of accumulations of gas pollutants (sand, water, precipitated salts, liquid and solid hydrocarbons such as paraffin, etc.) on the inner walls of the pipelines starts to create occlusions, this cleaning device is launched. Nowadays, the use of *pigs* is very widespread and in continuous evolution, by guaranteeing the increase in the productive flows, decrease in the pumping pressures and cleaner and safer productions.

Obviously not all pipes can be treated with a *pig*, but in most cases, upon construction, the line is implemented so that a *pig* could be launched for cleaning and water removal operations.

The essential condition for using *pigs* then is the presence of a launch station, wherein the *pig* is inserted, and an arrival station (which in case of loop can coincide with the launch one) wherein the *pig* will wait for being re-used. Obviously, it is strongly unadvisable to leave the *pig* captured in the line without having possibility to extract it. Moreover, the valves existing in the "piggable" lines have to allow the *pig* passage without creating inhomogeneities with the remaining portion of the line or representing an obstacle or a shrinkage which can be hardly overcome by the pad.

The *pig* technology is very effective and little risky if it is applied on a new line and it is fitted to the correct use of the technology itself: however, some outdated lines, worn by time, even if at the beginning are "piggable", they have no more safety and sliding conditions required to apply this technique. Should the occlusions in some tracts be too consolidated, or should the line geometry have changed due to a series of mechanical operations over the system life, this mechanical treatment becomes risky and it cannot be used.

Moreover, even if it is effective, the classical *pig* technology however is extremely invasive as far as application time and modes are concerned: the pipeline has to be closed and thus the production has to be stopped for a relatively long period of time. The lines, before being treated, have to be always drained with nitrogen to avoid possible risks of explosion, then the launch of *pig* requires quite long stopping periods of time, which could be estimated always in the order of some hours or even days (8 hours on the average).

The object of the present disclosure is to provide a new technology which overcomes the disadvantages of the known techniques and which is overall advantageous with respect thereto.

Summary

The present disclosure practically joins the technology of the foamers (*foamer*) with that of the launch of the *pig*, in which the new idea is represented by the formation of a *pig* formed by a foam pig, arranged inside the pipeline and produced by using water, surfactant and the same production gas. Under pig foam a piston or pad of dense, compact and sufficiently consistent foam is meant.

The foam which has formed in fact can have the consistency and the resistance of a real *pig* and it is capable of moving small accumulations of sediments, but, above all, all liquids accumulated and included in the pipeline by acting as a piston. Then, its cleaning and removing effect is obtained by means of a mechanical push rather than through the mechanisms underlying the techniques with foamers described in the prior art, that is decrease in the surface tension of accumulated water and integration of the same water in the foam then dragged towards the end of the pipeline.

Therefore, the present disclosure relates to:

a method for removing the liquids accumulated in the pipelines for the production and/or transportation of gas characterized by the following steps:

a) the flow of gas along the pipeline is locked through a (locking) shut-off valve;

b) a foam pig (pig) is provided which completely fills-up a section of the pipeline downstream of the shut-off valve and upstream of the section containing the accumulated liquids;

c) the flow of gas is re-activated that pushes the foam pig along the pipeline carrying the accumulations therewith.

In an aspect, there is provided a method for the removal of deposits accumulated in the pipelines of production and/or transport of natural and/or process gases comprising the following steps:

a) the flow of gas along the pipeline is blocked by a shut-off valve;

b) a compact foam cushion is provided which completely fills-up a section of the pipeline downstream of the shut-off valve and upstream of the section containing the deposits;

the flow of gas that pushes the foam cushion along the pipeline carrying the deposits with it is reactivated, wherein the foam cushion is produced by mixing one or more surfactants

and gas or air in a solvent selected from water, aqueous solution or organic solution

In another aspect, there is provided a foaming agent comprising, or consisting of, a surfactant selected from oxyethylated surfactants, oxyethylated phenols, oxyethylated fatty acids, oxyethylated alkyl monoethanolamides, lauryl beta imino-propionates, oxy-ethylene oxy-propylene copolymers, anionic surfactants, acid surfactants, basic or amphoteric surfactants or solid soaps in a method as defined above, for preparing a compact foam cushion.

In another aspect, there is provided a use of a foaming agent comprising, or consisting of, a surfactant selected from oxyethylated surfactants, oxyethylated phenols, oxyethylated fatty acids, oxyethylated alkyl monoethanolamides, lauryl beta imino-propionates, oxy-ethylene oxy-propylene copolymers, anionic surfactants, acid surfactants, basic or amphoteric surfactants or solid soaps in a method as defined above, for the preparation of a foam cushion.

A use of a foam cushion produced as defined above, for the removal of unwished gases existing in the pipes of industrial plants and/or for the drainage of said pipes.

In an example of the method of the disclosure the foam pig is produced *in situ* in the pipeline or is produced externally to the pipeline and subsequently introduced in the pipeline.

In another example the foam is produced by mixing in a solvent selected from water, aqueous solution or organic solution one or more surfactants and gas or air.

In another example the surfactant is selected from: oxyethylated surfactants, oxyethylated phenols, oxyethylated fatty acids, oxyethylated alkyl monoethanolamides, lauryl beta imino-propionates, oxy-ethylene oxy-propylene copolymers, anionic

surfactants, acid surfactants, basic or amphoteric surfactants or solid soaps.

In a specific example the foam pig is produced *in situ* in the pipeline and the method comprises the following steps:

- a section of pipeline is isolated through an initial valve and a final valve that delimits the downstream segment;
- it is vented in the segregated (isolated) section by reducing its pressure about to atmospheric pressure;
- the segregated line section is filled-up with a mixture of water and foamer;
- the initial valve is opened, upstream of the segregated section;
- the final valve is opened, downstream of the segregated segment by creating a strong turbulence downstream of the valve that intimately mixes the thrust gas with the water and the surfactant in solution;
- the gas pressure is allowed to push the foam pig along the pipeline and the pig pushes water and any debris accumulated up to a collection station.

In another specific example the foam pig is produced externally to the pipeline and the method comprises the following steps:

- the pipeline is closed by means of a shut-off valve upstream of the section including accumulations;
- the foam is produced externally to the pipeline through suitable means;
- the foam is inserted inside the pipeline, downstream of the shut-off valve, through a side-load line;
- the shut-off valve is completely re-opened.
- the gas pressure is allowed to push the foam pig along the pipeline and the pig pushes the liquids and any debris accumulated up to a collection station.

In another example the suitable means to produce the foam is selected from: a mixer, a pump for the water/product mixture, having high flow rate and high operating pressures, an orifice or nozzle, a pressure reducer (figure 3).

Secondly, the disclosure relates to a foaming agent comprising, or consisting of, a surfactant selected from oxyethylated surfactants, oxyethylated phenols, oxyethylated fatty acids, oxyethylated alkyl monoethanolamides, lauryl beta imino-propionates, oxy-

ethylene oxy-propylene copolymers, anionic surfactants, acid surfactants, basic or amphoteric surfactants or solid soaps in a method aas defined above, for the preparation of a foam pig (or pad).

Thirdly, the disclosure relates to the use of a foaming agent comprising, or consisting of, a surfactant selected from oxyethylated surfactants, oxyethylated phenols, oxyethylated fatty acids, oxyethylated alkyl monoethanolamides, lauryl beta imino-propionates, oxy-ethylene oxy-propylene copolymers, anionic surfactants, acid surfactants, basic or amphoteric surfactants or solid soaps in a method as defined above, for the preparation of a foam pig (or pad).

Fourthly, the disclosure relates to an industrial plant for the gas production and/or transportation, comprising a pipeline for the gas transportation, equipped with means for generating a foam pig (foam pig) inside the pipeline itself and suitable for the removal of deposits which impede the gas flow through the pipeline.

In a specific example of the plant according to the disclosure, the means for the production of the foam pig is represented by at least one segment of the pipeline itself (segregable) isolable from the rest of the pipeline by a first upstream valve and a second downstream valve and provided with at least one external valve for opening to the atmosphere for venting the internal gases and for loading a foaming agent and at least one valve cut-off, that is a side tube having small section, for the insertion of an instrument (thermometer, pressure gauge, …) or for gas sampling, said isolable segment being upstream of the pipeline area obstructed by deposits.

In an additional example the plant is a refinery, comprising means for the production of the foam pig described in the present disclosure for the drainage of the lines transporting gas inside said plant between an operating phase and the subsequent one.

At last, the present disclosure relates to the use of a foam pig as described and defined in the present description and claims, for handling unwished gases which can accumulate in the tubes of industrial plants and/or for the drainage of said pipelines.

In another example or as implementation of the above-described examples, the means for generating a foam pig (*foam pig*) is foam production means external and in parallel with respect to the pipeline itself comprising an instrument suitable for the foam production and a pipeline for introducing the foam in the main line.

The unwished gases, or however the gases to be removed by means of the foam pig according to the present disclosure, can be natural gases, a not limiting example thereof is represented by methane and/or propane, or they can be gases which develop in the plant after refining processes (herein defined even as “process gases”) a not limiting example thereof is represented by propane, butane, hydrogen sulphide, mercaptans and other gases known to the person skilled in the art.

Advantages

The foam forming procedures are very simple: mainly a line section, which can be segregated from the remaining portion of the system, or an external foam production plant or apparatus can be used.

Both modes were tested effectively, by providing optimum results and then they are an essential portion of this invention. The whole procedure can be concluded in very short time (fractions of one hour or little more) and the production standstill is very limited in time, much shorter than the traditional applications of the mechanical *pigs*.

The use of this new technique then allows to move huge quantities of water in very short periods of time. In the classical application it is necessary to wait for the foaming product being transported by the gas, reaching the first bag of water accumulated in the line, concentrating until reaching the critical concentration of foam formation, developing then the foam and therethrough transporting progressively the water (only the water contributing to the foam formation is transported): same mechanism for the subsequent bags, in which the foam transported by the gas arrives, will dissolve partially and contribute to raise the surfactant concentration, until reaching again the critical one and to re-form foam, and so on.

This mechanism involves then long periods of time and the water arrives in the final station very diluted over time, in a period which can reach several days.

By using the invention technique of the *foam pigs*, the water arrives very quickly, pushed by a compact foam pig: clearly the attention in the gas receiving station should be higher. In fact, the arrival of huge quantities of water could create problems for the triphasic separators downstream of the pipeline.

CLAIMS

1. A method for the removal of deposits accumulated in the pipelines of production and/or transport of natural and/or process gases comprising the following steps:

a) the flow of gas along the pipeline is blocked by a shut-off valve;

b) a compact foam cushion is provided which completely fills-up a section of the pipeline downstream of the shut-off valve and upstream of the section containing the deposits;

c) the flow of gas that pushes the foam cushion along the pipeline carrying the deposits with it is reactivated, wherein the foam cushion is produced by mixing one or more surfactants and gas or air in a solvent selected from water, aqueous solution or organic solution.

2. The method according to claim 1 wherein the deposits are deposits of water and/or condensate materials.

3. The method according to claims 1 or 2, wherein the foam cushion is produced *in situ* in the pipeline or is produced externally to the pipeline and subsequently introduced into the pipeline.

4. The method according to claim 3 wherein the surfactant is selected from: oxyethylated surfactants, oxyethylated phenols, oxyethylated fatty acids, oxyethylated alkyl monoethanolamides, lauryl beta imino-propionates, oxy-ethylene oxy-propylene copolymers, anionic surfactants, acid surfactants, basic or amphoteric surfactants or solid soaps.

5. The method according to claim 4 wherein the acid surfactants are selected from: coco-carboxypropionic acid, acrylic acid/dimethyl-diallyl ammonium chloride copolymer, coconut trimethyl ammonium chloride, C9-11 alkyl (linear)-alcohol alkoxy sulphate, C6-10 alkyl (linear)-alcohol alkoxy sulphate, triethyleneglycol-monohexyl-ether sulfate, C14-16 alpha olefin sulfonate, ethylenediamine tetra acetic acid trisodium salt, oleic acid, dodecanoic acid, coconut acid, octadecanoic acid, lauryl acid, myristic acid, hexadecanoic acid, octanoic acid, coco-dimethylamine-oxide, cocot-amidopropyl sulfo betaine,

coconut-amidopropyl betaine, coconut-amidopropyl amine oxide, tall oil bis-hydroxyethyl glycinate, coco-diethanolamide, oleic acid diethanolamide, coco-N,N-bis-hydroxyethyl amide, oxyethylated coco-amine, laurylamine oxide, dihydroxy ethyl C12-15 alkoxypropyl amine oxide, coco-ampho-acetate, coco-ampho-propionate, coco-ampho-hydroxypropyl sulfonate, lauryl-ampho-acetate, lauryl-ampho-dipropionate, capryl-ampho-diacetate, sodium lauryl-imino propionate, disodium talloil iminodipropionate, stearyl ampho-propyl sulphonate.

6. The method according to claim 3 wherein the foam cushion is produced *in situ* in the pipeline and the method comprises the following steps:

- a section of pipeline is isolated through an initial valve and a final valve that delimits the downstream segment;
- it is vented in the segregated section by reducing its pressure to atmospheric pressure;
- the segregated line section is filled with a mixture of water and foamer;
- the initial valve is opened, upstream of the segregated section;
- the final valve is opened, downstream of the segregated segment by creating a strong turbulence downstream of the valve that intimately mixes the thrust gas with the water and the surfactant in solution;
- the gas pressure is allowed to push the foam cushion along the pipeline and the foam cushion pushes the water and any debris accumulated up to a collection station.

7. The method according to claim 6 wherein the sequence of all steps is repeated two or more times.

8. The method according to claim 3 wherein the foam cushion is produced externally to the pipeline and the method comprises the following steps:

- the pipeline is closed by means of a shut-off valve upstream of the section containing the deposits;
- the foam cushion is produced externally to the pipeline through suitable means;
- the foam cushion is inserted inside the pipeline, downstream of the shut-off valve, through a side-load line;
- the shut-off valve is completely pre-opened.

- the gas pressure is allowed to push the foam cushion along the pipeline and the foam cushion pushes the water and any debris accumulated up to a collection station.

9. The method according to claim 8, wherein the suitable means to produce the foam cushion is selected from: a mixer, a high flow-rate and high operating pressure pump, an orifice or nozzle, a pressure reducer.

10. A foaming agent comprising, or consisting of, a surfactant selected from oxyethylated surfactants, oxyethylated phenols, oxyethylated fatty acids, oxyethylated alkyl monoethanolamides, lauryl beta imino-propionates, oxy-ethylene oxy-propylene copolymers, anionic surfactants, acid surfactants, basic or amphoteric surfactants or solid soaps in a method according to anyone of claims 1 to 3 and 7 to 9, for preparing a compact foam cushion.

11. The foaming agent according to claim 10 wherein the surfactant is selected from: coco-carboxypropionic acid, acrylic acid/dimethyl-diallyl ammonium chloride copolymer, coconut trimethyl ammonium chloride, C9-11 alkyl (linear)-alcohol alkoxy sulphate, C6-10 alkyl (linear)-alcohol alkoxy sulphate, triethyleneglycol-monohexyl-ether sulfate, C14-16 alpha olefin sulfonate, ethylenediamine tetra acetic acid trisodium salt, oleic acid, dodecanoic acid, coconut acid, octadecanoic acid, lauryl acid, myristic acid, hexadecanoic acid, octanoic acid, coco-dimethylamine-oxide, coco-amidopropyl sulfo betaine, coconut-amidopropyl betaine, coconut-amidopropyl amine oxide, tall oil bis-hydroxyethyl glycinate, coco-diethanolamide, oleic acid diethanolamide, coco-N,N-bis-hydroxyethyl amide, oxyethylated coco-amine, laurylamine oxide, dihydroxy ethyl C12-15 alkoxypropyl amine oxide, coco-ampho-acetate, coco-ampho-propionate, coco-ampho-hydroxypropyl sulfonate, lauryl-ampho-acetate, lauryl-ampho-dipropionate, capryl-ampho-diacetate, sodium lauryl-imino propionate, disodium talloil iminodipropionate, stearyl ampho-propyl sulphonate.

12. The foaming agent according to one of claims 10 or 11 comprising water and surfactant in water/surfactant ratios from 1:3 to 1:1, wherein the surfactant is selected from coco-carboxypropionic acid, acrylic acid/dimethyl-diallyl ammonium chloride copolymer, coconut trimethyl ammonium chloride, C9-11

alkyl (linear)-alcohol alkoxy sulphate, C6-10 alkyl (linear)-alcohol alkoxy sulphate, triethyleneglycol-monohexyl-ether sulfate, C14-16 alpha olefin sulfonate, ethylenediamine tetra acetic acid trisodium salt, oleic acid, dodecanoic acid, coconut acid, octadecanoic acid, lauryl acid, myristic acid, hexadecanoic acid, octanoic acid, coco-dimethylamine-oxide, cocot-amidopropyl sulfo betaine, coconut-amidopropyl betaine, coconut-amidopropyl amine oxide, tall oil bis-hydroxyethyl glycinate, coco-diethanolamide, oleic acid diethanolamide, coco-N,N-bis-hydroxyethyl amide, oxyethylated coco-amine, laurylamine oxide, dihydroxy ethyl C12-15 alkoxypropyl amine oxide, coco-ampho-acetate, coco-ampho-propionate, coco-ampho-hydroxypropyl sulfonate, lauryl-ampho-acetate, lauryl-ampho-dipropionate, capryl-ampho-diacetate, sodium lauryl-imino propionate, disodium talloil iminodipropionate, stearyl ampho-propyl sulphonate,

13. A use of a foaming agent comprising, or consisting of, a surfactant selected from oxyethylated surfactants, oxyethylated phenols, oxyethylated fatty acids, oxyethylated alkyl monoethanolamides, lauryl beta imino-propionates, oxy-ethylene oxy-propylene copolymers, anionic surfactants, acid surfactants, basic or amphoteric surfactants or solid soaps in a method according to anyone of claims 1 to 3 and 7 to 9, for the preparation of a foam cushion.

14. The use according to claim 13 wherein the surfactant is selected from: coco-carboxypropionic acid, acrylic acid/dimethyl-diallyl ammonium chloride copolymer, coconut trimethyl ammonium chloride, C9-11 alkyl (linear)-alcohol alkoxy sulphate, C6-10 alkyl (linear)-alcohol alkoxy sulphate, triethyleneglycol-monohexyl-ether sulfate, C14-16 alpha olefin sulfonate, ethylenediamine tetra acetic acid trisodium salt, oleic acid, dodecanoic acid, coconut acid, octadecanoic acid, lauryl acid, myristic acid, hexadecanoic acid, octanoic acid, coco-dimethylamine-oxide, cocot-amidopropyl sulfo betaine, coconut-amidopropyl betaine, coconut-amidopropyl amine oxide, tall oil bis-hydroxyethyl glycinate, coco-diethanolamide, oleic acid diethanolamide, coco-N,N-bis-hydroxyethyl amide, oxyethylated coco-amine, laurylamine oxide, dihydroxy ethyl C12-15 alkoxypropyl amine oxide, coco-ampho-acetate, coco-ampho-propionate, coco-ampho-hydroxypropyl sulfonate, lauryl-ampho-acetate, lauryl-ampho-

dipropionate, capryl-ampho-diacetate, sodium lauryl-imino propionate, disodium talloil iminodipropionate, stearyl ampho-propyl sulphonate.

15. A use of a foam cushion produced as described in claims 1 to 9, for the removal of unwished gases existing in the pipes of industrial plants and/or for the drainage of said pipes.