

SPECIFICATION

TITLE OF THE INVENTION

LIQUID QUICK-SETTING AGENT

5 TECHNICAL ART

[0001]

The present invention relates to a liquid quick-setting agent that is sprayed onto bedrock surfaces exposed in tunnels for roads, railways, head races, etc.

10

BACKGROUND ART

[0002]

So far, a quick-setting cement (comprising a mixture of a quick-setting agent with concrete) spraying method
15 has been used for prevention of the collapse of bedrocks exposed during tunneling work or the like (Patent Publication 1).

In this method, usually, concrete for spraying is first prepared by metering and mixing together cement, an
20 aggregate and water in a metering/mixing plant set up at a tunneling work site. The concrete is then delivered on an agitator car, pumped by a concrete pump, and mixed in a merging pipe placed on the way with a quick-setting agent pumped out of another site into a quick-setting spraying
25 concrete. The spraying concrete is then sprayed onto bedrock surfaces up to a given thickness.

[0003]

Powder quick-setting agents comprising calcium

aluminate with an alkali metal aluminate, an alkali metal carbonate or the like are often used as the quick-setting agent. It is desirable to use an acidic liquid quick-setting agent composed mainly of an aluminum salt because
5 the amount of dust is small upon spraying and there is no or little alkali injury (Patent Publications 2 to 6).

[0004]

The aluminum salt used for liquid quick-setting agents is often a sulfate; the higher the concentration,
10 the more quickly the liquid sets and the smaller the amount of the agent added for spraying becomes.

However, the solubility of aluminum sulfate in water is 27% by mass at 20°C. Therefore, a liquid quick-setting agent having an aluminum sulfate concentration higher than
15 27% by mass is turned into a suspension in which insoluble matters coagulate or settle down, resulting in an increase in the viscosity of the liquid.

For such a liquid quick-setting agent, therefore, it is not only required to disperse sediments by agitation or
20 shaking, but also there are hoses or pumps clogged up by precipitates and there is an insufficient mixing of the quick-setting agent with concrete. Further, since the solubility is proportional to temperatures, these disadvantages become more noticeable when it is used at
25 lower temperatures, leaving much to be desired in the prior art.

[0005]

In order to improve the quick-setting capability of

the liquid quick-setting agent, it has also been known to add to it an alkali metal, an alkaline earth metal, a fluorine compound, an alcoholamine and a carboxylic acid or the like. However, this may possibly lead to a lowering of long-term strength, and more ingredients give rise to more preparation steps and the need for temperature and pH adjustments. There is also much left to be desired in production cost.

[0006]

10 A quick-setting agent containing a bisphenol-type condensation product and a quick-setting component has been reported (Patent Publication 7).

 However, the quick-setting component referred to there is calcium aluminate different from aluminum sulfate in the invention described herein.

[0007]

 There are some reports about a spraying material containing a bisphenol-type condensation product and aluminum sulfate (Patent Publications 8 to 10).

20 All of these prior publications disclose a spraying material comprising an aqueous solution of aluminum sulfate in a saturated aqueous solution state, viz. an aqueous solution of aluminum sulfate in which the upper limit to the concentration of aluminum sulfate is 27% by mass and to which the bisphenol-type condensation product is added: that spraying material is different from the liquid quick-setting agent of the invention containing aluminum sulfate in an amount exceeding its solubility.

The purpose of using the bisphenol-type condensation product in such prior publications is to prevent concrete from sliding down due to reactions with a polyalkylene oxide used in combination.

5 [0008]

In the invention, a bisphenol-type condensation product is typically used to disperse aluminum sulfate in water while insoluble particles formed upon addition of aluminum sulfate to water in an amount greater than its
10 solubility are prevented from settling down or isolation.

The invention described herein is different from such prior publications in terms of the purpose of using the bisphenol-type condensation product.

These prior publications say nothing about the
15 development of liquid quick-setting agents containing aluminum sulfate in large amounts exceeding its solubility and the dispersion of aluminum sulfate in which the bisphenol type condensation product turns into insoluble particles.

20

LISTING OF PRIOR ARTS

PATENT PUBLICATIONS

[0009]

Patent Publication 1: JP(B) 60-4149

25 Patent Publication 2: JP(A) 10-87358

Patent Publication 3: JP(A) 2003-246659

Patent Publication 4: JP(A) 2005-89276

Patent Publication 5: JP(A) 2006-193388

Patent Publication 6: JP(A) 2008-30999
Patent Publication 7: JP(A) 2002-220267
Patent Publication 8: JP(A) 2002-121061
Patent Publication 9: JP(A) 2001-335353
5 Patent Publication 10: JP(A) 2002-249356

SUMMARY OF THE INVENTION

OBJECT OF THE INVENTION

[0010]

10 The inventor has made study about the aforesaid problems and demands. As a result, the inventor has found that the aforesaid problems can be solved by the invention, bringing the invention to completion.

15 MEANS FOR EMBODYING THE INVENTION

[0011]

 The invention can be embodied as follows.

- (1) A liquid quick-setting agent containing at least 30 parts by mass of aluminum sulfate as calculated on
20 solid basis per 100 parts by mass thereof, and a bisphenol-type condensation product.
- (2) A liquid quick-setting agent containing 30 to 45 parts by mass of aluminum sulfate and 0.5 to 5 parts by mass of a bisphenol-type condensation product as
25 calculated on solid basis per 100 parts by mass thereof, and water.
- (3) A liquid quick-setting agent as recited in (1) or (2), wherein said bisphenol-type condensation product has

an average molecular weight of 1,000 to 30,000.

- (4) A liquid quick-setting agent as recited in any one of (1) to (3), wherein said bisphenol-type condensation product is bisphenol S.
- 5 (5) A liquid quick-setting agent as recited in any one of (1) to (4), which is a suspension wherein insoluble particles containing aluminum sulfate is dispersed at -5 to 40°C in water.
- (6) A cement composition containing cement and a liquid
10 quick-setting agent as recited in any one of (1) to (5).
- (7) A spraying material containing a cement composition as recited in (6).
- (8) A spraying method in which cement is mixed with a
15 liquid quick-setting agent as recited in any one of (1) to (5).

ADVANTAGES OF THE INVENTION

[0012]

20 For instance, as compared with conventional liquid quick-setting agents, the liquid quick-setting agent of the invention is more improved in terms of storage stability and fluidity irrespective of the fact that the concentration of aluminum sulfate as calculated on solid
25 base is high.

Further, use of this liquid quick-setting agent ensures that the quick setting capability and strength development of the quick-setting spraying cement concrete

are better than those of conventional liquid quick-setting agents.

MODES FOR CARRYING OUT THE INVENTION

5 [0013]

The invention is now explained at greater length.

The cement concrete referred to herein is a general term of cement pastes, mortars, and concretes.

Unless otherwise stated, the "parts" and "%" used
10 herein are based on mass.

The liquid referred to herein encompasses a suspension.

[0014]

The invention provides a liquid quick-setting agent
15 containing at least 30 parts of aluminum sulfate as calculated on solid basis per 100 parts thereof, and a bisphenol-type condensation product. Preferably, the liquid quick-setting agent of the invention comprises aluminum sulfate and the bisphenol-type condensation
20 product with the remainder being water.

[0015]

Aluminum sulfate used herein may be either an anhydrate or a hydrate. In the invention, use may also be made of an aqueous solution of aluminum sulfate produced
25 by a reaction of aluminum hydroxide with an aqueous solution of sulfuric acid. Among these, the hydrate is preferable because it is well dispersed upon dissolution, and a 14 hydrate is more preferable.

[0016]

The amount of aluminum sulfate used per 100 parts of the liquid quick-setting agent is preferably at least 30 parts, more preferably 30 to 45 parts, and most preferably 5 32 to 40 parts as calculated on solid basis. In less than 30 parts, improved quick-setting capability is often unobtainable upon mixing with cement concrete. When the amount of aluminum sulfate is greater than 30 parts, the liquid quick-setting agent is basically a suspension in 10 which insoluble particles containing aluminum sulfate are dispersed in water, because aluminum sulfate is present in an amount exceeding its solubility.

The liquid quick-setting agent has a viscosity of preferably 4,000 mPa·s or lower, and more preferably 15 2,000 mPa·s or lower in view of pumpability.

[0017]

The bisphenol-type condensation product used herein is a general term for products obtained by the condensation reaction of a compound having, for instance, 20 two phenols crosslinked through a functional group and formaldehyde.

The functional group that makes a crosslinkage between two phenols includes, but is not limited to, a methylene group, an ethylidene group, a propylidene group, 25 a butylidene group, a cyclohexylidene group, a vinylidene group, a carbonyl group, an imino group, an ether group, a sulfide group, and a sulfonyl group.

Further, these functional groups may have any

hydrogen atom substituted by an alkyl group having 1 to 4 carbon atoms, a phenyl group, an amino group, a hydroxy group, a fluoro group, a chloro group, a bromo group, an iodo group or the like.

5 The phenol referred to herein also includes a compound in which any hydrogen atom bonded to an aromatic ring is substituted by an alkyl group having 1 to 4 carbon atoms, a cyclohexyl group, a phenyl group, an amino group, a carboxyl group, a hydroxyl group, a fluoro group, a
10 chloro group, a bromo group, an iodo group or the like as well as a compound in which a part of the hydrogen atom of a hydroxyl group is substituted to an alkali metal atom or the like. The bisphenol-type condensation products may be used alone or in combination. Among these, preference is
15 given to bis(4-hydroxyphenyl)sulfone (commonly known as bisphenol S) having two phenols crosslinked by a sulfonyl group because insoluble particles containing aluminum sulfate are uniformly dispersed in water, and the resulting suspension is lower in terms of viscosity and
20 more improved in terms of pumpability and quick-setting capability.

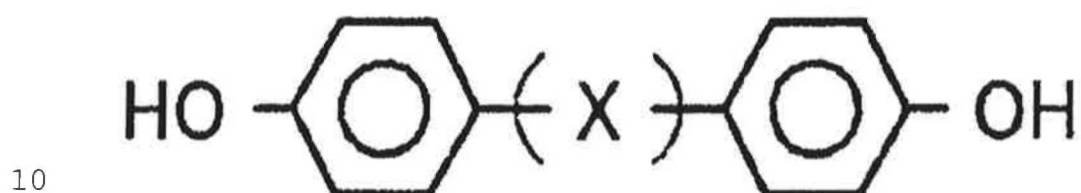
 The "uniformly dispersed state" referred to herein, for instance, is understood to mean a state wherein insoluble particles have a diameter of 0.5 mm or less, and
25 suspend in a disperse medium without settling down over a period of 1 month or longer even upon subjected to agitation or shaking: at least 90% by volume of insoluble particles are in suspension.

[0018]

The bisphenol-type condensation product used herein may be its salt. A bisphenol includes, but is not limited to, compounds represented by the following formula (1).

5 [0019]

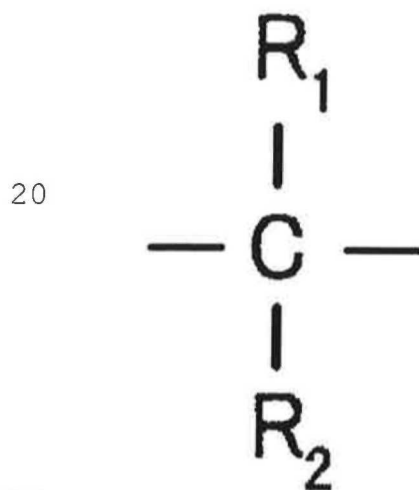
Formula (1)



where X stands for any one of groups represented by the following formulae (2), (3), (4) and (5), O (oxygen), and S (sulfur).

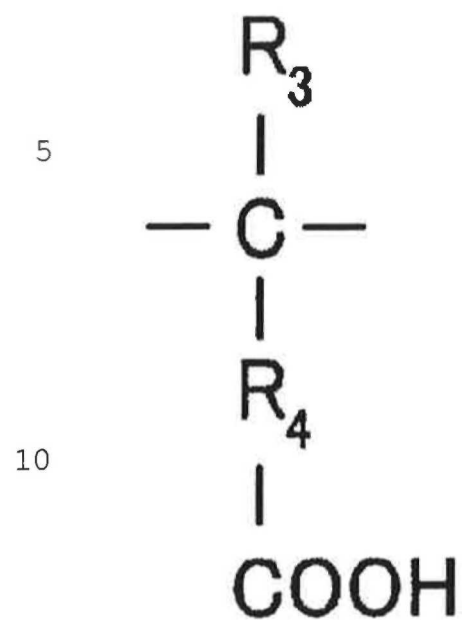
15 [0020]

Formula (2)



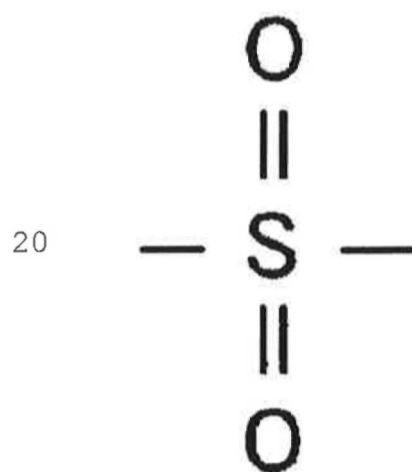
[0021]

Formula (3)



[0022]

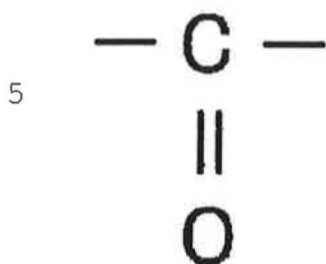
15 Formula (4)



25

[0023]

Formula (5)



10 In Formulae (2), (3), (4) and (5), R₁, R₂ and R₃ are each independently hydrogen, a halogen or an alkyl group, and R₄ is an alkylene group.

[0024]

 The bisphenol-type condensation product has an
15 average molecular weight of preferably 700 to 35,000, more preferably 1,000 to 30,000, and most preferably 5,000 to 20,000. Within such ranges, the insoluble particles can be uniformly dispersed in water, and the liquid quick-setting agent can have a lower viscosity with improved
20 pumpability. The average molecular weight used herein is understood to refer to a weight-average molecular weight. By way of example, the bisphenol-type condensation product may be obtained by heating and condensing the respective components in the presence of an alkali.

25 [0025]

 The amount of the bisphenol-type condensation product used per 100 parts of the liquid quick-setting agent is preferably 0.2 to 7 parts, more preferably 0.5 to

5 parts, and most preferably 0.5 to 3 parts as calculated on solid basis. Within such ranges, the insoluble particles can be uniformly dispersed in water, and the suspension can have a lower viscosity with improved pumpability and makes sure better quick-setting capability upon mixing with cement concretes.

[0026]

The amount of the liquid quick-setting agent used herein is preferably 3 to 20 parts, more preferably 5 to 15 parts, and most preferably 7 to 10 parts per 100 parts of cement as calculated on solid basis. Within such ranges, the quick-setting capability of quick-settable spraying concrete can be accelerated, allowing the concrete to keep on developing strength over an extended period of time.

[0027]

The cement used herein is understood to refer to various Portland cements such as normal Portland cement, high early strength Portland cement, moderate heat Portland cement and super high early strength cement, and various blended cements such as ones obtained by mixing such Portland cements with fly ashes or blast-furnace slag. These cements may be finely pulverized for use.

[0028]

The cement concrete used herein contains cement and an aggregate.

The aggregate used herein should preferably have a low water absorption rate and a high strength. There is no

particular limitation on the maximum size of aggregate provided that it can be sprayed.

[0029]

River sand, pit sand, lime sand, silica sand, etc.
5 may be used as fine aggregates, and river gravel, pit gravel, lime gravel, etc. may be used as coarse aggregates.

[0030]

The amount of water used for cement concrete is preferably at least 35%, and more preferably 40 to 55% for
10 the purpose of keeping on developing strength. Within such ranges, sufficient mixing of cement concrete is achievable.

[0031]

The wet spraying method used herein includes, but is
15 not limited to, a method of spraying a quick-setting wet spraying cement concrete obtained by mixing cement, a fine aggregate, a coarse aggregate and water, delivering the resulting mixture by means of pneumatic pumping, and combining and mixing it with a liquid quick-setting agent
20 fed out of one portion of a Y-shaped pipe located on the way by means of a quick-setting agent feeder.

[0032]

The pressure of air used to pump the liquid quick-setting agent should preferably be 0.01 to 0.3 MPa higher
25 than the pressure for pumping the cement concrete such that there is no clogging of a liquid quick-setting agent pumping pipe upon feeding of cement concrete into it.

EXAMPLES

[0033]

The present invention is now explained in further details with reference to specific examples. Note here
5 that the temperature of a testing (experimenting) environment was set at 20°C.

[0034]

Experimental Example 1

Aluminum sulfate and bisphenol-type condensation
10 products shown in Table 1 were added to water in such amounts as shown in Table 1 and as calculated on solid basis per 100 parts of the liquid quick-setting agent, and the resulting solutions were agitated for 1 hour to prepare various liquid quick-setting agents. After
15 agitation, each liquid quick-setting agent was allowed to stand for 3 hours to measure its viscosity with a viscometer. After agitation, each liquid quick-setting agent was transferred into a messcylinder (graduated cylinder) where it was allowed to stand for 1 month to
20 measure a separation factor as an index of the dispersibility of the liquid quick-setting agent. The results are also set out in Table 1.

[0035]

Materials used for experimentation

25 Aluminum sulfate:

Commercially available aluminum sulfate 14 hydrate

Bisphenol-type condensation product A:

Commercially available condensation product of bis(4-

hydroxyphenyl)methane having an average molecular weight of 12,000

Bisphenol-type condensation product B:

Commercially available condensation product of 2,2-bis(4-
5 hydroxyphenyl)propane having an average molecular weight of 12,000

Bisphenol-type condensation product C:

Commercially available condensation product of 2,2-bis(4-
hydroxyphenyl)hexafluoropropane having an average
10 molecular weight of 12,000

Bisphenol-type condensation product D:

Commercially available condensation product of 2,2-bis(3-
methyl-4-hydroxyphenyl)propane having an average molecular
weight of 12,000

15 Bisphenol-type condensation product E:

Commercially available condensation product of 4,4'-
dihydroxybenzophenone having an average molecular weight
of 12,000

Bisphenol-type condensation product F:

20 Commercially available condensation product of bis(4-
hydroxyphenyl)sulfide having an average molecular weight
of 12,000

Bisphenol-type condensation product G:

Commercially available condensation product of bis(4-
25 hydroxyphenyl)sulfone having an average molecular weight
of 12,000

[0036]

Measuring Methods

Viscosity was measured using a B-type viscometer (TVB-10 Type available from Toki Sangyo Co., Ltd.).

For the separation factor, the volumetric proportion of the supernatant liquid relative to the overall liquid quick-setting agent was calculated (% by volume). The supernatant liquid used herein is understood to refer to an insoluble particle-free liquid phase resulting from separation over time of the liquid quick-setting agent present in the form of a suspension. There is the suspension below the supernatant liquid. A smaller separation factor is preferable because the insoluble particles are more uniformly dispersed in water.

[0037]

Table 1

Run No.	Amount of aluminum sulfate used (parts)	Bisphenol-type condensation product		Viscosity	Separation factor (Volume %)	Remarks
		Type	Amount used (parts)			
1- 1	35	—	0.0	7,000	48	Comparative
1- 2	35	A	1.0	1,300	4	Inventive
1- 3	35	A	3.0	2,400	2	Inventive
1- 4	35	B	1.0	1,800	3	Inventive
1- 5	35	B	3.0	3,800	1	Inventive
1- 6	35	C	1.0	900	9	Inventive
1- 7	35	C	3.0	1,800	4	Inventive
1- 8	35	D	1.0	1,700	3	Inventive
1- 9	35	D	3.0	3,700	2	Inventive
1-10	35	E	1.0	1,200	3	Inventive
1-11	35	E	3.0	2,000	2	Inventive
1-12	35	F	1.0	1,000	9	Inventive
1-13	35	F	3.0	2,000	6	Inventive

1-14	35	G	0.2	5,500	14	Inventive
1-15	35	G	0.5	1,600	3	Inventive
1-16	35	G	1.0	750	1	Inventive
1-17	35	G	3.0	980	1	Inventive
1-18	35	G	5.0	1,800	1	Inventive
1-19	35	G	7.0	3,200	1	Inventive
1-20	30	G	1.0	50	5	Inventive
1-21	32	G	1.0	140	3	Inventive
1-16	35	G	1.0	750	1	Inventive
1-22	40	G	1.0	1,800	1	Inventive
1-23	45	G	1.0	3,800	1	Inventive

The amounts of aluminum sulfate and the bisphenol-type condensation product used are per 100 parts of the liquid quick setting agent as calculated on solid basis.

[0038]

From Table 1 it is found that as at least 30 parts of aluminum sulfate as calculated on solid basis and the bisphenol-type condensation product are contained per 100 parts of the liquid quick-setting agent, it causes the liquid quick-setting agent to be lower in terms of viscosity and better in terms of dispersibility. Among the bisphenol-type condensation products, preference is given to bis(4-hydroxyphenyl)sulfone (bisphenol S).

10 [0039]

Experimental Example 2

Bisphenol S having such average molecular weights shown in Table 2 was used to prepare liquid quick-setting agents containing 35 parts of aluminum sulfate and 1 part of bisphenol S as calculated on solid basis per 100 parts thereof. The viscosity and separation factor were

measured. Experimental Example 1 was otherwise repeated.
The results are also set out in Table 2.

[0040]

Materials used for experimentation

5 Bisphenol S(a):

Commercially available product having an average molecular
weight of 700

Bisphenol S(b):

Commercially available product having an average molecular
10 weight of 1,000

Bisphenol S(c):

Commercially available product having an average molecular
weight of 5,000

Bisphenol S(d):

15 Bisphenol-type condensation product G; commercially
available product having an average molecular weight of
12,000

Bisphenol S(e):

Commercially available product having an average molecular
20 weight of 16,000

Bisphenol S(f):

Commercially available product having an average molecular
weight of 20,000

Bisphenol S(g):

25 Commercially available product having an average molecular
weight of 24,000

Bisphenol S(h):

Commercially available product having an average molecular

weight of 30,000

Bisphenol S(i):

Commercially available product having an average molecular weight of 35,000

5 [0041]

Measuring Method

The average molecular weight was measured by gel permeation chromatography (the standard substance: sodium polystyrene sulfonate).

10 [0042]

Table 2

Run No.	Bisphenol S		Viscosity (mPa·s)	Separation factor (Volume %)	Remarks
	Type	Average molecular weight			
2- 1	(a)	700	6,600	29	Inventive
2- 2	(b)	1,000	3,600	9	Inventive
2- 3	(c)	5,000	1,200	3	Inventive
1-16	(d)	12,000	750	1	Inventive
2- 4	(e)	16,000	890	1	Inventive
2- 5	(f)	20,000	1,500	1	Inventive
2- 6	(g)	24,000	2,400	1	Inventive
2- 7	(h)	30,000	3,400	1	Inventive
2- 8	(i)	35,000	6,800	1	Inventive

[0043]

From Table 2 it is found that the bisphenol-type condensation products having an average molecular weight of 1,000 to 30,000 give more preferable viscosity and better dispersibility to the liquid quick-setting agents.

[0044]

Experimental Example 3

Aluminum sulfate and bisphenol (S)(d) in such amounts as shown in Table 3 and as calculated on solid basis per 100 parts of the liquid quick-setting agent were added to water to prepare liquid quick-setting agents.

Mortar having a sand/water ratio=3 and a water/cement ratio=52% was prepared. Seven (7) parts of the liquid quick-setting agent as calculated on solid basis per 100 parts of cement were added to the mortar to obtain a quick-setting mortar. The setting time and compressive strength of the quick-setting mortar were measured. The results are set out in Table 3 as well.

[0045]

15 Materials used for Experimentation

Cement:

Commercially available Portland cement having a Blaine value of 4,000 cm²/g and a specific gravity of 3.16

Fine aggregate:

20 Fine aggregate occurring in Himekawa, Itoigawa-shi, Niigata-ken, and dried on the surface with a specific gravity of 2.62

[0046]

Measuring Method

25 For the setting time, the quick-setting mortar was measured pursuant to the Japan Society of Civil Engineer Standard "Quality Standard for Quick-Setting Agents for Spraying Concretes (JSCED-102)".

For the compressive strength, the quick-setting mortar was measured pursuant to JIS R 5201.

[0047]

Table 3

Run No.	Amount of aluminum sulfate used (parts)	Amount of the bisphenol-type condensation product used (parts)	Setting time (min.)		Compressive strength (N/mm ²)			Remarks
			Start	End	3 hours	1 day	28 days	
3- 1	27	1.0	20.0	60.0	0.2	9.1	47.2	Comparative
3- 2	30	1.0	8.0	25.0	0.3	12.6	50.3	Inventive
3- 3	32	1.0	6.0	14.0	0.7	14.3	51.6	Inventive
3- 4	35	1.0	4.0	13.0	1.0	17.4	52.5	Inventive
3- 5	40	1.0	3.0	11.0	1.3	17.0	50.3	Inventive
3- 6	45	1.0	2.5	10.0	1.4	16.2	47.5	Inventive
3- 7	35	0.5	2.0	9.0	1.3	18.2	51.8	Inventive
3- 8	35	3.0	4.5	15.0	0.8	15.6	52.7	Inventive
3- 9	35	5.0	6.0	20.0	0.6	13.5	53.0	Inventive
3-10	35	7.0	10.0	40.0	0.2	10.2	47.2	Inventive

The amounts of aluminum sulfate and the bisphenol-type condensation product used are per 100 parts of the liquid quick setting agent as calculated on solid basis.

5 [0048]

It is found from Table 3 that at least 30 parts of aluminum sulfate give preferable properties to some liquid quick-setting agents, and that 30 to 45 parts of aluminum sulfate and 0.5 to 5 parts of the bisphenol-type condensation products give more preferable properties to some liquid quick-setting agents.

[0049]

Experimental Example 4

Prepared were liquid quick-setting agents containing

35 parts of aluminum sulfate and 1 part of bisphenol S(d) as calculated on solid basis per 100 parts of the liquid quick-setting agent, with the balance being water. The liquid quick-setting agent in such amounts as shown in Table 4 and as calculated on solid basis was added to 100 parts of cement to obtain quick-setting mortars. The setting time and compressive strength of the quick-setting mortars were measured. Experimental Example 3 was otherwise repeated. The results are set out in Table 4 as well.

[0050]

Table 4

Run No.	Liquid quick-setting agents (parts)	Setting time (min.)		Compressive strength (N/mm ²)			Remarks
		Start	End	3 hours	1 day	28 days	
4- 1	0	—	—	0.1	5.7	45.3	Comparative
4- 2	3	7.0	20.0	0.4	11.8	50.1	Inventive
4- 3	5	5.5	16.0	0.8	13.7	53.1	Inventive
3- 4	7	4.0	13.0	1.0	17.4	52.5	Inventive
4- 4	10	3.5	12.0	1.0	16.5	51.0	Inventive
4- 5	15	3.0	10.0	1.1	15.9	49.8	Inventive
4- 6	20	2.5	8.0	1.2	14.2	48.1	Inventive
4- 7	23	2.5	7.0	1.2	11.0	42.0	Inventive

The amount of the liquid quick-setting agent used is per 100 parts of cement as calculated on solid basis, and "—" of setting time is 60 minutes or more.

[0051]

It is found from Table 4 that the amount of the liquid quick-setting agents used is preferably 3 to 20 parts per 100 parts of cement, because it gives preferable

properties to the spraying material.

INDUSTRIAL APPLICABILITY

[0052]

5 The liquid quick-setting agent of the invention is better than conventional liquid quick-setting agents in terms of storage stability and fluidity so that the ability to keep on developing quick-setting properties and strength can be improved, because the use of the
10 bisphenol-type condensation product having a dispersion effect ensures that even when aluminum sulfate is used in an amount exceeding its solubility, it is uniformly dispersed in water without settling down. For this reason, the liquid quick-setting may be used over a wide range of
15 civil engineering, construction and other fields.

WHAT IS CLAIMED IS:

[Claim 1]

A liquid quick-setting agent containing at least 30 parts by mass of aluminum sulfate as calculated on solid basis per 100 parts by mass thereof, and a bisphenol-type condensation product, wherein the bisphenol-type condensation product is bisphenol S condensation product.

[Claim 2]

A liquid quick-setting agent containing 30 to 45 parts by mass of aluminum sulfate and 0.5 to 5 parts by mass of a bisphenol-type condensation product as calculated on solid basis per 100 parts by mass thereof, and water.

[Claim 3]

A liquid quick-setting agent as recited in claim 1 or 2, wherein said bisphenol-type condensation product has an average molecular weight of 1,000 to 30,000.

[Claim 4]

A liquid quick-setting agent as recited in any one of claims 1 to 3, which is a suspension wherein insoluble particles containing aluminum sulfate is dispersed at -5 to 40°C in water.

[Claim 5]

A cement composition containing cement and a liquid quick-setting agent as recited in any one of claims 1 to 4.

[Claim 6]

A spraying material containing a cement composition as recited in claim 5.

[Claim 7]

5 A method of preparing a spraying material in which cement is mixed with a liquid quick-setting agent as recited in any one of claims 1 to 4.

10