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(54) **High consistency-aqueous slurry of powdered coal.**

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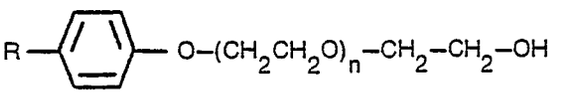
Description

Background of the Invention

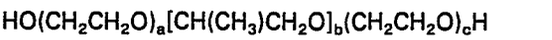
This invention relates to a high consistency (coal solids content) aqueous slurry of powdered coal which may be conveyed by a hydraulic pump and is combustible as such.

It is well-known that one of major disadvantages of coal compared with petroleum as an energy source is the difficulty of transportation and storage. Powdered coal cannot be conveyed pneumatically because of the danger of spontaneous explosition. It has been proposed to transport powdered coal as an aqueous slurry by pumping. However, as the consistency of powdered coal increases, the slurry will become too viscous and lose its fluidity completely so that its transportation by a hydraulic pump becomes impossible. Transportation at lower consistencies is not attractive not only for economical reasons but also for the incapability of combusting as such.

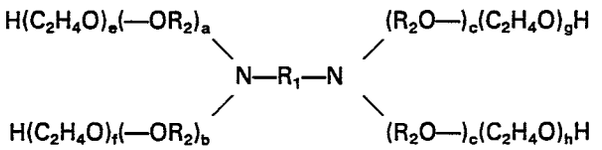
Polyalkylene oxide nonionic surfactants are already described in EP—A—57 576 which is prior art according to article 54 (3) EPC. Those surfactants disclosed therein are glycol ethers of alkylated phenols of the formula I



poly(oxyethylene)-poly(oxypropylene)-poly(oxyethylene) of the formula II:



and, block polymers of ethylene oxide and another alkylene oxide derived from alkylene diamines of the formula III:



The starting active hydrogen compounds of nonionic surfactants of formulae I, II and III are alkylated phenols having only one active hydrogen atom, propylene glycol having only two hydrogen atoms and alkylenediamines having only two nitrogen atoms.

Therefore, this prior art does not teach the use of the polyalkylene oxides as described hereinafter.

Description of the Invention

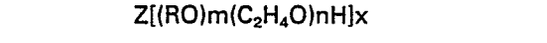
According to the present invention, there is provided a fluid aqueous coal slurry having at least 60% by weight coal solids content and consisting essentially of a mixture of water and powdered coal rendered fluid by the presence therein, as a viscosity lowering agent, of an amount effective to render the slurry fluid of a polyalkylene oxide having a molecular weight of at least 1000 and an oxyethylene unit content of at least 10% by weight, based on the total oxyalkylene unit content, which is characterized in that the polyalkylene oxide is a polyether adduct of a lower alkylene oxide and an active hydrogen compound selected from the group consisting of

(a) polyhydroxyl compounds having at least three active hydrogen atoms;
(b) polyamines having 5 or more active hydrogen atoms;
(c) condensates of a phenolic compound with an aliphatic aldehyde;
(d) polyalkyleneimines and derivatives thereof having 7 to 200 nitrogen atoms;
(e) carboxylic acids; and
(f) compounds having two or more different active hydrogen-containing functional groups.

According to a further embodiment the fluid aqueous coal slurry is characterized in that the polyalkylene oxide is (a) the reaction product of a cross-linking agent with a polyether adduct of an alkylene oxide and an active hydrogen compound, or (b) the reaction product of (a) or of said adduct with an inorganic or organic acylating agent, a halogenating agent, an oxidizing agent or a monoisocyanate.

The polyether compounds may be prepared by first synthesizing the compound a) and then optionally converting the same into compounds b) or c).

a) The compound a) typically has the formula:



wherein Z is the residue of an active hydrogen compound, RO is a C_3 or C_4 oxyalkylene unit, n and m each represents a recurring number, and x is the number of oxyalkylene chain bonded to the residue Z.

The above polyether compound may be prepared in per se known manner by reacting a starting active hydrogen compound with ethylene oxide and optionally with a C_3—C_4 alkylene oxide, epichlorhydrin or ethylene carbonate under elevated pressures in the presence of an acid or alkaline catalyst. Where two or more different alkyene oxides are combined, the resulting copolymer may be either a block or random copolymer. However, the copolymer must contain at least 10% by weight of oxyethylene unit based on the total oxyalkylene chain content. The molar ratio of alkylene oxide to the starting active hydrogen compound is adjusted such that the resulting adduct has a molecular weight of at least 1,000, preferably from 1,000 to 600,000.

The active hydrogen compound used herein must have at least one hydrogen-containing, functional group such as hydroxyl, amino, imino, and carboxylic groups.

Examples of hydroxyl group-containing compounds include water; monohydric alcohols such as ethanol, butanol, octanol, cyclohexanol and benzyl alcohol; dihydric alcohols such as ethylene glycohol, polyethylene glycol, propylene glycol, polypropylene glycol, butanediol, pentanediol and hexanediol; trihydric alcohols such as glycerine, butanetriol, hexanetriol, trimethylolpropane and triethanolamine; tetrahydric alcohols such as diglycerine and pentaerythritol; those having five or more hydroxyl groups such as xylitol, sorbitol, glucose, sucrose, partially saponified products of vinyl acetate polymers or copolymers, cellulose and starch; and the like.

Aromatic hydroxyl compounds may also be used as a starting active hydrogen compounds. Examples thereof include monophenols such as phenol, cresol, xylenol, butylphenol, nonylphenol, aminophenol and hydroxybenzoic acid; polyphenols such as catechol, resorcine and pyrogallol; mono- and polynaphthols such as naphtol, methylnaphthol, butylnaphthol, octylnaphthol, naphthoresorcine and α-naphthohydroquinone; bisphenols such as bisphenol A and bisphenol S; condensates of these aromatic hydroxyl compounds with an aliphatic aldehyde such as formaldehyde, acetaldehyde or glyoxal; and the like.

Examples of amino or imino group-containing compounds include secondary amines such as dimethylamine and N-methyllaurylamine; primary amines such as methylamine, ethylamine, propylamine, butylamine, allylamine, amylamine, octylamine, dodecylamine, laurylamine, tetradecylamine, pentadecylamine, octadecylamine, tallow alkylamine, coconut alkylamine, aniline, p-toluidine, m-toluidine, nitroaniline, benzylamine, chloraniline, p-dodecylbenzylamine and cyclohexylamine; amines having three active hydrogen atoms such as ammonia and tallow propylenediamine; amines having four active hydrogen atoms such as urea, ethylenediamine, tetramethylenediamine, hexamethylenediamine, phenylenediamine, benzidine, dicyandiamide and cyclohexyldiamine; amines having five or more active hydrogen atoms such as diethylenetriamine, triethylenetetramine and tetraethylenepentamine; polyalkyleneimines such as polyethyleneimine, polypropyleneimine, addition products of alkyleneimine such as ethyleneimine or propyleneimine with alochols, phenols, amines or carboxylic acids; condensates of said polyalkyleneimines with aldehydes, ketones, alkyl halides, isocyanates, thioisocyanates, active double bond-containing compounds, epoxy compounds, epihalohydrines, cyanamides, guanidines, urea, carboxylic acids, their acid anhydrides and acid halides; and the like. The polyalkyleneimines and their derivatives preferably have 7 to 200, more preferably 9 to 200 nitrogen atoms per mole.

Examples of carboxylic acids includes monocarboxylic acids such as acetic acid and lauric acid; dicarboxylic acids such as oxalic acid, fumaric acid and maleic acid; tri- or higher carboxylic acids such as trimesic acid, butanetetracarboxylic acid, and pyromellitic acid; and the like.

Compounds having two or more different active hydrogen-containing functional groups such as lactic acid, glycolic acid, glycine, N-monoalkylglycine, malic acid, tartaric acid, monoethanolamine, diethanolamine and aminoethylethanolamine may also be used as a starting active hydrogen compound.

The average molecular weight of the resulting polyether may be easily estimated by determining the hydroxyl number thereof.

The polyether compounds of the above class a) have at least one free hydroxyl group at the terminal of oxyalkylene chain. This hydroxyl group may be entirely or partially reacted with an appropriate acylating agent to obtain the corresponding inorganic or organic ester. Examples of inorganic acylating agents include sulfuric acid, chlorosufonic acid, sulfamic acid and sodium bisulfite for sulfate esters, and phosphorus pentoxide, metaphosphoric acid and thiophosphates for phosphate esters. These esters may take the form of a free acid or salt with a metal such as sodium, potassium, calcium and magnesium, or other cations such as ammonia, organic amines and quaternary ammonium ions.

Similarly, the hydroxyl group of compound a) may be modified by per se known reaction to obtain the corresponding ester with inorganic or organic acid, halide such as chloride or bromide, aldehyde, carboxylic acid and urethane.

b) Cross-linked polyether compounds b) may be prepared by reacting a polyether compound a) mentioned-above with a cross-linking agent.

A variety of cross-linking agents may be employed for this purpose including polyisocyanates such as hexamethylene diisocyanate, tolylene diisocyanate, xylylene diisocyanate, 1,5-naphthylene diisocyanate and 4,4'-diphenylmethane diisocyanate; polyepoxy compounds such as diglycidyl bisphenol A, diglycidyl ethylene glycol and diglycidyl tetraoxyethylene glycol; polycarboxylic acids and their functional derivatives (e.g. anhydrides and halides) such as oxalic acid, malonic acid, phthalic acid, maleic acid, glutaric acid, adipic acid, azelaic acid, sebatic acid, dodecanedioic acid, dimer acid, hemimellitic acid, trimellitic acid, butanetetracarboxylic acid, pyromellitic acid, ethylenediamine tetraacetic acid, polymers and copolymers

of acrylic acid, polymers and copolymers of methacrylic acid, polymers and copolymers of maleic anhydride, partially saponified polymers and copolymers of acrylates or methacrylates; and functional derivatives (e.g. anhydride or halides) of these acids; polyaldehydes such as glyoxal and succinaldehyde; peroxides (free radical generating catalysts) such as hydrogen peroxide, benzoyl peroxide, di-t-butyl peroxide, cumene hydroperoxide and dicumyl peroxide; and formaldehyde in combinatioon with acid catalysts.

When the above polyisocyanate or polyepoxide cross-linking agents are used, they may be added in 0.05 to 5, preferably 0.1 to 3 equivalents per equivalent of terminal hydroxyl group present in the polyoxyalkylene chain of the polyether compound a). The reaction may be carried out by heating the reaction components at a temperature of 40 to 150°C, preferably 50 to 120°C optionally in the presence of a conventional acid or alkali catalyst.

Polycarboxylic acids or their derivatives may be used in 0.05 to 5, preferably 0.1 to 3 equivalents per equivalent of said hydroxyl group. The reaction may be carried out at a temperature of 60 to 250°C, preferably 80 to 220°C optionally in the presence of a conventional esterifying catalyst. When acid halides are used, the reaction temperature may be lowered to −10 to 150°C, preferably 0 to 120°C with blowing an inert gas into the reaction mixture or in the presence of an acid acceptor.

The cross-linking of polyethers with free radical-generating peroxide catalysts is known from e.g. Journal of Applied Polymer Science, Vol. 7, 461—468 (1963). Using this technique, polyethers a) may be reacted with 0.05 to 10% by weight, preferably 0.1 to 5% by weight of a peroxide catalyst at a temperature of 50 to 250°C, preferably 70 to 180°C optionally in an inert solvent.

When formaldehyde is used for the cross-linking reaction, 0.1 to 10 equivalents, preferably 0.5 to 5 equivalents of formaldehyde are reacted with one equivalent of polyethers a) in the presence of 0.005 to 0.05 equivalents of a conventional acid catalyst by heating at a temperature of 60 to 100°C for 1 to 3 hours and then continuing the reaction at a temperature of 100 to 180°C.

When the resulting cross-linked polyethers b) still have remaining hydroxyl group or groups, they may be converted into their derivatives c) by modifying the residual hydroxyl group by per se known reactions. Said derivatives include esters with inorganic or organic acids, halides such as chlorides and bromides, corresponding aldehydes or carboxylic acids, and urethanes with monoisocyanates.

Various types of coal may be used for preparing the aqueous slurry of powdered coal of the present invention and include anthracite, bituminous coal, subbituminous coal, lignite and cleaned coal of these types.

The term "cleaned coal" as used herein refers to those products obtained from mined coal by removing or decreasing its inorganic impurity contents such as ash and sulfur. Several processes are known for cleaning coal in this manner such as the heavy media separation process, the oil agglomeration process, the floatation process and other processes. Any process may be applied for preparing cleaned coal used in the present invention.

The oil agglomeration process, for example, may be carried out by adding an amount of oil to an aqueous slurry of pulverized coal particles or suspending oil-coated pulverized coal particles in water, and then stirring the slurry. Organic components in the coal are wetted selectively with oil to agglomerate into a mass, while inorganic impurities thereof remain in the aqueous phase. Separation of aqueous phase from the mixture gives cleaned coal having a greatly reduced inorganic impurity content. The process is generally carried out at a coal concentration from 10 to 65%. Examples of oils which may be used in the oil agglomeration process include petroleum crude oil and liquid fractions thereof such as kerosine, light oil, bunker A, bunker B, bunker C and the like. Other mineral oils such as residue from ethylene-cracking, shale oil, lubricant oil and cleaning oil as well as benzene, toluene, xylene and various animal and vegetable oils may be used. Heavy oils such as bunker C or tar residue oil are preferable for economical reason. The amount of oil needed for giving a satisfactory result is generally less than 20% by weight based on the weight of coal.

The floatation process may be carried out, as is well-known, by adding a very small amount of oil into a pulverized coal-water slurry and then vigorously stirring the slurry to form froth. Organic components of coal selectively adhere to oil films of the froth while inorganic impurities remain in the aqueous phase. Examples of oils which may be employed in the floatation process include terpene oil, tar, bunker A, bunker C, light oil and kerosine.

The above two processes generally reduce the inorganic impurities by several tens of percent of their original contents.

The use of cleaned coal in the composition of this invention has the important advantage that the viscosity lowering agent used herein is more effective with cleaned coal than with uncleaned coal thereby allowing the preparation of slurries having several points higher consistencies than when uncleaned coal is employed. Additionally, damages to boilers and loads to desulfuring and ash disposal equipments are greatly decreased.

It is preferable that the particle size of powdered coal used herein complies with the requirements by various users such as power plants and is such that at least 70% of the particles can pass through a standard screen having 74 × 74 μm square eyes according to JIS.

The viscosity lowering agent used in the present invention remarkably decreases the viscosity of and imparts fluidity to aqueous slurries of powdered coal which are otherwise too viscous to be conveyed by

pumping. Normally, simple aqueous slurries of powdered coal will lose fluidity completely at a consistency of 50% or higher. The aqueous slurries of the present invention have a consistency higher than 60%, preferably 70% by weight while retaining sufficient fluidity to be conveyed by pumping. When cleaned coal is used, the consistency may be further increased by 3 to 10 points.

The amount of viscosity lowering agent needed for achieving satisfactory results lies generally from 0.01 to 5.0%, preferably from 0.03% to 2.0% by weight based on the entire composition.

Although the present invention is not bound to a particular theory, it is postulated that the visocosity lowering agent used in the present invention is strongly adsorbed by coal particles on their surfaces because of their unique structure and then hydrated with surrounding water molecules. This results in the formation of lubricant configuration of water molecules surrounding coal particles, while retaining coal particles as stable primary particles, thereby increasing in fluidity and decreasing in viscosity.

It is also postulated that cleaned coal can be fluidized more effectively with the viscosity lowering agent because of its increased organic nature due to the removal of hydrophilic, fine ash components.

The viscosity lowering agent used in the present invention stabilizes the aqueous slurry of powdered coal and prevents coal particles from sedimentating upon stationary standing for a long period of time, e.g. for one month.

Various methods for preparing the aqueous slurry and for mixing the viscosity lowering agent thereto may be employed. For example, coal blocks may be disintegrated in the dry process and the powdered coal may be mixed with water containing the viscosity lowering agent. Alternatively, coal may be disintegrated in a mill by the wet process in the presence of water and the viscosity lowering agent.

The invention is further illustrated by the following examples in which all parts and percents are by weight.

Example 1

Using various viscosity lowering agents listed in Table 1, aqueous slurries as shown in Table 2 were prepared from powdered coal pulverized to 80% passing through a screen having 74 × 74 µm square eyes according to JIS. The viscosities and fluidities of the resultant slurries were determined at 25°C, respectively.

After standing for one month, the occurrence of phase separation in each sample was visually observed.

Alternatively, the slurries were poured into a cylinder up to 18 cm level and allowed to stand for one month. Thereafter, the consistencies at upper layer (up to 1 cm below the top level) and lower layer (up to 1 cm above the bottom) respectively were determined.

The results obtained were shown in Table 2. As shown in Table 2, the aqueous slurries of the present invention have a viscosity ranging from 800 to 2 800 mPas and retain a sufficient fluidity for pumping transportation at a powdered coal consistency ranging from 72 to 77%. It is also noted from Table 2 that the slurries of the present invention are stable upon storage and no or little sedimentation of coal particles occurs upon standing for at least one month.

In contradistinction, control slurries in which no or conventional surfactants are added have a viscosity higher than 20 000 mPas and exhibit almost no fluidity even at a coal consistency of 50%.

Example 2

The procedure of Example 1 was repeated except that cleaned powdered coal was used. Formulations and results obtained were shown in Table 3.

The slurries have a viscosity ranging from 1000 to 2800 mPas and retain a sufficient fluidity for pumping transportation at a coal consistency ranging from 76 to 80%, while control samples exhibit a viscosity higher than 20 000 mPas and no fluidity even at a coal consistency of 50%.

In tables I and II compounds nos. 1—3, 5, 7, 43—46, 56, 69—70, 74 and 91—93 are outside the scope of the invention. However, these compounds are listed for comparison purposes.

TABLE I-1
List of Viscosity Lowering Agents

Compound No.	Active hydrogen compound	Alkylene oxide (%)	Form of EO units	M.W.
1	octanol	PO 75, EO 25	block	2,500
2	toludine	PO 60, EO 40	block	3,300
3	butanediol	BO 86, EO 14	block (terminal)	18,000
4	hexanetriol	PO 56, EO 44	random	10,000
5	phenylenediamine	PO 77, EO 23	block (terminal)	22,000
6	diglycerine	BO 16, PO 50, EO 34	block	69,000
7	hexamethylenediamine	PO 85, EO 15	block (terminal)	7,500
8	starch	PO 80, EO 20	block (terminal)	8,000
9	sorbitol	PO 65, EO 35	block	75,000
10	tetraethylenepentamine	PO 63, EO 37	random	10,000
11	sucrose	PO 84, EO 16	block (terminal)	5,000
12	sulfate ester of No. 3, sodium salt			
13	sulfate ester of No. 5, monoethanolamine sat			
14	phosphate ester of No. 9, potassium salt			
15	partial phosphate ester of No. 10, ammonium salt			
16	polyethyleneimine (N 150)	PO 80, EO 20	block (terminal)	450,000
17	polyethyleneimine (N 15)	PO 18, EO 82	block (terminal)	8,000
18	polyethyleneimine (N 85)	PO 80, EO 20	random	500,000
19	polyethyleneimine (N 45)	PO 15, EO 85	block	250,000

TABLE I-2
List of Viscosity Lowering Agents

Compound No.	Active hydrogen compound	Alkylene oxide (%)	Form of EO units	M.W.
20	polyethyleneimine (N 24)	PO 25, EO 75	block (terminal)	65,000
21	polyethyleneimine (N 85)	PO 50, EO 50	block (terminal)	130,000
22	polyethyleneimine (N 13)	PO 65, EO 35	block	14,000
23	adduct of ethyleneimine + glycerine (N 76)	PO 30, EO 70	random	100,000
24	adduct of ethyleneimine + nonylphenol (N 32)	PO 60, EO 40	block (terminal)	20,000
25	reaction product of polyethyleneimine (1 mole) + diethyl ketone (1 mole) (N 20)	PO 65, EO 35	block	15,000
26	reaction product of polyethyleneimine (1 mole) + ethylchloride (3 moles) (N 80)	PO 55, EO 45	block (terminal)	170,000
27	reaction product of polyethyleneimine (1 mole) + caprylic acid (5 moles) (N 30)	PO 25, EO 75	block	45,000
28	sulfate ester of No. 20, sodium salt			
29	sulfate ester of No. 21, ethanolamine salt			
30	partial phosphate ester of No. 24, ammonium salt			
31	condensate of formaldehyde + phenol (condensation degree 3.0)	PO 85, EO 15	block	2,200
32	condensate of formaldehyde + naphthol (condensation degree 4.5)	BO 80, EO 20	random	3,400
33	condensate of formaldehyde + nonylphenol (condensation degree 13.0)	PO 20, EO 80	block	20,000
34	condensate of formaldehyde + methylnaphthol (condensation degree 24.0)	PO 55, EO 45	block	82,000
35	condensate of formaldehyde + phenol (condensation degree 8.0)	PO 65, EO 35	random	8,000

TABLE I-3
List of Viscosity Lowering Agents

Compound No.	Active hydrogen compound	Alkylene oxide (%)	Form of EO units	M.W.
36	condensate of formaldehyde + pyrogallol (condensation degree 14.0)	PO + BO 40, EO 60	random	54,000
37	condensate of formaldehyde + aminophenol (condensation degree 5.5)	BO 50, EO 50	random	16,000
38	condensate of formaldehyde + butylnaphthol (condensation degree 9.5)	PO 60, EO 40	block	33,000
39	condensate of formaldehyde + butylphenol (condensation degree 20.0)	PO 10, EO 90	block	24,000
40	sulfate ester of No. 33, Na salt			
41	sulfate ester of No. 34, diethanolamine salt			
42	phosphate ester of No. 39, K salt			
43	tallow alkylamine	PO 5, EO 95	random	5,500
44	ethylenediamine	PO 15, EO 85	block (terminal)	12,000
45	hexamethylenediamine	BO 30, EO 70	block (terminal)	16,000
46	cyclohexyldiamine	PO 35, EO 65	block (terminal)	19,000
47	diethylenetriamine	PO 26, EO 74	block (terminal)	44,000
48	triethylenetetramine	PO 15, EO 85	block (terminal)	22,000
49	triethylenetetramine	BO 4, PO 20, EO 76	block (terminal)	37,000
50	tetraethylenepentamine	PO 12, EO 88	block (terminal)	48,000
51	tetraethylenepentamine	PO 35, EO 65	block (terminal)	30,000
52	phosphate ester of No 45, K salt			

TABLE I-4
List of Viscosity Lowering Agents

Compound No.	Active hydrogen compound	Alkylene oxide (%)	Form of EO units	M.W.
53	sulfate ester of No. 48, Na salt			
54	mono coconut fatty acid ester of No. 50			
55	sulfate ester of No. 51, monoethanolamine salt			
56	ethylene glycol	PO 5, EO 95		5,000
57	glycerine	PO 35, EO 95	random	21,000
58	pentaerythritol	BO 18, EO 82	block (terminal)	43,000
59	diglycerine	PO 30, EO 70	block (terminal)	37,000
60	sorbitol	PO 12, EO 88	block (terminal)	23,000
61	glucose	PO 25, EO 75	block (terminal)	48,000
62	partially (55%) saponified PVAc (M.W. 2200)	PO 15, EO 85	block (terminal)	40,000
63	starch	BO 15, PO 10, EO 75	block (terminal)	35,000
64	cellulose	PO 15, EO 85	block (terminal)	32,000
65	sulfate ester of No. 59, Na salt			
66	reaction product of No. 61 with phenylisocyanate			
67	Phosphate ester of No. 62, diethanolamine salt			
68	acetate of No. 63			
69	octanol	PO 4, EO 96	random	6,000
70	propylene glycol	BO 2, EO 98	block (terminal)	12,000
71	oleic acid	EO 100	—	20,000

TABLE I-5
List of Viscosity Lowering Agents

Compound No.	Active hydrogen compound	Alkylene oxide (%)	Form of EO units	M.W.
72	adipic acid	EO 100	—	32,000
73	oleyl amine	EO 100	—	11,000
74	nonylphenol	EO 100	—	20,000
75	sulfate ester of No. 70, Na salt			
76	phosphate ester of No. 72, Na salt			
77	stearate of No. 74			
78	hexanetriol	PO 4, EO 96	block (terminal)	4,000
79	glycerine	PO 3, EO 79	block (terminal)	3,000
80	diglycerine	BO 4, EO 96	block (terminal)	72,000
81	pentaerythritol	EO 100	—	14,000
82	sucrose	EO 100	—	20,000
83	starch	EO 100	—	16,000
84	glucose	EO 100	—	18,000
85	sorbitol	EO 100	—	72,000
86	sorbitol	EO 100	—	25,000
87	partially saponified PVAc	EO 100	—	51,000
88	sulfate ester of No. 82, Na salt			
89	phosphate ester of No. 83, NH_4 salt			
90	acetate of No. 85			
91	ethylenediamine	PO 3, EO 97	random	4,000

TABLE I-6
List of Viscosity Lowering Agents

Compound No.	Active hydrogen compound	Alkylene oxide (%)	Form of EO units	M.W.
92	ethylenediamine	PO 2, BO 1, EO 97	block (terminal)	12,000
93	hexamethylenediamine	EO 100	—	18,000
94	diethylenetriamine	EO 100	—	11,000
95	diethylenetriamine	EO 100	—	23,000
96	triethylenetetramine	EO 100	—	12,000
97	tetraethylenepentamine	EO 100	—	64,000
98	tetraethylenepentamine	EO 100	—	80,000
99	phosphate ester of No. 93, Na salt			
100	sulfate ester of No. 94, K salt			
101	sulfate ester of No. 97, NH_4 salt			
102	polyethlyeneimine (N 170)	PO 2, EO 98	randomn	500,000
103	polyethyleneimine (N 80)	BO 2, PO 2, EO 96	block (terminal)	360,000
104	polyethyleneimine (N 12)	EO 100	—	20,000
105	polyethyleneimine (N 45)	EO 100	—	120,000
106	adduct of ethyleneimine + sorbitol (N 26)	EO 100	—	60,000
107	adduct of ethyleneimine + naphthol (N 65)	EO 100	—	220,000
108	reaction product of polyethyleneimine (1 mole) + methyl ethyl ketone (5 mole) (N 35)	EO 100	—	90,000
109	sulfate ester of No. 104, Na salt			
110	stearate of No. 105			

TABLE I-7
List of Viscosity Lowering Agents

Compound No.	Active hydrogen compound	Alkylene oxide (%)	Form of EO units	M.W.
111	phosphate ester of No. 107, tetra Na salt			
112	condensate of formaldehyde + phenol (condensation degree 1.7)	PO 3, EO 97	random	8,000
113	condensate of formaldehyde + naphthol (condensation degree 5.0)	PO 2, BO 2, EO 96	block (terminal)	12,000
114	condensate of formaldehyde + nonylphenol (condensation degree 8.0)	EO 100	—	20,000
115	condensate of formaldehyde + methylnaphthol (condensation degree 3.5)	EO 100	—	16,000
116	condensate of formaldehyde + pyrogallol (condensation degree 11.0)	EO 100	—	67,000
117	condensate of formaldehyde + butylphenol (condensation degree 23.0)	EO 100	—	85,000
118	condensate of formaldehyde + butylnaphthol (condensation degree 7.5)	EO 100	—	32,000
119	sulfate ester of No. 113, Na salt			
120	phosphate ester of No. 114, K salt			
121	acetate of No. 117			

TABLE I-8
List of Viscosity Lowering Agents

Compound No.	Polyether compound and M.W.		Cross-linking agent	Moles per mole of polyether	Final M.W.
122	oleyl alcohol + PO 85/EO 15 (random)	1,700	TDI	0.5	3,600
123	ethylene glycol + PO 80/EO 20 (block)	3,200	TDI	0.5	6,600
124	butanediol + PO 70/EO 30 (block, terminal)	6,000	maleic anhydride	0.5	12,000
125	stearic acid + BO 35/PO 25/EO 40 (block, terminal)	7,200	DGBP-A	0.5	14,700
126	adipic acid + PO 45/EO 55 (random)	10,000	XDI	0.67	30,400
127	laurylamine + PO 90/EO 10 (random)	4,300	TDI	0.67	13,300
128	aniline + PO 50/EO 50 (block)	6,200	TDI	0.89	57,200
129	nonylphenol + PO 85/EO 15 (block, terminal)	4,200	formaldehyde	0.75	16,800
130	methylnaphthol + PO 70/EO 30 (random)	6,300	benzoylperoxide	(1.0%)	69,300
131	sulfate ester of No. 124, Na salt				
132	phosphate ester of No. 127, NH_4 salt				
133	stearate of No. 130				
134	NH_4 + PO 8/EO 92 (block, terminal)	4,000	TDI	0.5	8,200
135	hexamethylenediamine + PO 8/EO 92 (block, terminal)	3,600	HMDI	0.5	7,400
136	diethylenetriamine + PO 20/EO 80 (block, terminal)	8,000	TDI	0.67	24,300
137	diethylenetriamine + BO 12/EO 88 (block, terminal)	10,000	phthaloyl chloride	0.8	50,500
138	triethylenetetramine + PO 28/EO 72 (block, terminal)	7,000	glyoxal	0.75	28,200
139	triethylenetetramine + PO 25/EO 75 (block, terminal)	3,000	TDI	0.9	31,600
140	triethylenetetramine + BO 8/PO 12/EO 80 (block, terminal)	11,000	DGBP-A	0.86	79,000

TABLE I-9
List of Viscosity Lowering Agents

Compound No.	Polyether compound and M.W.		Cross-linking agent	Moles per mole of polyether	Final M.W.
141	tetraethylenepentamine + PO 22/EO 78 (block, terminal)	9,000	DGEG	0.88	73,100
142	tetraethylenepentamine + PO 14/EO 86 (block, terminal)	5,000	XDI	0.75	20,600
143	tetraethylenepentamine + PO 26/EO 74 (block, terminal)	6,000	di-t-butyl peroxide	(1.0%)	54,000
144	sulfate ester of No. 136, diethanolamine salt				
145	phosphate of No. 140, Na salt				
146	oleate of No. 142				
147	glycerine + PO 35/EO 65 (block, terminal)	3,000	TDI	0.67	9,300
148	pentaerythritol + PO 8/EO 92 (block, terminal)	4,200	adipic acid	0.5	8,500
149	sorbitol + PO 28/EO 72 (block, terminal)	9,000	TDI	0.9	91,600
150	sorbitol + BO 15/EO 85 (block, terminal)	12,000	HMDI	0.5	24,200
151	glucose + PO 25/EO 75 (block, terminal)	8,000	DGBP-A	0.75	33,000
152	sucrose + PO 20/EO 80 (block, terminal)	10,000	glyoxal	0.83	60,300
153	sucrose + BO 4/PO 8/EO 88 (block, terminal)	4,000	XDI	0.86	29,100
154	starch + PO 22/EO 78 (block, terminal)	8,000	TDI	0.67	24,300
155	cellulose + PO 28/EO 72 (block, terminal)	3,000	benzoyl peroxide	(1.0%)	52,000
156	partially saponified PVAc + PO 15/EO 85 (block, terminal)	10,000	DGEG	0.80	50,600
157	acetate of No. 149				
158	phosphate ester of No. 152, NH_4 salt				
159	sulfate of No. 156, K salt				

TABLE I-10
List of Viscosity Lowering Agents

Compound No.	Polyether compound and M.W.		Cross-linking agent	Moles per mole of polyether	Final M.W.
160	formaldehyde/phenol condensate (1.6) + PO 38/EO 62 (block, terminal)	2,500	TDI	0.67	7,800
161	formaldehyde/methylnaphthol condensate (3.0) + PO 32/EO 68 (block, terminal)	3,500	maleic anhydride	0.5	7,100
162	formaldehyde/naphtol condensate (11.0) + PO 20/EO 80 (block, terminal)	7,000	DGEG	0.75	28,500
163	formaldehyde/naphtol condensate (6.5) + BO 8/PO 20/EO 72 (block, terminal)	9,000	TDI	0.5	18,200
164	formaldehyde/phenol condensate (4.5) + PO 12/EO 88 (block, terminal)	4,200	formaldehyde	0.83	25,300
165	formaldehyde/butylphenol condensate (16.0) + PO 25/EO 75 (block, terminal)	11,000	XDI	0.88	89,300
166	formaldehyde/pyrogallol condensate (7.5) + BO 17/EO 83 (block, terminal)	6,700	formaldehyde	0.67	20,100
167	formaldehyde/buthylnaphtol condensate (4.0) + PO 22/EO 78 (block, terminal)	4,900	benzoyl peroxide	(1.0%)	58,800
168	formaldehyde/nonylphenol condensate (21.0) + PO 15/EO 85 (block, terminal)	13,000	HMDI	0.5	26,200
169	formaldehyde/aminophenol condensate (9.0) + PO 28/EO 72 (block, terminal)	8,300	glyoxal	0.90	83,500
170	oleate of No. 163				
171	sulfate ester of No. 167, K salt				
172	phosphate ester of No. 168, Na salt				
173	polyethyleneimine (N 170) + PO 80/EO 20 (block, terminal)	40,000	TDI	0.91	442,000

TABLE I-11
List of Viscosity Lowering Agents

Compound No.	Polyether compound and M.W.		Cross-linking agent	Moles per mole of polyether	Final H.W.
174	polyethyleneimine (N 8) + BO 9/EO 91 (block, terminal)	4,000	XDI	0.5	8,200
175	polyethyleneimine (N 90) + PO 65/EO 35 (block, terminal)	32,000	HMDI	0.5	64,200
176	polyethyleneimine (N 40) + PO 20/EO 80 (block, terminal)	24,000	TDI	0.88	193,200
177	polyethyleneimine (N 22) + PO 28/EO 72 (block, terminal)	19,000	TDI	0.67	57,300
178	polyethyleneimine (N 75) + BO 10/PO 20/EO 70 (block, terminal)	50,000	glyoxal	0.75	200,200
179	polyethyleneimine (N 13) + PO 50/EO 50 (block, terminal)	3,200	adipic acid	0.75	13,100
180	nonylphenol/ethyleneimine adduct (N 35) + PO 35/EO 65 (block, terminal)	12,000	DGEG	0.5	24,200
181	1 mole of polyethyleneimine/1 mole of diethyl ketone (N 95) + PO 15/EO 85 (block, terminal)	4,100	TDI	0.88	34,000
182	1 mole of polyethyleneimine/3 moles ethyl chloride (N 50) + PO 55/EO 45 (block, terminal)	46,000	benzoyl peroxide	(1.%)	278,000
183	phosphate ester of No. 177, NH_4 salt				
184	sulfate ester of No. 178, Na salt				
185	sulfate ester of No. 182, ethanolamine salt				
186	stearyl alcohol + PO 2/EO 98 (block, terminal)	6,500	TDI	0.5	13,300
187	butanediol + BO 1/PO 3/EO 96 (block, terminal)	11,000	maleic anhydride	0.8	55,500

TABLE I-12
List of Viscosity Lowering Agents

Compound No.	Polyether compound and M.W.		Cross-linking agent	Moles per mole of polyether	Final M.W.
188	adipic acid + EO 100	6,800	DGBP-A	0.86	49,400
189	monoethanolamine + EO 100	5,000	XDI	0.67	15,300
190	tallow alkylamine + EO 100	13,000	benzoyl peroxide	(1.0%)	26,000
191	sulfate ester of No. 187, diethanolamine salt				
192	phosphate ester of No. 190, K salt				
193	glycerine + PO 3/EO 97 (block, terminal)	4,000	TDI	0.75	16,500
194	sucrose + EO 100	8,000	HMDI	0.80	40,600
195	sorbitol + EO 100	5,000	maleic anhydride	0.85	35,000
196	sorbitol + EO 100	11,000	XDI	0.50	21,800
197	starch + EO 100	14,000	glyoxal	0.67	38,000
198	phosphate ester of No. 195, Na salt				
199	sulfate ester of No. 196, K salt				
200	ethylenediamine + PO 4/EO 96 (block, terminal)	5,000	TDI	0.75	20,500
201	diethylenetriamine + EO 100	7,000	HMDI	0.50	14,100
202	triethylenetetramine + EO 100	8,000	XDI	0.80	40,700
203	tetrathylenepentamine + EO 100	20,000	glyoxal	0.75	80,100
204	phosphate ester of No. 201, diethanolamine salt				
205	sulfate ester of No. 202, Na salt				
206	acetate of No. 203				

TABLE I-13
List of Viscosity Lowering Agents

Compound No.	Polyether compound and M.W.		Cross-linking agent	Moles per mole of polyether	Final M.W.
207	polyethyleneimine (N 8) + PO 4/EO 96 (block, terminal)	5,000	TDI	0.9	51,600
208	polyethyleneimine (N 21) + EO 100	50,000	adipic acid	0.67	150,200
209	polyethyleneimine (N 45) + EO 100	100,000	DGBP-A	0.5	200,000
210	polyethyleneimine (N 10) + EO 100	15,000	benzoyl peroxide	(1.0%)	30,000
211	phenol/ethyleneimine (N 30) + EO 100	30,000	XDI	0.75	120,000
212	polyethyleneimine (1 mole)/butyl chloride (8 mole) (N 24) + EO 100	12,000	glyoxal	0.5	24,100
213	sulfate ester of No. 209, diethanolamine salt				
214	phosphate ester of No. 210, K salt				
215	formaldehyde/phenol condensate (3.0) + PO 4/EO 96 (random)	3,000	TDI	0.75	12,500
216	formaldehyde/methylnaphtol condensate (17.0) + PO 2/EO 98 (block, terminal)	21,000	TDI	0.75	12,500
217	formaldehyde/aminophenol condensate (6.5) + EO 100	8,000	DGBP-A	0.67	63,700
218	formaldehyde/naphthol condensate (8.0) + EO 100	10,000	benzoyl peroxide	(1.0%)	75,000
219	formaldehyde/butylphenol condensate (12.5) + EO 100	18,000	maleic anhydride	0.5	36,100
220	oleate of No. 216				
221	sulfate ester of No. 217, NH_4 salt				
222	phosphate ester of No. 219, monoethanolamine salt				

TABLE I-14
List of Viscosity Lowering Agents

PO: propylene oxide	TDI: tolylene diisocyanate	DGBP-A: diglycidyl bisphenol A
EO: ethylene oxide	XDI: xylylene diisocyanate	DGEG: diglycidyl ethylene glycol
BO: butylene oxide	HMBI: hexamethylene diisocyanate	

TABLE II—1
Aqueous Slurry of Powdered Coal (Uncleaned)

Viscosity lowering agent		Coal	Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Phase separation after one month
Compound No.	Amount (% in slurry)					
1	0.5	bituminous	72	2800	Yes	No
2	0.5	"	72	2700	"	"
3	0.5	"	72	2300	"	"
4	0.3	"	74	2500	"	"
5	0.3	"	72	1300	"	"
6	0.3	subbituminous	75	2800	"	"
7	0.3	bituminous	75	2600	"	"
8	0.3	"	77	2300	"	"
9	0.2	"	72	800	"	"
10	0.2	anthracite	77	2000	"	"
11	0.2	subbituminous	77	2200	"	"
12	0.5	bituminous	72	2300	"	"
13	0.3	"	74	2000	"	"
14	0.2	subbituminous	77	1900	"	"
15	0.2	butuminous	77	1800	"	"
16	0.3	"	72	2500	"	"
17	0.3	"	74	2700	"	"

TABLE II—2
Aqueous Slurry of Powdered Coal (Uncleaned)

Viscosity lowering agent		Coal	Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Phase separation after one month
Compound No.	Amount (% in slurry)					
18	0.3	bituminous	74	2600	Yes	No
19	0.2	"	77	1500	"	"
20	0.2	subbituminous	77	1600	"	"
21	0.2	"	77	1400	"	"
22	0.2	bituminous	77	1700	"	"
23	0.2	"	77	1700	"	"
24	0.2	butuminous	77	1600	"	"
25	0.2	subbituminous	77	1500	"	"
26	0.2	"	77	1600	"	"
27	0.2	anthracite	77	1700	"	"
28	0.2	bituminous	77	1300	"	"
29	0.2	"	77	1200	"	"
30	0.2	"	77	1200	"	"
31	0.3	"	74	2100	"	"
32	0.3	subbituminous	74	2200	"	"
33	0.2	bituminous	74	1300	"	"
34	0.2	"	77	1900	"	"
35	0.2	"	77	2300	"	"

TABLE II—3
Aqueous Slurry of Powdered Coal (Uncleaned)

Viscosity lowering agent		Coal	Coal consistency (%)	Slurry viscosity (mPas, at 250°C)	Fluidity	Phase separation after one month
Compound No.	Amount (% in slurry)					
36	0.1	anthracite	77	2500	Yes	No
37	0.1	bituminous	77	2600	"	"
38	0.2	"	77	1900	"	"
39	0.2	"	77	2200	"	"
40	0.2	subbituminous	77	2300	"	"
41	0.2	bituminous	77	1900	"	"
42	0.2	"	77	2300	"	"
43	0.5	"	72	2800	"	"
44	0.3	"	72	1800	"	"
45	0.3	"	74	2200	"	"
46	0.2	subbituminous	74	2000	"	"
47	0.2	bituminous	74	1200	"	"
48	0.2	"	74	1100	"	"
49	0.2	"	77	2000	"	"
50	0.2	"	77	1700	"	"
51	0.2	subbituminous	77	2900	"	"
52	0.2	bituminous	77	2100	"	"
53	0.2	"	77	2000	"	"

0 077 909

TABLE II—4
Aqueous Slurry of Powdered Coal (Uncleaned)

Viscosity lowering agent		Coal	Coal consistency (%)	Slurry viscosity (mPas, at 250°C)	Fluidity	Phase separation after one month
Compound No.	Amount (% in slurry)					
54	0.2	bituminous	77	1800	Yes	No
55	0.2	anthracite	77	1900	"	"
56	0.5	bituminous	72	2800	"	"
57	0.3	"	72	2000	"	"
58	0.3	subbituminous	74	2100	"	"
59	0.2	bituminous	74	2200	"	"
60	0.2	"	74	1400	"	"
61	0.2	"	74	1100	"	"
62	0.2	"	77	2100	"	"
63	0.2	"	77	1900	"	"
64	0.2	anthracite	77	2000	"	"
65	0.2	subbituminous	77	2000	"	"
66	0.2	bituminous	77	1900	"	"
67	0.2	"	77	2000	"	"
68	0.2	"	77	1800	"	"

TABLE II—5
Aqueous Slurry of Powdered Coal (Uncleaned)

Viscosity lowering agent		Coal	Coal consistency (%)	Slurry viscosity (mPas, at 250°C)	Fluidity	Phase separation after one month
Compound No.	Amount (% in slurry)					
Control:						
None	—	bituminous	50	>20000	No	Yes
Na oleate	2.0	"	50	"	"	"
Na dodecyl-benzene sulfonate	2.0	"	50	"	"	"

TABLE II—6
Aqueous Slurry of Powdered Coal (Uncleaned)

Viscosity lowering agent		Coal	Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Consistency (%) after one month	
Compound No.	Amount (% in slurry)					Upper layer	Lower layer
69	0.3	bituminous	77	2800	Yes	66.0	79.0
70	"	"	"	2400	"	68.4	77.2
71	0.2	"	"	1800	"	73.0	78.2
72	"	subbituminous	"	2000	"	72.9	78.0
73	"	"	"	1900	"	"	"
74	"	anthracite	"	1700	"	73.3	77.9
75	"	bituminous	"	2000	"	"	78.1
76	"	"	"	1800	"	72.8	"
77	"	"	"	1900	"	73.0	78.0
78	0.3	"	74	2700	"	72.8	75.3
79	"	"	"	2800	"	72.9	75.2
80	0.2	"	"	2300	"	73.1	75.0
81	"	"	"	2100	"	73.0	74.9
82	0.1	"	77	1900	"	76.2	77.7
83	"	"	"	1700	"	76.4	77.8
84		subbituminous	"	1700	"	"	"

TABLE II—7
Aqueous Slurry of Powdered Coal (Uncleaned)

Viscosity lowering agent		Coal	Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Consistency (%) after one month	
Compound No.	Amount (% in slurry)					Upper layer	Lower layer
85	0.1	bituminous	77	1800	Yes	76.5	77.6
86	"	"	"	2000	"	76.3	77.7
87	"	anthracite	"	1800	"	76.4	77.5
88	"	bituminous	"	2000	"	76.3	77.7
89	"	"	"	1800	"	76.5	77.5
90	"	"	"	1700	"	76.4	"
91	0.3	"	74	2700	"	72.7	75.5
92	0.2	bituminous	74	2200	"	73.0	75.0
93	0.1	"	77	1800	"	76.3	77.6
94	"	"	"	2000	"	76.5	77.7
95	"	anthracite	"	1700	"	76.4	77.5
96	"	bituminous	"	1800	"	"	77.6
97	"	"	"	"	"	76.3	"
98	"	subbitiminous	"	1700	"	76.5	77.5
99	"	"	"	2000	"	76.4	77.6
100	"	bituminous	"	1800	"	76.5	77.5
101	"	"	"	1700	"	76.4	77.7

TABLE II—8
Aqueous Slurry of Powdered Coal (Uncleaned)

Viscosity lowering agent		Coal	Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Consistency (%) after one month	
Compound No.	Amount (% in slurry)					Upper layer	Lower layer
102	0.3	bituminous	77	2800	Yes	72.7	75.2
103	0.2	"	"	2100	"	73.0	75.0
104	0.1	"	"	1800	"	76.4	77.6
105	"	"	"	1900	"	76.5	77.5
106	"	subbituminous	"	"	"	76.4	"
107	"	"	"	2000	"	"	77.7
108	"	bituminous	"	1800	"	76.3	77.6
109	"	"	"	1700	"	76.4	"
110	"	anthracite	"	1900	"	76.3	77.5
111	"	bituminous	"	1800	"	"	77.7
112	0.3	"	74	2800	"	72.7	75.3
113	0.2	"	"	2000	"	72.9	75.0
114	0.1	"	77	1700	"	76.9	77.6
115	0.1	bituminous	77	1800	"	76.4	77.6
116	"	"	"	2000	"	"	77.7
117	"	subbituminous	"	1900	"	76.5	77.5
118	"	anthracite	"	1700	"	76.4	77.6

TABLE II—9
Aqueous Slurry of Powdered Coal (Uncleaned)

Viscosity lowering agent		Coal	Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Consistency (%) after one month	
Compound No.	Amount (% in slurry)					Upper layer	Lower layer
119	0.1	subbituminous	77	2000	Yes	76.3	77.7
120	〃	bituminous	〃	1800	〃	76.4	〃
121	〃	〃	〃	1900	〃	〃	77.6
122	0.3	〃	74	2700	〃	65.0	79.0
123	〃	〃	〃	2800	〃	66.5	79.1
124	0.2	〃	〃	1300	〃	69.0	78.1
125	〃	subbituminous	77	1900	〃	73.0	78.0
126	0.1	〃	〃	2000	〃	〃	78.1
127	〃	bituminous	〃	2100	〃	〃	77.8
128	〃	〃	〃	1800	〃	72.9	〃
129	〃	〃	〃	2000	〃	〃	77.9
130	〃	anthracite	〃	1900	〃	73.1	〃
131	〃	bituminous	〃	1700	〃	〃	78.0
132	〃	〃	〃	2100	〃	73.0	〃
133	〃	〃	〃	2000	〃	73.1	78.1
134	0.2	〃	74	2100	〃	72.9	75.1
135	〃	〃	〃	2300	〃	73.0	75.2

TABLE II—10
Aqueous Slurry of Powdered Coal (Uncleaned)

Viscosity lowering agent		Coal	Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Consistency (%) after one month	
Compound No.	Amount (% in slurry)					Upper layer	Lower layer
136	0.1	bituminous	74	1000	Yes	73.5	74.6
137	"	subbituminous	77	1900	"	76.4	77.6
138	0.1	subbituminous	77	1800	"	76.4	77.7
139	"	bituminous	"	1600	"	"	77.5
140	"	"	"	1900	"	76.5	"
141	"	"	"	1700	"	76.3	77.6
142	"	"	"	1800	"	76.5	77.5
143	"	anthracite	"	1800	"	76.3	77.6
144	"	"	"	1600	"	"	"
145	"	bituminous	"	1900	"	76.5	77.7
146	"	"	"	1700	"	"	77.5
147	0.2	"	74	2000	"	72.9	75.1
148	"	"	"	2200	"	73.0	75.2
149	0.1	"	"	900	"	73.4	74.6
150	"	"	77	1600	"	76.4	77.6
151	"	subbituminous	"	1700	"	"	77.5
152	"	"	"	1500	"	76.5	"

TABLE II—11
Aqueous Slurry of Powdered Coal (Uncleaned)

Viscosity lowering agent		Coal	Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Consistency (%) after one month	
Compound No.	Amount (% in slurry)					Upper layer	Lower layer
153	0.1	bituminous	77	1800	Yes	76.3	77.7
154	〃	〃	〃	〃	〃	〃	77.5
155	〃	anthracite	〃	1600	〃	76.5	77.6
156	〃	bituminous	〃	1700	〃	〃	〃
157	〃	〃	〃	1500	〃	76.4	77.5
158	〃	〃	〃	1800	〃	76.5	77.7
159	〃	〃	〃	1700	〃	76.3	〃
160	0.2	〃	74	2200	〃	72.8	75.2
161	0.2	bituminous	74	2400	〃	73.0	75.0
162	0.1	〃	〃	900	〃	73.4	74.6
163	〃	〃	77	1700	〃	76.3	77.7
164	〃	subbituminous	〃	1800	〃	76.4	77.5
165	〃	〃	〃	〃	〃	76.5	〃
166	〃	bituminous	〃	1900	〃	〃	77.7
167	〃	〃	〃	1700	〃	76.4	77.6
168	〃	〃	〃	1900	〃	〃	77.5

TABLE II—12
Aqueous Slurry of Powdered Coal (Uncleaned)

Viscosity lowering agent		Coal	Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Consistency (%) after one month	
Compound No.	Amount (% in slurry)					Upper layer	Lower layer
169	0.1	anthracite	77	1700	Yes	76.5	77.6
170	"	"	"	1600	"	76.3	"
171	"	bituminous	"	1800	"	"	77.7
172	"	"	"	1900	"	76.4	77.5
173	0.2	"	74	2300	"	72.9	75.1
174	"	"	"	2000	"	72.7	75.3
175	0.1	"	"	800	"	73.1	74.9
176	"	"	77	1700	"	76.4	77.6
177	"	"	"	1900	"	76.2	77.7
178	"	subbituminous	"	1500	"	76.3	"
179	"	"	"	"	"	76.2	"
180	"	bituminous	"	1800	"	76.7	77.4
181	"	anthracite	"	1600	"	76.5	77.5
182	"	bituminous	"	1500	"	76.6	"
183	"	"	"	1700	"	76.4	77.6
184	0.1	bituminous	77	1400	"	76.4	77.5
185	"	"	"	1800	"	76.2	77.7

TABLE II—13
Aqueous Slurry of Powdered Coal (Uncleaned)

Viscosity lowering agent		Coal	Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Consistency (%) after one month	
Compound No.	Amount (% in slurry)					Upper layer	Lower layer
186	0.3	bituminous	74	2500	Yes	71.0	75.1
187	"	"	"	2400	"	68.8	77.0
188	0.2	"	"	1000	"	71.0	75.1
189	"	subbituminous	77	1800	"	73.0	78.1
190	"	anthracite	"	2000	"	72.9	77.9
191	"	bituminous	"	1800	"	73.1	78.2
192	"	subbituminous	"	1700	"	73.2	"
193	"	bituminous	74	2000	"	73.1	76.1
194	0.1	"	"	1000	"	73.6	74.6
195	"	subbituminous	77	1900	"	76.3	77.8
196	"	bituminous	"	1700	"	76.5	77.4
197	"	"	"	1800	"	"	77.5
198	"	"	"	1700	"	76.5	77.4
199	"	"	"	1900	"	"	77.5
200	0.2	"	74	2100	"	73.0	75.0
201	0.1	anthracite	"	1000	"	73.4	74.6
202	"	subbituminous	77	1800	"	76.4	77.4

TABLE II—14

Aqueous Slurry of Powdered Coal (Uncleaned)

Viscosity lowering agent		Coal	Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Consistency (%) after one month	
Compound No.	Amount (% in slurry)					Upper layer	Lower layer
203	0.1	bituminous	77	1700	Yes	76.6	77.6
204	〃	〃	〃	1800	〃	76.5	77.8
205	〃	subbituminous	〃	2000	〃	〃	77.6
206	〃	bituminous	〃	1700	〃	76.3	77.5
207	0.2	bituminous	74	2300	〃	72.9	75.0
208	0.1	〃	〃	1000	〃	73.2	74.8
209	〃	〃	77	1800	〃	76.4	77.6
210	〃	subbituminous	〃	1700	〃	76.5	〃
211	〃	anthracite	〃	1800	〃	76.4	77.5
212	〃	bituminous	〃	1900	〃	〃	77.7
213	〃	〃	〃	2000	〃	76.3	〃
214	〃	〃	〃	1700	〃	〃	77.6
215	0.2	〃	74	2200	〃	73.0	75.1
216	〃	〃	〃	2000	〃	〃	75.0
217	0.1	〃	〃	1000	〃	73.5	74.6
218	〃	subbituminous	77	1800	〃	76.4	77.7
219	〃	bituminous	〃	1900	〃	〃	77.6

TABLE II—15
Aqueous Slurry of Powdered Coal (Uncleaned)

Viscosity lowering agent		Coal	Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Consistency (%) after one month	
Compound No.	Amount (% in slurry)					Upper layer	Lower layer
220	0.1	bituminous	77	2000	Yes	76.5	77.6
221	"	anthracite	"	1900	"	76.3	77.7
222	"	bituminous	"	1700	"	76.4	77.5
Controls:							
None	—	bituminous	50	>20000	No	0	80.0
Na oleate	2.0	"	"	"	"	0	81.2
Na dodecyl-benzene sulfonate	"	"	"	"	"	0	81.0

TABLE III—1
Aqueous Slurry of Powdered Coal (Cleaned)

Viscosity lowering agent		Powdered coal			Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Phase separation after one month
Compound No.	Amount (% in slurry)	Coal	Cleaning process	Deashed %				
3	0.5	bituminous	OA	50	76	2200	Yes	No
5	0.3	"	"	70	"	1700	"	"
9	0.2	"	"	40	80	1800	"	"
10	"	anthracite	float.	65	"	1700	"	"
11	"	subbituminous	"	45	"	1800	"	"
15	"	bituminous	OA	45	"	1500	"	"
17	"	"	"	55	77	1800	"	"
19	"	subbituminous	"	45	80	1400	"	"
20	"	bituminous	"	50	"	1500	"	"
21	"	"	float.	40	"	1300	"	"
23	"	subbituminous	"	70	"	1400	"	"
30	"	bituminous	OA	60	"	1100	"	"
31	0.2	"	"	55	76	2100	"	"
32	"	subbituminous	float.	35	"	1900	"	"
33	0.1	bituminous	OA	65	78	1300	"	"
34	"	"	float.	40	80	2500	"	"
36	"	anthracite	"	45	"	2600	"	"
39	"	bituminous	OA	50	"	2500	"	"

TABLE III—2
Aqueous Slurry of Powdered Coal (Cleaned)

Viscosity lowering agent		Powdered coal			Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Phase separation after one month
Compound No.	Amount (% in slurry)	Coal	Cleaning process	Deashed %				
40	0.7	subbituminous	OA	60	80	2300	Yes	No
42	"	bituminous	float.	35	"	2800	"	"
45	0.3	"	OA	55	78	2000	"	"
47	0.2	"	"	65	"	1300	"	"
48	"	"	float.	45	80	1800	"	"
51	0.2	subbituminous	OA	60	80	1900	"	"
53	"	bituminous	float.	35	"	2000	"	"
54	"	"	OA	50	"	1900	"	"
56	0.5	"	"	55	76	2500	"	"
58	0.3	subbituminous	float.	40	78	1700	"	"
61	0.2	bituminous	OA	50	80	1700	"	"
62	"	"	"	65	"	1500	"	"
64	"	anthracite	"	45	"	1800	"	"
67	"	bituminous	float.	40	"	1700	"	"
68	"	"	OA	60	"	1800	"	"
Controls:								
None	—	bituminous	OA	50	50	>20000	No	Yes
Na oleate	2.0	"	"	65	"	"	"	"
Na dodecyl-bezene sulfonate	2.0	"	float.	45	"	"	"	"

TABLE III—3
Aqueous Slurry of Powdered Coal (Cleaned)

Viscosity lowering agent		Powdered coal			Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Consistency after one month	
Compound No.	Amount (% in slurry)	Coal	Cleaning process	Deashed %				Upper layer	Lower layer
69	0.3	bituminous	OA	55	78	2700	Yes	74.0	79.3
70	〃	〃	〃	60	〃	2300	〃	76.0	79.1
71	0.2	〃	〃	45	80	1800	〃	79.0	80.7
73	〃	subbituminous	float.	45	〃	1900	〃	79.2	80.8
76	〃	bituminous	〃	35	〃	2000	〃	〃	80.6
77	〃	〃	OA	50	〃	1700	〃	79.1	〃
78	0.2	bituminous	〃	65	78	2400	〃	77.0	78.9
81	〃	〃	〃	65	〃	2500	〃	76.8	79.2
84	0.1	subbituminous	float.	45	80	1700	〃	79.5	80.6
85	〃	bituminous	〃	35	〃	1800	〃	79.4	80.7
87	〃	anthracite	OA	45	〃	〃	〃	79.5	80.5
90	〃	bituminous	〃	55	〃	1900	〃	79.5	80.6
92	0.2	〃	〃	50	78	2600	〃	76.9	79.1
94	0.1	〃	〃	55	80	2000	〃	79.3	80.6
96	〃	〃	〃	65	〃	1700	〃	79.4	〃
98	〃	subbituminous	float.	45	〃	1800	〃	79.3	80.8
100	〃	bituminous	〃	45	〃	1700	〃	〃	80.6
103	0.2	〃	OA	50	78	2300	〃	77.0	79.1

TABLE III—4
Aqueous Slurry of Powdered Coal (Cleaned)

Viscosity lowering agent		Powdered coal			Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Consistency after one month	
Compound No.	Amount (% in slurry)	Coal	Cleaning process	Deashed %				Upper layer	Lower layer
104	0.1	bituminous	OA	60	80	2000	Yes	79.5	80.5
105	"	"	"	55	"	1700	"	79.4	80.6
106	"	subbituminous	float.	40	"	1900	"	79.3	"
108	"	bituminous	"	35	"	1800	"	"	80.7
109	"	"	OA	45	"	1700	"	79.4	80.6
110	0.1	anthracite	OA	55	80	1800	"	79.5	80.7
113	0.2	bituminous	"	55	78	2400	"	76.9	79.1
115	0.1	"	"	60	80	2000	"	79.4	80.7
116	"	"	"	50	"	1900	"	"	80.6
117	"	subbituminous	float.	40	"	1700	"	79.5	80.5
118	"	anthracite	"	45	"	1800	"	79.3	80.7
119	"	subbituminous	OA	65	"	1900	"	79.4	"
120	"	bituminous	float.	35	"	2000	"	79.5	80.6
122	0.3	"	OA	60	78	2500	"	73.1	79.1
124	0.2	"	"	45	"	1200	"	76.0	"
125	"	subbituminous	"	50	80	1800	"	79.0	80.7
127	0.1	bituminous	"	55	"	1700	"	79.1	80.8
129	"	"	float.	35	"	1800	"	"	"

TABLE III—5
Aqueous Slurry of Powdered Coal (Cleaned)

Viscosity lowering agent		Powdered coal			Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Consistency after one month	
Compound No.	Amount (% in slurry)	Coal	Cleaning process	Deashed %				Upper layer	Lower layer
130	0.1	anthracite	float	40	80	1600	Yes	79.0	80.8
132	"	bituminous	OA	65	"	1900	"	79.2	80.9
133	"	"	"	50	"	1700	"	"	81.0
134	0.2	"	"	60	78	2700	"	76.9	79.1
136	0.1	"	"	50	"	1000	"	77.4	78.5
137	"	subbituminous	"	55	80	1800	"	79.4	80.6
139	"	bituminous	float	40	"	1700	"	79.3	80.5
142	"	"	"	35	"	"	"	"	80.7
143	"	anthracite	OA	65	"	1900	"	79.5	"
144	"	"	"	55	"	1700	"	79.4	80.5
145	0.1	bituminous	float.	45	80	1800	"	79.3	80.6
148	0.2	"	OA	60	78	2600	"	77.0	79.0
149	0.1	"	"	65	"	1100	"	77.4	78.5
151	"	subbituminous	"	50	80	1900	"	79.4	80.6
153	"	butiminous	float.	40	80	1700	"	79.5	80.6
155	"	anthracite	"	35	"	"	"	"	80.5
156	"	bituminous	OA	45	"	1800	"	79.3	80.7

TABLE III—6
Aqueous Slurry of Powdered Coal (Cleaned)

Viscosity lowering agent		Powdered coal			Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Consistency after one month	
Compound No.	Amount (% in slurry)	Coal	Cleaning process	Deashed %				Upper layer	Lower layer
158	0.1	bituminous	OA	55	80	1700	Yes	79.5	80.6
159	"	"	float.	45	"	1800	"	79.4	80.5
160	0.2	"	OA	60	78	2500	"	76.9	79.0
162	0.1	"	"	65	"	1100	"	77.4	78.6
165	"	subbituminous	"	50	80	1900	"	79.5	80.5
166	"	bituminous	float.	40	"	1800	"	79.4	80.6
168	"	"	"	45	"	1900	"	"	80.5
169	"	anthracite	OA	45	"	1700	"	79.3	80.7
170	"	bituminous	"	50	"	1800	"	79.4	"
172	"	"	float.	35	"	1700	"	79.5	80.5
174	0.2	"	OA	65	78	2500	"	76.8	79.2
175	0.1	"	"	55	"	1000	"	77.5	78.5
177	"	"	float.	35	80	1800	"	79.3	80.7
179	"	subbituminous	OA	50	"	"	"	"	80.6
181	"	anthracite	"	40	"	1900	"	79.5	80.5
182	"	bituminous	"	55	"	1600	"	79.4	80.6

TABLE III—7
Aqueous Slurry of Powdered Coal (Cleaned)

Viscosity lowering agent		Powdered coal			Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Consistency after one month	
Compound No.	Amount (% in slurry)	Coal	Cleaning process	Deashed %				Upper layer	Lower layer
184	0.1	bituminous	float.	45	80	1700	Yes	79.4	80.7
185	"	"	OA	50	"	1800	"	79.3	80.6
187	0.3	"	"	60	78	2400	"	76.0	79.2
188	0.2	"	"	65	"	1000	"	77.3	78.7
190	"	"	"	50	80	2000	"	79.2	80.9
191	"	anthracite	float.	45	"	1700	"	79.1	80.7
192	"	subbituminous	"	35	"	1800	"	"	"
194	0.1	bituminous	"	40	78	1000	"	77.3	78.5
195	"	subbituminous	"	45	"	1800	"	79.2	80.7
196	"	bituminous	OA	50	"	1700	"	79.5	80.5
200	"	"	float.	50	80	1900	"	79.5	80.5
201	0.2	anthracite	OA	60	78	1000	"	77.4	78.6
203	0.1	bituminous	float.	45	80	1800	"	79.3	80.6
204	"	"	"	50	"	1900	"	79.4	80.7
208	"	"	OA	65	78	1000	"	77.4	78.6
210	"	subbituminous	"	50	80	1800	"	79.4	80.7
211	"	anthracite	float.	45	"	2000	"	79.3	80.6
213	"	bituminous	"	40	"	1700	"	79.5	80.5

TABLE III—8
Aqueous Slurry of Powdered Coal (Cleaned)

Viscosity lowering agent		Powdered coal			Coal consistency (%)	Slurry viscosity (mPas, at 25°C)	Fluidity	Consistency after one month	
Compound No.	Amount (% in slurry)	Coal	Cleaning process	Deashed %				Upper layer	Lower layer
214	bituminous	01	OA	55	80	1900	Yes	79.4	80.6
217	〃	〃	〃	50	78	1000	〃	77.4	78.6
218	〃	subbituminous	〃	55	80	1900	〃	79.3	80.6
219	〃	bituminous	float.	40	〃	2000	〃	〃	80.7
220	〃	〃	OA	60	〃	1800	〃	79.5	80.5
221	0.1	anthracite	OA	45	80	1700	〃	79.4	80.7
Controls:									
None	—	bituminous	OA	50	50	>20000	No	0	83.0
Na oleate	2.0	〃	〃	65	〃	〃	〃	0	83.5
Na dodecyl-benzene sulfonate	2.0	〃	floating	45	〃	〃	〃	0	81.0

OA: oil Agglomeration process Float.: floatation process

Claims

1. A fluid aqueous coal slurry having at least 60% by weight coal solids content and consisting essentially of a mixture of water and powdered coal rendered fluid by the presence therein, as a viscosity lowering agent, of an amount effective to render the slurry fluid of a polyalkyleneoxide having a molecular weight of at least 1000 and an oxyethylene unit content of at least 10% by weight, based on the total oxyalkylene unit content, characterized in that, the polyalkyleneoxide is a polyether adduct of an lower alkylene oxide and an active hydrogen compound selected from the group consisting of

(a) polyhydroxyl compounds having at least three active hydrogen atoms;

(b) polyamines having 5 or more active hydrogen atoms;

(c) condensates of a phenolic compound with an aliphatic aldehyde;

(d) polyalkyleneimines and derivatives thereof having 7 to 200 nitrogen atoms;

(e) carboxylic acids; and

(f) compounds having two or more different active hydrogen-containing functional groups.

2. The slurry of claim 1, wherein said starting active hydrogen compound is glycerine, butanetriol, hexanetriol, trimethylolpropane, triethanolamine, diglycerin, pentaerythritol, xylitol, sorbitol, glucose, sucrose, partially saponified poly(vinyl acetate), cellulose or starch.

3. The slurry of claim 1, wherein said active hydrogen compound is diethylenetriamine, triethylene-tetraamine or tetraethylenepentamine.

4. The slurry of claim 1, wherein said active hydrogen compound is a condensate of phenol, cresol, xylenol, butylphenol, nonylphenol, aminophenol, hydroxybenzoic acid, catechol, resorcine, pyrogallol, naphthol, methylnaphthol, butylnaphthol, octylnaphthol, naphthoresorcine, α-naphthohydroquinone or a bisphenol with formaldehyde, acetaldehyde or glyoxal.

5. The slurry of claim 1, wherein said active hydrogen compound is polyethyleneimine; polypropylene-imine; an addition product of ethyleneimine or propyleneimine with an alcohol, phenol, amine or carboxylic acid; or a condensate of polyethyleneimine or polypropyleneimine with an aldehyde, ketone, alkyl halide, isocyanate, thioisocyanate, active double bond-containing compound, epoxy compound, epihalohydrin, cyanamide, guanidine, urea or a carboxylic acid or anhydride or acid halide thereof; all containing 7 to 200 nitrogen atoms.

6. The slurry of claim 1, wherein said active hydrogen compound is acetic acid, lauric acid, oxalic acid, fumaric acid, maleic acid, trimesic acid, butanetetracarboxylic acid, or pyromellitic acid.

7. The slurry of claim 1, wherein said active hydrogen compound is lactic acid, glycolic acid, glycine, N-mono-alkyl glycine, malic acid, tartaric acid, monoethanolamine, diethanolamine, or aminoethanolamine.

8. The slurry of claim 1, wherein said coal is cleaned coal.

9. The slurry of claim 8, wherein said slurry has a coal solids content of from 70 to 80% by weight.

10. The slurry of claim 1, wherein said polyether adduct is present in an amount from 0.03 to 2.0% by weight of the slurry.

11. The slurry of claim 10, wherein the coal is cleaned coal, the coal solids content is 76 to 80%, the viscosity lowering agent content of said slurry is about 0.1 to 0.3% by weight and the slurry has a viscosity ranging from 1000 to 2800 mPas.

12. The slurry of claim 10, wherein the coal is uncleaned coal, the coal solids content is 72 to 77%, the viscosity lowering agent content of said slurry is about 0.1 to 0.3% by weight and the slurry has a viscosity ranging from 800 to 2800 mPas.

13. A fluid aqueous coal slurry having at least 60% by weight coal solids content and consisting essentially of a mixture of water and powdered coal rendered fluid by the presence therein, as a viscosity lowering agent, of an amount effective to render the slurry fluid of a polyalkylene-oxide having a molecular weight of at least 1000 and an oxyethylene unit content of at least 10% by weight, based on the total oxyalkylene unit content, characterized in that the polyalkyleneoxide is (a) the reaction product of a cross-linking agent with a polyether adduct of an alkylene oxide and an active hydrogen compound, or (b) the reaction product of (a) or of said adduct with an inorganic or organic acylating agent, a halogenating agent, an oxidizing agent or a monoisocyanate.

14. The slurry of claim 13, wherein said active hydrogen-containing compound has at least one hydroxyl, amino, imino or carboxylic group.

15. The slurry of claim 14, wherein said polyether is (a) and said cros-linking agent is a polyisocyanate, a polyepoxy compound, a polyaldehyde, a functional derivative of polycarboxylic acid or a free radical-generating peroxide catalyst.

16. The slurry of claim 13, wherein said polyether is the reaction product of said adduct or of (a) with a sulfate or phosphate ester.

17. The slurry of claim 13, wherein said coal is cleaned coal.

18. The slurry of claim 17, wherein said powdered coal is present in an amount from 70 to 80% by weight of the slurry.

19. The slurry of claim 13, wherein said reaction product is present in an amount from 0.03 to 2.0% by weight of the slurry.

20. The slurry of claim 13, wherein the coal is cleaned coal, the coal solids content is 76 to 80%, the

viscosity lowering agent content of said slurry is about 0.1 to 0.3% by weight and the slurry has a viscosity ranging from 1000 to 2800 mPas.

21. The slurry of claim 13, wherein the coal is uncleaned coal, the coal solids content is 72 to 77%, the viscosity lowering agent content of said slurry is about 0.1 to 0.3% by weight and the slurry has a viscosity ranging from 800 to 2800 mPas.

Patentansprüche

1. Fluider, wäßriger Kohlenschlamm mit wenigstens 60 Gew.-% festen Kohlebestandteilen, der im wesentlichen aus einer Mischung von Wasser und Kohlepulver besteht, und der durch die Anwesenheit einer den Schlamm wirksam fluidisierenden Menge eines Polyalkylenoxids als Mittel zur Viskositätserniedrigung fluid ist, wobei das Polyalkylenoxid ein Molekulargewicht von wenigstens 1000 und einen Gehalt an Oxyethyleneinheiten von wenigstens 10 Gew.-%, bezogen auf den Gesamtgehalt an Oxyalkyleneinheiten, aufweist, dadurch gekennzeichnet, daß das Polyalkylenoxid ein Polyetheraddukt eines Niedrigalkylenoxids und einer Verbindung mit einem aktiven Wasserstoffatom ist, die ausgewählt ist unter

a) Polyhydroxyverbindungen mit wenigstens 3 aktiven Wasserstoffatomen;

b) Polyaminen mit 5 oder mehr aktiven Wasserstoffatomen;

c) Kondensaten einer Phenolverbindung mit einem aliphatischen Aldehyd;

d) Polyalkyleniminen und Derivaten davon mit 7 bis 200 Stickstoffatomen;

e) Carbonsäuren; und

f) Verbindungen mit 2 oder mehreren unterschiedlichen funktionellen Gruppen, die aktive Wasserstoffatome enthalten.

2. Kohlenschlamm nach Anspruch 1, wobei die Verbindung mit einem aktiven Wasserstoffatom Glycerin, Butantriol, Hexantriol, Trimethylolpropan, Triethanolamin, Diglycerin, Pentaerythrit, Xylit, Sorbit, Glucose, Saccharose, teilweise verseiftes Polyvinylacetat, Cellulose oder Stärke ist.

3. Kohlenschlamm nach Anspruch 1, wobei die Verbindung mit einem aktiven Wasserstoffatom Diethylentriamin, Triethylentetraamin oder Tetraethylenpentamin ist.

4. Kohlenschlamm nach Anspruch 1, wobei die Verbindung mit einem aktiven Wasserstoffatom ein Kondensat von Phenol, Cresol, Xylenol, Butylphenol, Nonylphenol, Aminophenol, Hydroxybenzoesäure, Catechin, Resorcin, Pyrogallol, Naphthol, Methylnaphthol, Butylnaphthol, Octylnaphthol, Naphthoresorcin, α-Naphtholhydrochinon oder einem Bisphenol mit Formaldehyd, Acetaldehyd oder Glyoxal ist.

5. Kohlenschlamm nach Anspruch 1, wobei die Verbindung mit einem aktiven Wasserstoffatom Polyethylenimin; Polypropylenimin, ein Additionsprodukt von Ethylenimin oder Propylenimin mit einem Alkohol, Phenol, Amin oder einer Carbonsäure; oder ein Kondensat von Polyethylenimin oder Polypropylenimin mit einem Aldehyd, Keton, Alkylhalogenid, Isocyanat, Thioisocyanat, einer Verbindung mit einer aktiven Doppelbindung, Epoxyverbindung, Epihalohydrin, Cyanamid, Guanidin, Harnstoff oder einer Carbonsäure oder deren Anhydrid oder Säurehalogenid ist, wobei alle Verbindungen 7 bis 200 Stickstoffatome enthalten.

6. Kohlenschlamm nach Anspruch 1, wobei die Verbindung mit einem aktiven Wasserstoffatom Essigsäure, Laurinsäure, Oxalsäure, Fumarsäure, Maleinsäure, Trimesinsäure, Butantetracarbonsäure oder Pyromellitsäure ist.

7. Kohlenschlamm nach Anspruch 1, wobei die Verbindung mit einem aktiven Wasserstoffatom Milchsäure, Glykolsäure, Glycin, N-Mono-alkylglycin, Äpfelsäure, Weinsäure, Monoethanolamin, Diethanolamin oder Aminoethanolamin ist.

8. Kohlenschlamm nach Anspruch 1, wobei die Kohle Reinkohle ist.

9. Kohlenschlamm nach Anspruch 8, wobei der Schlamm 70 bis 80 Gew.-% an festen Kohlebestandteilen aufweist.

10. Kohlenschlamm nach Anspruch 1, wobei das Polyetheraddukt in einer Menge von 0,03 bis 2,0 Gew.-% im Schlamm vorliegt.

11. Kohlenschlamm nach Anspruch 10, wobei die Kohle Reinkohle ist, der Gehalt an festen Kohlebestandteilen 76 bis 80% beträgt, der Gehalt an dem Mittel zur Viskositätserniedrigung des Schlamms ungefähr 0,1 bis 0,3 Gew.-% beträgt und der Schlamm eine Viskosität im Bereich von 1000 bis 2800 mPas besitzt.

12. Kohlenschlamm nach Anspruch 1, wobei die Kohle Rohkohle ist, der Gehalt an festen Kohlebestandteilen 72 bis 77% beträgt, der Gehalt an dem Mittel zur Viskositätserniedrigung des Schlamms ungefähr 0,1 bis 0,3 Gew.-% beträgt und der Schlamm eine Viskosität im Bereich von 800 bis 2800 mPas besitzt.

13. Fluider, wäßriger Kohlenschlamm mit wenigstens 60 Gew.-% festen Kohlebestandteilen, der im wesentlichen aus einer Mischung von Wasser und Kohlepulver besteht, und der durch die Anwesenheit einer den Schlamm wirksam fluidisierenden Menge eines Polyalkylenoxids als Mittel zur Viskositätserniedrigung fluid ist, wobei das Polyalkylenoxid ein Molekulargewicht von wenigstens 1000 und einen Gehalt an Oxyethyleneinheiten von wenigstens 10 Gew.-%, bezogen auf den Gesamtgehalt an Oxyalkyleneinheiten, aufweist, dadurch gekennzeichnet, daß das Polyalkylenoxid

a) das Reaktionsprodukt eines Vernetzungsmittels mit einem Polyetheraddukt eines Alkylenoxids und einer Verbindung mit einem aktiven Wasserstoffatom ist, oder

b) das Reaktionsprodukt von a) oder des erwähnten Addukts mit einem anorganischen oder orga-

nischen Acylierungsmittel, einem Halogenierungsmittel, einem Oxidationsmittel oder einem Monoisocyanat ist.

14. Kohlenschlamm nach Anspruch 13, wobei die Verbindung mit einem aktiven Wasserstoffatom wenigstens eine Hydroxy-, Amino-, Imino- oder Carboxylgruppe aufweist.

15. Kohlenschlamm nach Anspruch 14, wobei der Polyether das Produkt (a) ist und das Vernetzungsmittel ein Polyisocyanat, eine Polyepoxyverbindung, ein Polyaldehyd, ein funktionelles Derivat einer Polycarbonsäure oder ein freie Radikale erzeugender Peroxidkatalysator ist.

16. Kohlenschlamm nach Anspruch 13, wobei der Polyether das Reaktionsprodukt des erwähnten Addukts oder des Produkts (a) mit einem Sulfat- oder einem Phosphatester ist.

17. Kohlenschlamm nach Anspruch 13, wobei die Kohle Reinkohle ist.

18. Kohlenschlamm nach Anspruch 17, wobei das Kohlepulver in einer Menge von 70 bis 80 Gew.-% des Schlamms vorhanden ist.

19. Kohlenschlamm nach Anspruch 13, wobei das Reaktionsprodukt in einer Menge von 0,03 bis 2,0 Gew.-% des Schlamms vorhanden ist.

20. Kohlenschlamm nach Anspruch 13, wobei die Kohle Reinkohle ist, der Gehalt an festen Kohlebestandteilen 76 bis 80% beträgt, der Gehalt an dem Mittel zur Viskositätserniedrigung des Schlamms ungefähr 0,1 bis 0,3 Gew.-% beträgt und der Schlamm eine Viskosität im Bereich von 1000 bis 2800 mPas besitzt.

21. Kohlenschlamm nach Anspruch 13, wobei die Kohle Rohkohle ist, der Gehalt an festen Kohlebestandteilen 72 bis 77% beträgt, der Gehalt an dem Mittel zur Viskositätserniedrigung des Schlamms ungefähr 0,1 bis 0,3 Gew.-% beträgt und der Schlamm eine Viskosität im Bereich von 800 bis 2800 mPas besitzt.

Revendications

1. Suspension aqueuse de charbon fluide ayant une teneur en matières solides de charbon d'au moins 60% en poids et consistant essentiellement en un mélange d'eau et de charbon pulvérulent rendu fluide par la présence, comme agent réducteur de viscosité, d'une quantité efficace pour fluidifier la suspension d'un oxyde de polyalcoylène ayant un poids moléculaire d'au moins 1000 et une teneur en unités oxyde d'éthylène d'au moins 10% en poids, par rapport à la teneur totale en unités oxyde d'alcoylène, caractérisée en ce que l'oxyde de polyalcoylène est un produit d'addition polyéther d'un oxyde d'alcoylène inférieur et d'un composé à hydrogène actif choisi dans le groupe consistant en:

a) composés polyhydroxylés ayant au moins trois atomes d'hydrogène actif;
b) polyamines ayant cinq atomes d'hydrogène actif ou plus;
c) condensats d'un composé phénolique avec un aldéhyde aliphatique;
d) polyalcoylèneimines et dérivés ayant de 7 à 200 atomes d'azote;
e) acides carboxyliques; et
f) composés ayant deux groupes fonctionnels à hydrogène actif différents ou plus.

2. Suspension selon la revendication 1, dans laquelle ledit composé à hydrogène actif de départ est le glycérine, le butanetriol, l'hexanetriol, le triméthylolpropane, la triéthanolamine, la diglycérine, la pentaérythritol, le xylitol, le sorbitol, le glucose, le sucrose, l'acétate de polyvinyle partiellement saponifié, la cellulose ou l'amidon.

3. Suspension selon la revendication 1, dans laquelle ledit composé à hydrogène actif est la diéthylènetriamine, la triéthylènetétramine ou la tétraéthylènepentamine.

4. Suspension selon la revendication 1, dans laquelle ledit composé à hydrogène actif est un condensat de phénol, de crésol, de xylénol de butylphénol, de nonylphénol, d'aminophénol, d'acide hydroxybenzoique, de catéchol, de résorcine, de pyrogallol, de naphtol, de méthylnaphtol, de butylnaphtol, d'octylnaphtol, de naphtorésorcine, de α-naphtohydroquinone ou d'un bisphénol, avec le formaldéhyde, l'acetaldéhyde ou le glyoxal.

5. Suspension selon la revendication 1, dans laquelle ledit composé à hydrogène actif est la polyéthylèneimine, la polypropylèneimine; un produit d'addition de l'éthylèneimine ou de la propylèneimine avec un alcool, un phénol, une amine ou un acide carboxylique; ou un condensat de polyéthylèneimine ou de polypropylèneimine avec un aldéhyde, une cétone, un halogénure d'alcoyle un isocyanate, un thioisocyanate, un composé actif à double liaison, un composé époxyde, une épihalohydrine, un cyanamide, la guanidine, l'urée ou un acide carboxylique, un anhydride ou un halogénure d'acide; tous contenant de 7 à 200 atomes d'azote.

6. Suspension selon la revendication 1, dans laquelle ledit composé à hydrogène actif est l'acide acétique, l'acide laurique, l'acide oxalique, l'acide fumarique, l'acide maléique, l'acide trimésique, l'acide butanetétracarboxylique ou l'acide pyromellitique.

7. Suspension selon la revendication 1, dans laquelle ledit composé à hydrogène actif est l'acide lactique, l'acide glycolique, la glycine, la N-mono-alcoyl glycine, l'acide malique, l'acide tartrique, la monoéthanolamine, la diéthanolamine ou l'aminoéthanolamine.

8. Suspension selon la revendication 1, dans laquelle ledit charbon est du charbon épuré.

9. Suspension selon la revendication 8, dans laquelle ladite suspension a une teneur en matières solides de charbon de 70 à 80% en poids.

10. Suspension selon la revendication 1, dans laquelle ledit produit d'addition polyéther est présent dans la proportion de 0,03 à 2,0% du poids de la suspension.

11. Suspension selon la revendication 1, dans laquelle le charbon est du charbon épuré, la teneur en matières solides de charbon est de 76 à 80%, la teneur en agent réducteur de viscosité de ladite suspension est d'environ 0,1 à 0,3% en poids, et la suspension a une viscosité allant de 1000 à 2800 mPas.

12. Suspension selon la revendication 10, dans laquelle le charbon est du charbon non épuré, la teneur en matières solides de charbon est de 72 à 77%, la teneur en agent réducteur de viscosité de ladite suspension est d'environ 0,1 à 0,3% en poids et la suspension a une viscosité allant de 800 à 2800 mPas.

13. Suspension aqueuse de charbon fluide ayant une teneur en matières solides de charbon d'au moins 60% en poids et consistant essentiellement en un mélange d'eau et de charbon pulvérulent rendu fluide par la présence, comme agent réducteur de viscosité, d'une quantité efficace pour fluidifier la suspension d'un oxyde de polyalcoylène ayant un poids moléculaire d'au moins 1000 et une teneur en unités oxyde d'éthylène d'au moins 10% en poids, par rapport à la teneur totale en unités oxyde d'alcoylène, caractérisée en ce que l'oxyde de polyalcoylène est (a) le produit de la réaction d'un réticulant avec un produit d'addition polyéther d'un oxyde d'alcoylène et d'un composé à hydrogène actif, ou (b) le produit de la réaction de (a) ou dudit produit d'addition avec un agent d'acylation inorganique ou organique, un agent d'halogénation, un agent d'oxidation ou un monoisocyanate.

14. Suspension selon la revendication 13, dans laquelle ledit composé à hydrogène actif a au moins un groupe hydroxyle amino, imino ou carboxylique.

15. Suspension selon la revendication 14, dans laquelle ledit polyéther est (a) et ledit réticulant est un polyisocyanate, un composé polyépoxy, un polyaldéhyde, un dérivé fonctionnel d'un acide polycarboxylique ou un catalyseur peroxyde générateur de radicaux libres.

16. Suspension selon la revendication 13, dans laquelle ledit polyéther est le produit de la réaction dudit produit d'addition ou de (a) avec un ester sulfate ou phosphate.

17. Suspension selon la revendication 13, dans laquelle ledit charbon est du charbon épuré.

18. Suspension selon la revendication 17, dans laquelle ledit charbon pulvérulent est présent dans la proportion de 70 à 80% du poids de la suspension.

19. Suspension selon la revendication 13, dans laquelle ledit produit de réaction est présent dans la proportion de 0,03 à 2,0% du poids de la suspension.

20. Suspension selon la revendication 13, dans laquelle le charbon est du charbon épuré, la teneur en matières solides de charbon est de 76 à 80%, la teneur en agent réducteur de viscosité de ladite suspension est d'environ 0,1 à 0,3% en poids et la suspension a une viscosité allant de 1000 à 2800 mPas.

21. Suspension selon la revendication 13, dans laquelle le charbon est du charbon non épuré, la teneur en matières solides de charbon est de 72 à 77%, la teneur de ladite suspension en agent réducteur de viscosité est d'environ 0,1 à 0,3% en poids et la suspension a une viscosité allant de 800 à 2800 mPas.