

(19)



Europäisches Patentamt
European Patent Office
Office européen des brevets

(11)

Publication number:

**0 251 606
A2**

(12)

EUROPEAN PATENT APPLICATION

(21)

Application number: **87305495.1**

(51)

Int. Cl.4: **C06B 45/10** , **C06B 45/22** ,
C06B 21/00

(22)

Date of filing: **22.06.87**

(30)

Priority: **21.06.86 GB 8615212**

(43)

Date of publication of application:
07.01.88 Bulletin 88/01

(84)

Designated Contracting States:
AT BE CH DE ES FR GR IT LI LU NL SE

(71)

Applicant: **Freeman Chemicals Limited**
Polymers Division
P.O. Box 8, 5 Civic Way
Ellesmere Port South Wirral L65 0HB(GB)

(72)

Inventor: **Parr, Alan James**
Coed Y Foel Derwen
Corwen Clwyd(GB)
Inventor: **Wosley, Martin**
32 Conway Close
Saltney Chester(GB)

(74)

Representative: **Lyons, Andrew John et al**
ROYSTONS 531 Tower Building Water Street
Liverpool L3 1BA(GB)

(54)

Protection of dangerous substances.

(57)

Explosive substances are encapsulated in a gel formed by reacting a hydrophilic polymer, such as a polyisocyanate prepolymer, and an aqueous reactant, such as water.

EP 0 251 606 A2

Protection of dangerous substances

This invention relates to the protection of dangerous, particularly explosive, substances.

An obvious problem with the use of some explosives is their tendency to detonate when subjected to shock, for example, by impact such as during transportation or handling. Much care has to be taken when explosives are transported and used to guard against undesired detonation. Thus, it is beneficial for
5 packaging for explosives to be able to absorb impact shocks.

The object of this invention is to provide a means of packaging dangerous, particularly explosive, substances in order to eliminate or at least reduce the inherent hazards thereof and also to reduce flammability.

According to this invention dangerous, particularly explosive, water insoluble substances are encapsulated in a gel formed by mixing a hydrophilic polymer with an aqueous reactant.
10

In one aspect the invention provides a method of encapsulating a dangerous substance comprising mixing the dangerous substance with or adding same to a gel-forming mixture of a hydrophilic polymer and an aqueous reactant and allowing the mixture to set.

In another aspect the invention provides a dangerous substance encapsulated in a gel formed by
15 mixing a hydrophilic polymer and an aqueous reactant.

Any suitable gel forming hydrophilic polymer or mixture of polymers may be used in the invention. Examples of suitable hydrophilic polymers include polyisocyanates, acrylic based polymers and cellulose based polymers.

The gel formed by mixing the hydrophilic polymer and aqueous reactant is typically sufficiently dense
20 to retain the explosive substance but sufficiently resilient to attenuate shock waves caused by impact. Thus, explosive substances may be handled and transported in greater safety.

The aqueous reactant may be water or may be a mixture of water and other suitable substances.

Typical of such other substances would be water miscible organic liquids, such as polyols, solvents, dyes and inorganic fillers.

The method of the invention may be applied to any dangerous substance, particularly explosives
25 including, for example, trinitrotoluene and nitroglycerine and products based thereon. As well as explosive substances, it may be possible to use the method of the invention on corrosive or poisonous substances.

The gels used in the invention are desirably inert to the substances being encapsulated, so that, for example, explosive substances do not have their detonation properties impaired when mixed directly with
30 the gel for the period of time over which the encapsulated substance will be stored.

Preferred gels used in this invention possess a three-dimensional polymer network produced by reacting a water miscible polyisocyanate prepolymer with an aqueous reactant. The polyisocyanate prepolymer may be produced by end-capping a suitable water miscible polyol with a diisocyanate to give a final isocyanate functionality preferably greater than two. Typically the water miscible polyol is the product
35 of the polymerisation of ethylene oxide with or without propylene oxide in the presence of a polyfunctional precursor such as glycerine. The average molecular weight of the water miscible polyol is preferably in the range 200-20000, especially 600-6000, with a hydroxyl functionality of two or more and preferably containing at least 40% by weight of ethylene oxide adducts. The diisocyanate may typically be one of toluene diisocyanate (TDI), 4, 4' -diphenylmethane diisocyanate (MDI), hexamethylene diisocyanate (HDI) or isophorone diisocyanate (IPDI). The polyisocyanate prepolymer may be produced by reacting 0.55 - 1.5,
40 preferably 0.75 - 1.25, moles of diisocyanate with each equivalent of hydroxyl group in the water miscible polyol.

Gels can be produced by mixing the water miscible polyisocyanate prepolymer with either water alone or with a mixture of water and other suitable substances such as inorganic fillers and water miscible polyols,
45 solvents and dyes. With water alone, the proportion of water is preferably designed to give a Water Index Value in the range 40,000 - 300,000, especially 80,000 - 170,000 where:

$$\text{Water Index Value} = \frac{\text{Equivalents of Water}}{\text{Equivalents of Isocyanate}} \times 100$$

The properties of the gels may be modified by replacing part of the aqueous phase with one or more additives. For example, surface tack and tear resistance of the gel may be improved by incorporation of a low molecular weight glycol, such as ethylene glycol, diethylene glycol, propylene glycol or dipropylene glycol.

5 When the polyisocyanate prepolymer is blended with the aqueous reactant, mix times, dependent on the gel time of the system, are typically 10-60 seconds.

Gel times are a function of the Water Index Value, the nature of any additives in addition to the dangerous substances to be encapsulated and the temperature of the reactants and are typically 30 seconds to 5 minutes. Gel times are longer at lower temperatures.

10 Gels used in this invention may lose water and dimensional stability over a period of time. Therefore, it is preferred that the encapsulated substance be protected within a suitable impermeable membrane, such as of plastics film, e.g. polyethylene, or alternatively in its own water-tight container. If the gel is not intended for immediate use, it is recommended that storage temperatures do not exceed 25 degrees C. Gels which contain a modifying glycol such as propylene glycol, can be stored at 0 degrees C, or below
15 with reduced risk of freezing or cracking the gel.

The invention will now be further described with reference to the following Examples:

EXAMPLE 1

20 For encapsulating an explosive substance, such as trinitrotoluene or nitroglycerine a gel was prepared by first forming a polyisocyanate prepolymer by reacting 11.15% by weight of toluene diisocyanate (80/20 mixture of 2, 4/2,6 isomers) with 88.85% by weight of a 5000 molecular weight trifunctional polyol based on glycerine, extended with propylene oxide and capped with ethylene oxide. The resultant prepolymer
25 containing 3.2% by weight of isocyanate (as NCO) was mixed with water in the weight ratio of 10 parts prepolymer to 90 parts water. This blend was then poured into a mould containing the explosive substance and allowed to set.

The product could then be handled, packaged and transported.

30

EXAMPLE 2

This Example repeated Example 1 except that instead of mixing the prepolymer polyisocyanate with water, a mixture of water and propylene glycol in the weight ratio of 1:1 was used. 10 parts by weight of
35 prepolymer were mixed with 90 parts by weight of the water propylene glycol mixture.

EXAMPLES 3 and 4

40 These Examples repeated Examples 1 and 2 respectively except that the explosive substance was mixed directly with the gel forming mixture.

Claims

45

1. A method of encapsulating a dangerous, particularly explosive substance, comprising mixing the dangerous substance with or adding same to a gel-forming mixture of a hydrophilic polymer and an aqueous reactant and allowing the mixture to set.

2. A method as claimed in claim 1, wherein the hydrophilic polymer is a polyisocyanate prepolymer.

50 3. A method as claimed in claim 1 or 2, wherein the aqueous reactant is water.

4. A method as claimed in claim 2 or 3, wherein the polyisocyanate prepolymer is produced by end-capping a water miscible polyol with a diisocyanate.

5. A method as claimed in claim 4, wherein the water-miscible polyol is the product of the polymerisation of ethylene oxide with or without propylene oxide in the presence of a polyfunctional precursor,
55 such as glycerine.

6. A method as claimed in claim 4 or 5, wherein the average molecular weight of the water miscible polyol is in the range 200 to 20,000, preferably 600 to 6000.

7. A method claimed claim 5 or 6, wherein the water miscible polyol contains at least 40% by weight of ethylene oxide adducts.

8. A method as claimed in any one of claims 4 to 7, wherein the diisocyanate is selected from toluene diisocyanate, 4, 4'-diphenylmethane diisocyanate, hexamethylene diisocyanate, and isophorone diisocyanate.

9. A method as claimed in any one of claims 4 to 8, wherein the polyisocyanate prepolymer is produced by reacting 0.55 to 1.5, preferably 0.75 to 1.25, moles of diisocyanate with each equivalent of hydroxyl group in the water miscible polyol.

10. A method as claimed in any one of claims 3 to 9, wherein the proportions of water mixed with the polyisocyanate prepolymer is designed to give a water index value (as hereinbefore defined) of 40,000 to 300,000, preferably 80,000 to 170000.

11. A method as claimed in any one of claims 1 to 10, wherein the gel is modified by the addition of a low molecular weight glycol, such as ethylene glycol, diethylene glycol, propylene glycol or dipropylene glycol.

15

20

25

30

35

40

45

50

55