfactorily.

While the invention has been described in terms of certain examples, they are to be considered illustrative rather than limiting and it is intended to cover all modifications and embodiments that fall within the spirit and scope of the appended claims.

We claim:

1. An aqueous slurry blasting agent comprising water, particulate aluminum, an inorganic nitrate oxidizing agent

and a stabilizing amount of a phosphate selected from the group consisting of ammonium and alkali metal phosphates.

2. The composition set forth in claim 1 containing 0.1% to 2% by weight of said phosphate based on the weight of the composition.

3. The composition set forth in claim 1 wherein said phosphate is diammonium hydrogen phosphate.

4. An aqueous slurry blasting agent comprising water, particulate aluminum, ammonium nitrate and 0.1% to 2% by weight of diammonium hydrogen phosphate based on the weight of said slurry.

5. An aqueous explosive system comprising water, particulate aluminum, an inorganic nitrate oxidizing agent, and a stabilizing amount of a phosphate selected from the group consisting of ammonium and alkali metal phosphates.

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