United States Patent Office 3,341,383
Patented Sept. 12, 1967

3,341,383

AQUEOUS AMMONIUM NITRATE EXPLOSIVE SLURRIES CONTAINING PARTIALLY HYDROLYZED ACRYLAMIDE POLYMER

Jack Edward Bergwerk, Baldwin, N.Y., assignor to Stein, Hall & Co., Inc., New York, N.Y., a corporation of New York

No Drawing. Filed Aug. 12, 1966, Ser. No. 571,980
4 Claims. (Cl. 149—60)

This invention relates to aqueous slurries of explosives. More particularly, the invention relates to stable slurries of ammonium nitrate containing a partially hydrolyzed acrylamide polymer as a thickening additive.

Blasting explosives in the form of aqueous slurries or pumpable gels of ammonium nitrate are well known in the art. Large amounts of these explosives are used in oil discovery and recovery operations, mining and road-building. It is becoming common practice to formulate these explosives at or near the location where they are to be used. This procedure has a number of advantages, the most important of which is the avoidance of the hazards of transporting sensitive explosives through heavily populated areas.

In accordance with present practice, the ammonium nitrate in a convenient form, such as commercially available crystals, prills or of any other particle size which is readily dissolved in water, is transported directly to the site. It is there combined with other desired additives, including sensitizer, water and a suspending agent in a continuous manner, and may then be immediately pumped or poured into the location where it is to be exploded. The ammonium nitrate may also be transported to the site as an aqueous solution. Thus, where the slurry is prepared at an oil well site, all of the ingredients of the explosives are combined as a pumper truck delivers its load of nitrate solution past feeder hoppers through a hose directly into the bore hole of an oil well.

Under these conditions, a suspending agent requiring prehydration in order to achieve the desired level of particle suspending ability cannot be used, because the maximum suspending power of the solution must be developed within a matter of 20 or 30 seconds. Furthermore, as the nitrate slurry is introduced directly into the bore hole of a well, its water resistance, i.e., its ability to resist substantial dissolution when dropped into the water found in a bore hole, must also develop within a very short time.

It has now been found that a pourable, substantially nonsettling and water-resistant slurry of ammonium nitrate and sensitizer is provided by mixing therewith a partially hydrolyzed acrylamide polymer having a degree of hydrolysis such that from about 15% to about 40% of the monomeric units therein have been converted to the hydrolyzed form, as determined by the ash content. Furthermore, the partially hydrolyzed acrylamide polymer used in accordance with this invention has a molecular weight such that a 1% solution of the polymer in distilled water will have a viscosity in the range of 1500–7000 centipoises at 25° C., as measured by a Brookfield Viscometer operated at 20 r.p.m. with a No. 4 spindle.

Acrylamide polymers have been used in the prior art as waterflow retardants in aqueous ammonium nitrate slurries. U.S. Patent No. 3,097,120, for example, shows the use, in this environment, of acrylamide polymers which have been cross-linked in the presence of the other ingredients of the aqueous slurry composition. In accordance with the patent, only polyacrylamides having a so-called "free acid" content ranging from a minimum of about 0.1% to about 8% are considered satisfactory, and the maximum free acid content of 10% is considered to be excessive. Furthermore, the presence of a polyvalent

metal salt is required to provide the necessary cross-linking agent for the polyacrylamide. In view of this prior art, it was unexpected that improved results are obtained by using hydrolyzed polyacrylamides having a free acid content far in excess of the 10% upper limit imposed by the patentee. It was also unexpected that the use of the polymers of this invention do not require cross-linking agents to perform in a highly satisfactory manner.

A still further improvement is obtained by using a suspending agent comprising a mixture of the hydrolyzed polyacrylamide defined above with a cross-linked galactomannan gum. One suitable example of the latter is a mixture comprising 98% guar gum and 2% of potassium pyroantimonate. These materials are preferably combined in weight proportions ranging from 1:3 to 3:1. The use of this composition as a suspending agent provides an aqueous slurry of ammonium nitrate which has a soft, moldable consistency and good water resistance.

Table I below gives the preferred ranges over which the ingredients of the explosive slurries of this invention can be combined.

TABLE I

	Percent by weight
Ammonium nitrate	30–65
Sensitizer	15–50
Water	5–25
Partially hydrolyzed acrylamide polymer	0.1–5
Sodium nitrate[1]	to 25

[1] Optional replacement for part of ammonium nitrate.

As discussed above, the ammonium nitrate may be used in any convenient particle size. Sodium nitrate may be used where freeze-point depression is needed. The sensitizer used may be any of the well-known explosive sensitizers used in the art, such as TNT, nitrostarch and smokeless powder.

The following examples further illustrate the compositions of the present invention.

Example 1

An ammonium nitrate solution containing 423 grams of ammonium nitrate and 123 grams of water is prepared. In one instance, it is thickened with 0.1% guar gum. In the second instance, it is thickened with 0.1% of a partially hydrolyzed acrylamide polymer having a degree of hydrolysis such that about 22% of the monomeric units have been converted to the hydrolyzed form. The polymer is further characterized by having a molecular weight such that a 1% solution of polymer in distilled water will have a viscosity of about 4000 centipoises, at 25° C., measured by a Brookfield Viscometer operated at 20 r.p.m. with a No. 4 spindle. A mixture of nitrates made up of 72 grams of ammonium nitrate and 82 grams of sodium nitrate is then added. A sensitizer is then added and diammonium phosphate at a 0.3% level is added to buffer the composition to a pH of 5.8.

The sample stabilized with 0.1% of the polymer is substantially suspended whereas the guar gum stabilized slurry settles out rapidly. Also, in contrast to the guar-thickened slurry, the polymer prevents the formation of hard crystalline salt structures during standing and cooling of the solution, and maintains the slurry in a soft, workable, substantially homogeneous condition even after standing at room temperature overnight.

Example 2

An ammonium nitrate solution containing 90 parts by weight of ammonium nitrate and 10 parts by weight of water is prepared. To this is added 1% by weight a diesel oil and 0.3% by weight of a stabilizing agent comprising 1 part by weight of the partially hydrolyzed acrylamide polymer described in Example 1 and 3 parts by weight of

a cross-linked guar gum comprising 98% guar gum and 2% potassium pyroantimonate.

The resulting product is a soft, flowable, moldable gel having excellent water resistance. The ratio of the polymer to the guar may be varied from 1:3 to 3:1 in parts by weight.

I claim:

1. A pourable, nonseparating explosive slurry composition containing as its essential ingredients (a) from about 30% to about 65% by weight of ammonium nitrate, (b) from about 15% to about 50% by weight of an explosive sensitizer, (c) from about 5% to about 25% by weight of water, (d) from about 0.1% to about 5% by weight of a partially hydrolyzed acrylamide polymer having a degree of hydrolysis such that 15% to 40% of the monomeric units therein have been converted to the hydrolyzed form, and the polymer having a molecular weight such that a 1% solution of the polymer in distilled water will have a viscosity in the rage of 1500–7000 centipoises at 25° C.

2. The explosive slurry composition of claim 1, wherein the partially hydrolyzed acrylamide polymer has a degree of hydrolysis such that about 22% of the monomeric units therein are converted to hydrolyzed form, and the polymer has a viscosity of about 4000 centipoises.

3. The explosive slurry of claim 1, which additionally contains a cross-linked guar gum, the polymer and gum being present in the respective relative proportions, by weight, of 1:3 to 3:1.

4. The explosive slurry of claim 2, which additionally contains a cross-linked guar gum comprising 98% guar gum and 2% pyroantimonate, the guar and the polymer being present in respective relative proportions, by weight, of 1:3 to 3:1.

References Cited

UNITED STATES PATENTS

2,826,485	3/1958	Scalera et al.	149—52 X
3,097,120	7/1963	Hoffman et al.	149—60 X
3,097,121	7/1963	Bowkley et al.	149—60
3,190,777	6/1965	Breza et al.	149—57
3,202,556	8/1965	Chrisp	149—60 X

CARL D. QUARFORTH, *Primary Examiner.*

BENJAMIN R. PADGETT, *Examiner.*

S. J. LECHERT, JR., *Assistant Examiner.*