(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
08 October 2020 (08.10.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/198982 A1

(51) International Patent Classification:
C02F 5/14 (2006.01)

(21) International Application Number:
PCT/CN2019/080542

(22) International Filing Date:
29 March 2019 (29.03.2019)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant *(for all designated States except VC)*: **KEMIRA OYJ** [FI/FI]; Energiakatu 4, Helsinki, 00180 (FI).

(71) Applicant *(for VC only)*: **KEMIRA (ASIA) CO., LTD.** [CN/CN]; Innov Tower, Block A, 1801 Hongmei Road, Shanghai 200233 (CN).

(72) Inventors: **LI, Fengyang**; c/o Kemira (Asia) Co., Ltd., Kemira APAC R&D Center, 4E, No. 10 Building, No. 1188 Lianhang Road, PIV-park, Pujiang Town, Minhang Dist., Shanghai 201112 (CN). **XU, Yan**; c/o Kemira (Asia) Co., Ltd., Kemira APAC R&D Center, 4E, No. 10 Building, No. 1188 Lianhang Road, PIV-park, Pujiang Town, Minhang Dist., Shanghai 201112 (CN).

(74) Agent: **LUNG TIN INTELLECTUAL PROPERTY AGENT LTD.**; 18th Floor, Tower B, Grand Place No. 5 Huizhong Road, Chaoyang District, Beijing 100101 (CN).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:
— *of inventorship (Rule 4.17(iv))*

Published:
— *with international search report (Art. 21(3))*

WO 2020/198982 A1

(54) Title: DISPERSANT COMPOSITION, METHOD FOR CONTROLLING, PREVENTING AND/OR REDUCING FORMATION OF INORGANIC SCALE AND DEPOSITS, AND USE OF COMPOSITION

(57) Abstract: A typical dispersant comprises a copolymer of phosphono and carboxylic acid, at least 5-weight-% of a terpolymer consisting of (meth) acrylic acid and maleic acid monomers or their salts, at least 10 weight-% of acrylic acid-2-acrylamido-2-methyl-propane sulfonic acid copolymer (AA/AMPS), and at least 5-weight-% of at least one monomeric or polymeric phosphonate comprising at least one phosphonic acid group, or its salt (s). Use of the dispersant and a method for controlling, preventing and/or reducing the formation inorganic scale and/or deposits in an aqueous system are provided.

DISPERSANT COMPOSITION, METHOD FOR CONTROLLING, PREVENTING AND/OR REDUCING FORMATION OF INORGANIC SCALE AND DEPOSITS, AND USE OF COMPOSITION

Field of the invention

The invention relates to a dispersant composition and its use according to the preambles of the enclosed independent claims. The present invention also relates to a method for controlling, preventing and/or reducing the formation of inorganic scale and/or deposit in an industrial aqueous system.

Background of the invention

Scaling of undesired, sparingly-soluble inorganic salts onto process surfaces is a major problem in several industrial processes. Scaling occurs when a solution contains more dissolved solute than it is possible for saturated solution and salt precipitates spontaneously from the aqueous phase, generally onto different surfaces in the process environment and forms scale. For example, when water is heated or cooled, scale is typically formed on heat transfer equipment, such as heat exchangers, condensers, evaporators, cooling towers, boilers and pipe walls. The formation of scale on heated surfaces causes the heat transfer coefficient to decline with time. Often the only option is to shut down the process and perform a cleanup. Scaling may also cause equipment failures, production losses, costly repair and higher operating costs.

There is a constant need in various industries, such as e.g. oil exploitation and refinery, geothermal resource production, coal gasifiers, for improved inorganic scale inhibitors, which could tolerate harsh process conditions and elevated temperatures.

One problematic application finds in coal gasification process in CTX (coal-to-chemical) industry, when using poor-quality coal application with high Fe and S content as a raw material. Coal gasification is a technological process that can convert any carbon-based raw material such as coal into fuel gas, also called as syngas. Gasification is performed in a gasifier, generally a high temperature/pressure vessel where oxygen and/or air and water steam are

directly contacted with the coal or other feed material causing a series of chemical reactions to occur that convert the feed to fuel gas and ash/slag (mineral residues). The fuel gas is a syngas mixture consisting primarily of carbon monoxide (CO), hydrogen (H_2), and carbon dioxide (CO_2). Hangtian Lu (HT-L) gasification technology developed by Hangtian company is one of the dominant gasification technologies in CTX industry. HT-L gasifier compared to other gasification technologies could take all kinds of coal as raw material. However, some coals with high ash, iron and sulphur content, such as brown coal, would lead to tiny suspended solids and more complicated impurities in the grey water (process water) of the gasification process. In addition, it has been observed that formation and accumulation of slimes and deposits will be aggravated when using coal with high ash and sulphur content as raw material. Also, corrosion of equipment and iron scaling and deposition is increased due to high Fe and S coal. Therefore, there is a need for efficient composition for preventing and inhibiting scale and deposit formation and for inhibiting corrosion. Same kind of need is also present in other industrial effluents/process streams with high water hardness, high temperature, high solid suspension and high iron content.

Summary of the Invention

It is an object of the present invention to reduce or even eliminate the above-mentioned problems appearing in prior art.

An object of the present invention is to provide a composition having good dispersant performance of suspended inorganic particles. Especially, an object is to provide a composition having a good dispersant performance also at high temperatures and an object of the present invention is especially to provide a dispersant composition for use in processes having high temperatures.

An object of the present invention is especially to provide a dispersant composition for preventing iron scaling and deposition and also preventing corrosion in an industrial aqueous system.

In order to achieve among others the objects presented above, the invention is characterized by what is presented in the enclosed independent claims.

Some preferred embodiments of the invention will be described in the other claims.

The embodiments and advantages mentioned in this text relate, where applicable, both to the composition, the method as well as to the uses according to the invention, even though it is not always specifically mentioned.

A typical dispersant composition according to the invention comprises

- a copolymer of phosphono and carboxylic acid,
- at least 5-weight-% of a terpolymer consisting of (meth)acrylic acid and maleic acid monomers or their salts, optionally acrylic acid monomers containing sulfonic acid groups,
- at least 10 weight-% of acrylic acid-2-acrylamido-2-methylpropane sulfonic acid copolymer (AA/AMPS), and
- at least 5 weight-% of at least one monomeric or polymeric phosphonate comprising at least one phosphonic acid group, or its salt(s),

calculated from the total weight of the constituents in the composition.

The composition according to the present invention is typically used in controlling, preventing and/or reducing the formation of inorganic scale and/or deposit.

Typical method according to the present invention for controlling, preventing and/or reducing the formation of inorganic scale and/or deposits in an aqueous system comprises adding a composition according to the present invention to the aqueous system.

Now, it has been found that a composition according to the present invention provides good dispersion performance of suspended inorganic particles, especially in harsh process conditions, e.g. at high temperature and/or high-pressure conditions. By using a composition according to the present invention, deposition of inorganic particles on equipment and/or pipes may be reduced or even prohibited. A composition according to the invention is suitable for use in processes having high temperatures and/or high-pressure conditions. A composition according to the present invention tolerates high

temperatures, even temperatures > 240 °C. Especially, it has been found that a composition according to the present invention controls, prevents and/or reduces efficiently iron scaling and deposition. Especially, the scale inhibition and iron dispersion at high temperature (>240 °C) is enhanced largely. A composition according to the present invention may also prevent corrosion of equipment. Inhibition of corrosion will prolong equipment service life.

In addition to iron dispersant performance, it has also been observed that the composition according to the present invention has also high efficiency in carbonate scale and sulfate scale control. The dispersant composition according to the present invention also tolerates high hardness of water in an industrial aqueous system. Hardness tolerance of the composition according to the present invention is observed to be more than 1000 mg/L as calcium carbonate content. The composition of the present invention is not only capable of effectively reducing or eliminating the scale formation on the surfaces of process equipment even at high process temperatures, but it is also effective in aqueous environments having high water hardness.

The composition according to the invention is able to provide several advantages simultaneously, such as high temperature tolerance, good iron dispersant performance and inhibition of corrosion, and high carbonate and/or sulphate scale inhibition effect. The composition according to the present invention can be widely used in different applications, wherein iron dispersant performance is required. Especially, the composition according to the present invention provides iron dispersant for applicable to use in the harsh temperature and/or pressure conditions. The composition according to the present invention is able to function as a dispersant and to control scale formation in industrial systems having elevated temperature and/or pressure conditions, for example, in heat exchangers and/or evaporative equipment. It is also suitable for use in processes having temperature above 100 °C, more typically above 120 °C and even the systems having temperature above 240°C. The composition according to the present invention does not loss its effectiveness in harsh conditions. A composition according to the present invention can be used e.g. in coal gasifiers in CTX industry, desalination process, steam locomotive, low pressure boilers, crude oil evaporation, petroleum pipeline, industrial circulating cool water systems or the like.

Detailed description of the invention

A composition according to the present invention comprises the following constituents:

- a copolymer of phosphono and carboxylic acid,
- a terpolymer consisting of (meth)acrylic acid and maleic acid monomers or their salts, optionally acrylic acid monomers containing sulfonic acid groups,
- at least one monomeric or polymeric phosphonate comprising at least one phosphonic acid group, or its salt(s), and
- acrylic acid-2-acrylamido-2-methylpropane sulfonic acid copolymer (AA/AMPS),

wherein the synergistic effect of the constituents provides high temperature tolerance, improved scale inhibition and good dispersant performance for inorganic particles, and especially iron dispersion is enhanced largely.

The composition according to the invention comprises a copolymer of phosphono and carboxylic acid, also called as phosphono-carboxylic acid (PCA) or POCA, for providing good dispersant performance and also good scale inhibition performance for calcium carbonate and sulphate scale. Further, good temperature resistance of the composition according to the present invention is achieved by means of a copolymer of phosphono and carboxylic acid. The composition according to the invention comprises a copolymer of phosphono and carboxylic acid in an amount of 20 – 80 weight -%, calculated from the total weight of the constituents in the composition, by depending on the amounts of other constituents in the composition. According to an embodiment of the present invention, the composition comprises preferably 40 – 60 weight-% and more preferably about 50 weight-% of a copolymer of phosphono and carboxylic acid, calculated from the total weight of the constituents in the composition.

The composition according to the invention comprises at least 5-weight-% of a terpolymer consisting of (meth)acrylic acid and maleic acid monomers or their salts, optionally acrylic acid monomers containing sulfonic acid groups, calculated from the total weight of the constituents in the composition, for providing and improving high temperature resistance of the composition. A terpolymer is a polymer that results from copolymerization of three discrete

monomers. A terpolymer according to the present invention is an acrylate-maleate terpolymer consisting of (meth)acrylic and maleic acid monomers or their salts, and optionally acrylic acid monomers containing sulfonic acid groups, preferably 2-sulfoethyl methacrylate. In an embodiment according to the invention the composition comprises a sodium salt of poly(acrylic acid-co-maleic acid) or a sodium salt of acrylate maleate terpolymer containing 2-sulfoethyl methacrylate. Further, said acrylate-maleate terpolymer provides excellent dispersion performance for not only calcium carbonate, but also sulfate scale. An acrylate-maleate terpolymer may have a weight average molecular weight MW of 500 – 5000 g/mol, preferably in a range of 1000 - 3000 g/mol. The molecular weights are determined by using gel permeation chromatography (GPC).

An acrylate-maleate terpolymer may have the molar ratio of acrylate to maleate monomers from 1:10 to 10:1 respectively. Further, an acrylate-maleate terpolymer may have acrylic acid ester monomers containing sulfonyl groups in the range of 0.05 – 10 molar percent of the total weight of the monomers.

According to one embodiment of the invention the dispersant composition comprises said acrylate-maleate terpolymer or its salt(s) in an amount of 5 – 20 weight-%, preferably 10 – 15 weight-% and more preferably about 10 weight-%, calculated from the total weight of the constituents in the composition.

The composition according to the invention comprises at least 10 weigh-% of acrylic acid-2-acrylamido-2-methylpropane sulfonic acid copolymer (AA/AMPS), calculated from the total weight of the constituents in the composition, for improving iron dispersion effect and fine corrosion performance of the composition. Further, common scale inhibitor and corrosion inhibitor properties are achieved by using AA/AMPS as one of the constituents of the composition. The AA/AMPS copolymer may consist of acrylic acid (AA) monomers and 2-acrylamido 2-methylpropane sulfonic acid (AMPS) monomers in the molar ratio between 1:50 to 50:1 respectively.

According to one embodiment of the invention the composition comprises the AA/AMPS in an amount of 10 – 40 weight-%, preferably 20 – 40 weight-%

and more preferably about 30 weight-%, calculated from the total weight of the constituents in the composition.

The composition comprises further at least 5-weight-% of at least one monomeric or polymeric phosphonate comprising at least one phosphonic acid group, calculated from the total weight of the constituents in the composition. At least one monomeric or polymeric phosphonate is used as a scale inhibitor and/or chelating agent. The monomeric phosphonate may also comprise any suitable salt(s) thereof. The phosphonate may be selected from hydroxyethylene diphosphonic acid (HEDP), amino tris(methylenephosphonic acid)(ATMP), 2-phosphonobutane-1,2,4-tricarboxylic acid (PBTC), diethylenetriaminepenta(methylene phosphonic acid) (DTPMPA), hexamethylenediamine tetramethylenephophonic acid (BHMTPMPA), polyamino polyether methylene phosphonic acid (PAPEMP) or any combination of them. According to one preferable embodiment the phosphonate comprises diethylenetriaminepenta(methylene phosphonic acid) (DTPMPA), since its good calcium carbonate inhibition performance and metal chelation.

In an embodiment according to the present invention, the total amount of monomeric and/or polymeric phosphonates of the composition may be 5 – 30 weight -% or 5 – 20 weight-% and preferably about 10 weight-%, calculated from the total weight of the constituents in the composition.

The amounts of the constituents of the dispersant composition are dependent on the process conditions of the application and can be adjusted for each application for achieving optimal results.

According to one preferred embodiment of the present invention, the composition comprises a copolymer of phosphono and carboxylic acid (POCA; CAS:71050-62-9), a sodium salt of acrylate maleate terpolymer containing 2-sulfoethyl methacrylate (CAS:52255-49-9), AA/AMPS (CAS:40623-75-4) and DTPMPA (CAS:15827-60-8). In one preferred embodiment according to the present invention, the composition comprises

- 50 weight-% of a copolymer of phosphono and carboxylic acid (POCA),
- 10 weight-% of a sodium salt of acrylate maleate terpolymer containing 2-sulfoethyl methacrylate,

- 30 weight-% of AA/AMPS, and
- 10 weight-% of DTPMPA,

calculated from the total weight of the constituents in the composition.

The dispersant composition according to the present invention can be used in any operation temperatures, but it also tolerates high temperatures, i.e. it is effective also in high temperatures. The composition according to the present invention can also be added to the industrial systems having temperature of higher than 100 °C. The temperature tolerance of the composition according to the present invention has observed to be even over 250 °C. According to one embodiment, the operating temperature of the process to which the composition is added may be in the range of 120 - 280 °C. The system may have a pressure between 6 - 60 bar at the location where the composition is dosed.

The composition according to the invention may be used in any dose, depending on the nature of the inorganic scale and/or other conditions in the system where it is used. For example, according to one embodiment of the invention the addition of the composition may be in the range of 5 – 120 ppm, preferably 5 – 70 ppm, and more preferably 5 – 50 ppm.

The composition according to the present invention may be used at any process stage of suitable application, where there is a risk for inorganic scale formation and need for good dispersion performance of suspended solid particles. According to one embodiment of the invention the composition according to the present invention may be used for reducing or eliminating the formation of inorganic scale, such as iron scale and/or calcium carbonate scale and/or sulphate scale, in the aqueous system of a desalination plant of flash vaporization equipment, a low pressure boiler, crude oil evaporator, petroleum pipeline, an industrial circulating cool water system, a heat exchanger and/or a coal gasifier at high temperature, typically in a temperature of the system being above 100 °C, more typically above 120 °C and even the systems having temperature above 250 °C.

One target of the present invention is to provide a dispersant composition for use in the poor-quality coal application with high ash content and high S and Fe in CTX industry. The composition of the invention provides a novel high

temperature tolerant dispersant for used in a coal gasifier in CTX industry. Especially, the composition of the present invention is observed to be advantageous in HT-L gasifier. As disclosed already in the disclosure of the background, one advantage of HT-L gasifier compared to other gasification technologies is that it could take all kinds of coal as raw material. However, some coals with high ash and high sulphur and iron content, such as brown coal, would lead to tiny suspended solids and more complicated impurities in the grey water (process water) of the gasification process. In addition, it has been observed that formation and accumulation of slimes and deposits will be aggravated when using coal with high ash and sulphur content as raw material. High sulphur content may also cause corrosion of equipment and iron scaling and deposition. Therefore, the composition of the present invention is especially beneficial to be used in HT-L gasifier by reducing or even eliminating problems appeared when using coal with high ash and sulphur and iron content as raw material. The composition makes possible to utilize poor quality coal efficiently. The quality of coal as raw material is not critical, when using a composition according to the present invention in the coal gasification process. Shutdowns of the process for cleaning can also be reduced since the deposition and scaling is inhibited and/or reduced. The composition according to the invention may be used e.g. for reducing or eliminating calcium scaling in washing tank(s), heat exchanger(s) and/or pipeline; and/or for iron scaling in washing tank(s) and/or flask tank(s). In HT-L gasification process or other gasification processes, the composition according to the invention can be added to any suitable stream for preventing scaling and deposition. It may be added prior to and/or after gasifier, since it tolerates also high temperatures present in the gasifier. It may also be added to washing tank(s) and/or tower(s), flash tanks(s) and/or any process stream prior to or after them.

A better understanding of the present invention may be obtained through the following examples which are set worth to illustrate but are not to be construed as the limit of the present invention.

EXPERIMENTAL PART

Dispersion stabilization of Fe is studied under different dispersant compositions. By the means of ICP determination, the Fe concentrations before and after reaction are investigated. Further, the effects of the dispersant composition according to present invention on Ca scaling are studied.

Evaluation method for Iron dispersant performance

- Solution A: cation $CaCl_2$ liquid, Ca^{2+} concentration 300ppm.
- Solution B: Scale inhibitor to be tested.
- Solution C: 5g($FeSO_4 \cdot 7H_2O$)/L.
- Solution D: 500ppm $Na_2B_4O_2$ liquid.

Blank test: 50mL solution A + 12mL deionized water + 1mL solution C + 37mL solution D (in order).

Scale inhibition test: 50mL solution A + 12mL deionized water + defined dosage of solution B + 1mL solution C + 37mL solution D (in order).

Three parallel tests were conducted under the same condition.
pH was kept at about 8.7.

Scale inhibitors to be tested are pre-treated in hydrothermal synthesis reactor at 240 °C for 3h. The dosage of the scale inhibitor composition was 40 ppm and 60 ppm.

After all the chemicals are added into the bottle, the bottles are shaken well for 15 min. Then, the bottles are put into the water bath (T = 90 °C) and heated for 20h.

The bottles are taken out from the water bath and stand for 1h. Fe content is determined by ICP.

The dispersion of Fe in water is calculated using equation:

$$\eta = (X2 - X1) / (10 - X1),$$

wherein

- X1 is Iron (Fe) concentration after blank test without water treatment agent, mg/L,
- X2 is Iron (Fe) concentration after dispersion test with water treatment agent, mg/L, and
- 10 is the initial concentration of iron, mg/L.

Scale inhibitors used in the tests:

- Kemquard 11-350C, Kemquard 11-320C and Kemquard 5876 are commercial product for scale inhibition,
- Formula 1 consisting of 50 weight-% of KemGuard 5876 and 50 weight-% of POCA,
- Formula 2 consisting of 50 weight-% of KemGuard 5876 and 50 weight-% polyacrylamide,
- DTPMPA (CAS:15827-60-8),
- PAA is polyacrylamide,
- Formula 3 is the novel high temperature tolerant dispersant according to the present invention. Formula 3 consists of 50 weight-% of a copolymer of phosphono and carboxylic acid (POCA; CAS:71050-62-9), 10 weight-% of a sodium salt of acrylate maleate terpolymer containing 2-sulfoethyl methacrylate (Kemquard 5876; CAS: 52255-49-9), 30 weight-%of AA/AMPS (CAS: 40623-75-4), and 10 weight-% of DTPMPA (CAS:15827-60-8).

Table 1 shows results of the residual iron rate (%).

The result shows that the composition according to the present invention has excellent iron dispersant performance at temperature of 90 °C. It was clearly proven that the ingredients in Formula 3 have together a synergistic effect in dispersing iron at high temperature. Compared to acrylate-maleate-copolymers or terpolymers with 2-sulfonyl methacrylate alone, a chelating agent alone or polyacrylic amide alone, the composition of Formula 3 has a superior efficiency in dispersing iron.

Table 1. Iron dispersion performance at 90 °C, residual iron rate at different dosage amounts.

	Residual iron rate [%]	
Scale inhibitor	**40 ppm dosage**	**60 ppm dosage**
Kemquard 11-350C	0.13	1.01
Kemquard 11-320C	0.31	0.96
Formula 1	0.98	5.00
Formula 2	1.01	3.01
Kemquard 5876	-0.15	0.02
DTPMPA	19.62	19.63
PAA	1.83	5.57
Formula 3	63.88	61.37

Evaluation method for Ca scale inhibition rate

- Solution A: cationic $CaCl_2$ liquid
- Solution B: anionic $NaHCO_3$ liquid
- Solution C: Scale inhibitor to be tested

Blank sample: 50 mL solution A + 50 mL solution B
Reference sample: 50 mL solution A + 50 mL deionized water
Test sample: 50mL solution A + defined dosage of solution C + 50 mL solution B

After all the chemicals of each sample are added into respective bottles, the bottles are shaken well. Then, the bottles are put into the water bath at 80 °C for 24h. The bottles are taken out from the water bath. The solution from each bottle is filtered and Ca^{2+} concentration in the filtrates are determined using inductively coupled plasma (ICP) instrument.

Calculation of inhibition rate (%):

$$\eta = (X4 - X3) / (X2 - X3),$$

wherein

X2 is Ca^{2+} of reference sample, mg/L,

X3 is Ca^{2+} of blank sample, mg/L, and

X4 is Ca^{2+} of test sample of a scale inhibitor, mg/L.

Scale inhibition rate is determined after 240 °C treatment for 3 h in the hydrothermal synthesis reactor, wherein initial Ca^{2+} is 600 mg/L. The dosages of the scale inhibitor compositions are 80, 60 and 40 ppm. The results are presented in Table 2. The scale inhibitors Formula 1, Formula 2 and Formula 3 are same as in the iron dispersant performance above.

Table 2. Scale inhibition rate (%) after 3 hours at 240 °C in the hydrothermal synthesis reactor

	80 ppm dosage	**60 ppm dosage**	**40 ppm dosage**
Formula 1	75.1	68.2	60.1
Formula 2	77.9	65.3	60.2
Formula 3	85.5	78.2	75.2

As shown in Table 2, the composition according to the invention (Formula 3) is stable even at high temperatures and inhibition rate stays good. The behaviour is better than reference compositions.

Claims

1. Dispersant composition, **characterized** in that the composition comprises
- a copolymer of phosphono and carboxylic acid,
- at least 5-weight-% of a terpolymer consisting of (meth)acrylic acid and maleic acid monomers or their salts, optionally acrylic acid monomers containing sulfonic acid groups,
- at least 10 weight-% of acrylic acid-2-acrylamido-2-methylpropane sulfonic acid copolymer (AA/AMPS), and
- at least 5-weight-% of at least one monomeric or polymeric phosphonate comprising at least one phosphonic acid group, or its salt(s)

calculated from the total weight of the constituents in the composition.

2. The composition according to claim 1, **characterized** in that said terpolymer has a weight average molecular weight MW of 500 – 5000 g/mol, preferably 1000 – 3000 g/mol.

3. The composition according to claim 1 or 2, **characterized** in that the composition comprises said terpolymer in an amount of 5 – 20 weight-%, preferably 10 – 15 weight-% and more preferably about 10 weight-%, calculated from the total weight of the constituents in the composition.

4. The composition according to any of the preceding claims, **characterized** in that the composition comprises the AA/AMPS in an amount of 10 - 40 weight-%, preferably 20 – 40 weight-% and more preferably about 30 weight-%, calculated from the total weight of the constituents in the composition.

5. The composition according to any of the preceding claims, **characterized** in that the composition comprises monomeric and/or polymeric phosphonate(s) in an amount of 5 – 30 weight-% or 5 – 20 weight-% and more preferably about 10 weight-%, calculated from the total weight of the constituents in the composition.

6. The composition according to any of the preceding claims, **characterized** in that the monomeric or polymeric phosphonate may be selected from hydroxyethylene diphosphonic acid (HEDP), amino tris(methylenephosphonic

acid)(ATMP), 2-phosphonobutane-1,2,4-tricarboxylic acid (PBTC), diethylenetriaminepenta(methylene phosphonic acid) (DTPMPA), hexamethylenediamine tetramethylenephophonic acid (BHMTPMPA), polyamino polyether methylene phosphonic acid (PAPEMP) or any combination of them.

7. Use of dispersant composition according to any of preceding claims 1 to 6 for controlling, preventing and/or reducing the formation inorganic scale and/or deposits in an aqueous system.

8. Use according to claim 7, **characterized** in that temperature of the aqueous phase in the aqueous system is at least 100 °C, preferably at least 120 °C, more preferably in the range of 120 – 280 °C.

9. Use according to claim 7 or 8, **characterized** in that the aqueous system is the aqueous system of a desalination plant of flash vaporization equipment, a low-pressure boiler, crude oil evaporator, petroleum pipeline, an industrial circulating cool water system, a heat exchanger or a coal gasifier.

10. Use according to claim 7 or 8, **characterized** in that the aqueous system is HT-L gasification process.

11. A method for controlling, preventing and/or reducing the formation inorganic scale and/or deposits in an aqueous system, the method comprising adding a composition according to any of claims 1 to 6 to an aqueous system.

12. The method according to claim 11, **characterized** in that the addition of the composition is in the range of 5 – 120 ppm, preferably 5 – 70 ppm, and more preferably 5 – 50 ppm.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2019/080542

A. CLASSIFICATION OF SUBJECT MATTER

C02F 5/14(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC; CNKI; VEN; CNTXT; CNABS; Elsevier Science:inhibitor, dispersant, phosphono, carboxylic, copolymer, terpolymer, acrylic

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 106830378 A (SHANDONG HUAYOU WATER TREAT TECH CO., LTD.) 13 June 2017 (2017-06-13) claims 1-2	1-12
Y	CN 1068801 A (ROHM & HAAS CO.) 10 February 1993 (1993-02-10) claims 1-16	1-12
A	CN 101913712 A (URUMQI KEFAZHAN FINE CHEMICAL CO., LTD.) 15 December 2010 (2010-12-15) the whole document	1-12
A	CN 109231509 A (SHANDONG TAIHE WATER TREAT TECHNOLOGIES CO., LTD.) 18 January 2019 (2019-01-18) the whole document	1-12
A	WO 2014150096 A1 (ECOLAB USA INC) 25 September 2014 (2014-09-25) the whole document	1-12

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 December 2019	**31 December 2019**
Name and mailing address of the ISA/CN **National Intellectual Property Administration, PRC** **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088** **China** Facsimile No. **(86-10)62019451**	Authorized officer **SUN,Zhenjun** Telephone No. **86-(010)-62084781**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2019/080542

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 106830378 A	13 June 2017	None	
CN 1068801 A	10 February 1993	DE 69130712 T2	02 September 1999
		AT 175172 T	15 January 1999
		KR 0171602 B1	18 February 1999
		AU 1248197 A	13 March 1997
		DK 0459661 T3	18 September 1995
		DE 69111698 D1	07 September 1995
		AU 7282594 A	08 December 1994
		EP 0459661 B1	02 August 1995
		JP 3055815 B2	26 June 2000
		GR 3017029 T3	30 November 1995
		EP 0654449 B1	30 December 1998
		AU 676756 B2	20 March 1997
		AT 125785 T	15 August 1995
		JP H04356580 A	10 December 1992
		DE 69111698 T2	18 January 1996
		CA 2042341 A1	24 November 1991
		AU 654279 B2	03 November 1994
		DE 69130712 D1	11 February 1999
		AU 7731091 A	28 November 1991
		CN 1056593 C	20 September 2000
		EP 0654449 A1	24 May 1995
		CA 2042341 C	12 June 2001
		EP 0459661 A1	04 December 1991
		ES 2077168 T3	16 November 1995
		NZ 238229 A	26 October 1993
CN 101913712 A	15 December 2010	CN 101913712 B	05 October 2011
CN 109231509 A	18 January 2019	None	
WO 2014150096 A1	25 September 2014	US 2016017500 A1	21 January 2016
		AU 2014237526 B2	12 April 2018
		US 10443133 B2	15 October 2019
		US 2014272133 A1	18 September 2014
		PE 20151504 A1	23 October 2015
		AU 2014237526 A1	29 October 2015
		CA 2904581 A1	25 September 2014
		CL 2015002509 A1	29 January 2016
		PE 15042015 A1	23 October 2015
		US 9175405 B2	03 November 2015