PROCESS, METHOD, AND SYSTEM FOR REMOVING MERCURY FROM PIPELINES

TECHNICAL FIELD

[001] The invention relates generally to a process, method, system, and management plan for removal and control of heavy metals such as mercury accumulating on pipes.

BACKGROUND

[002] Heavy metals such as mercury can be present in trace amounts in all types of produced fluids such as hydrocarbon gases, crude oils, and produced water. The amount can range from below the analytical detection limit to several thousand ppbw (parts per billion by weight) depending on the source. Mercury has been predominately managed with mercury removal adsorbent beds in facilities handling hydrocarbon gases, and by operationally managing mercury with mercury specific personal protection equipment ("PPE") and procedures.

[003] Some gas processing facilities may operate for extended periods of time, e.g., years, before mercury is detected in the inlet facilities. It is known that mercury slowly accumulates in the flowlines from the wells to the gas processing facilities via adsorption. Once the flowlines become "saturated" with mercury, mercury will "breakthrough" and be detected at the inlet facilities. After "breakthrough," the rate of rise in mercury at the inlet facilities can be low, giving some notice time to implement a solution.

[004] There is a need for a management scheme to/ leverage the flowline adsorption capacity to manage, control, and remove mercury in produced fluids from a reservoir, e.g., gas, crude, condensate, and produced water.

SUMMARY

[004a] In one aspect, there is provided a process for producing a produced fluid having a reduced concentration of mercury from a pipeline, comprising transporting a produced fluid containing mercury along the pipeline for a sufficient amount of time for the mercury to accumulate in the pipeline as elemental mercury, mercury sulfide and combinations thereof, wherein a sufficient amount of mercury accumulates on the pipeline reach a first mercury concentration at a check point downstream from an entry point of the produced fluid into the pipeline; stopping the transport of the produced fluid in a section of the pipeline; injecting a leading pig into the pipeline; injecting a composition comprising an

aqueous sulfidic solution comprising at least 0.1 wt. % of any of a sulfide, a polysulfide, and combinations thereof, forming a first slug at rear of the leading pig, wherein the aqueous sulfidic solution reacts with elemental mercury accumulated on the pipeline along the first slug forming soluble mercury complexes in the aqueous sulfidic solution; injecting a first trailing pig into the pipeline at rear of the first slug; resuming flow of the produced fluid; and recovering the produced fluid having a mercury concentration of less than 50% of the first mercury concentration at a location downstream from the first slug.

[004b] In one aspect, there is provided a process for producing a produced fluid having a reduced concentration of mercury from a pipeline, comprising transporting a produced fluid containing mercuric sulfide along the pipeline for a sufficient amount of time for the mercuric sulfide to accumulate in the pipeline as elemental mercury, mercury sulfide and combinations thereof, wherein one of elemental mercury, mercury sulfide and combinations thereof accumulates on the pipeline for the produced fluid to reach a first mercury concentration of one of elemental mercury, mercury sulfide and combinations thereof-at a check point downstream from an entry point of the produced fluid into the pipeline; stopping the transport of the produced fluid in a section of the pipeline; injecting a leading pig into the pipeline, wherein the leading pig is propelled by hydraulic pressure or flow of the produced fluid in the pipeline; injecting a composition comprising at least 0.1 wt. % of an inorganic sulfide, and combinations thereof, forming a first slug at rear of the leading pig, wherein the inorganic sulfide reacts with the mercuric sulfide accumulated on the pipeline along the first slug forming anionic mercury complexes of HgS_2H^- and HgS_2^{-2}; injecting a first trailing pig into the pipeline at rear of the first slug; resuming flow of the produced fluid; and recovering the produced fluid having a mercury concentration of less than 50% of the first mercury concentration at a location downstream from the first slug.

[004c] In one aspect, there is provided a process for producing a produced fluid having a reduced concentration of mercury from a pipeline, comprising transporting a produced fluid containing elemental mercury (Hg^0) along the pipeline for a sufficient amount of time for the elemental mercury to accumulate in the pipeline as elemental mercury, mercury sulfide and combinations thereof, wherein one of elemental mercury, mercury sulfide and combinations thereof, accumulates on the pipeline for the produced fluid to reach a first mercury concentration of one of elemental mercury, mercury sulfide and combinations thereof, at a check point downstream from an entry point of the produced fluid into the pipeline; stopping the transport of the produced fluid in a section of the pipeline; injecting a leading pig into the pipeline, wherein the leading pig is propelled by hydraulic pressure or

flow of the produced fluid in the pipeline; injecting a composition comprising at least 0.1 wt. % of an inorganic polysulfide, and combinations thereof, forming a first slug at rear of the leading pig, wherein the inorganic polysulfide reacts with the elemental mercury accumulated on the pipeline along the first slug forming soluble mercury complexes of HgS_2H^-; injecting a first trailing pig into the pipeline at rear of the first slug; resuming flow of the produced fluid; and recovering the produced fluid having a mercury concentration of less than 50% of the first mercury concentration at a location downstream from the first slug.

[005] In one aspect, the invention relates to a method to producing a produced fluid having a reduced concentration of mercury from a pipeline remove mercury contaminants from gas and / or crude productions. The method comprises: transporting a produced fluid containing mercury along the pipeline for a sufficient amount of time for the mercury to accumulate in the pipeline as elemental mercury, mercury sulfide and combinations thereof, wherein mercury accumulates on the pipeline for the produced fluid to reach a first mercury concentration at a check point downstream from an entry point of the produced fluid into the pipeline; stopping the transport of the produced fluid in a section of the pipeline; injecting a

WHAT IS CLAIMED IS:

1. A process for producing a produced fluid having a reduced concentration of mercury from a pipeline, comprising:

transporting a produced fluid containing mercury along the pipeline for a sufficient amount of time for the mercury to accumulate in the pipeline as elemental mercury, mercury sulfide and combinations thereof, wherein a sufficient amount of mercury accumulates on the pipeline reach a first mercury concentration at a check point downstream from an entry point of the produced fluid into the pipeline; stopping the transport of the produced fluid in a section of the pipeline; injecting a leading pig into the pipeline;

injecting a composition comprising an aqueous sulfidic solution comprising at least 0.1 wt. % of any of a sulfide, a polysulfide, and combinations thereof, forming a first slug at rear of the leading pig, wherein the aqueous sulfidic solution reacts with elemental mercury accumulated on the pipeline along the first slug forming soluble mercury complexes in the aqueous sulfidic solution;

injecting a first trailing pig into the pipeline at rear of the first slug; resuming flow of the produced fluid; and

recovering the produced fluid having a mercury concentration of less than 50% of the first mercury concentration at a location downstream from the first slug.

2. The process of claim 1, wherein the leading pig is propelled by any hydraulic pressure, a cable along a length of the pipeline, and flow of the produced fluid in the pipeline.

3. The process of claim 1, prior to resuming flow of the produced fluid, further comprising:

injecting a flushing solution at rear of the first trailing pig, wherein the flushing solution displaces the aqueous sulfidic solution and forms a second slug at rear of the first trailing pig; and

injecting a second trailing pig into the pipeline at rear of the first slug.

4. The process of claim 1, prior to resuming flow of the produced fluid, further comprising draining the aqueous sulfidic solution containing anionic mercury complexes from the pipeline.

5. The process of claim 1, wherein the aqueous sulfidic solution comprises 0.1 wt % to 25 wt % of any of a sulfide, a polysulfide, and combinations thereof.

6. The process of claim 5, wherein the mercury accumulated on the pipeline comprises mercuric sulfide, and wherein the mercuric sulfide dissolves in the aqueous sulfidic solution to form soluble mercury complexes is selected from HgS_xH, HgS_x^{-2} and combinations thereof, and wherein x >= 2.

7. The process of claim 6, wherein the soluble mercury complexes are selected from HgS_2H^- and HgS_2^{-2}.

8. The process of claim 7, wherein the mercury accumulated on the pipeline comprises elemental mercury, and wherein the elemental mercury is oxidized by and dissolved in the aqueous sulfidic solution to form soluble mercury complexes of HgS_xH^- wherein x >= 2.

9. The process of claim 1, wherein the aqueous sulfidic solution comprises at least 0.1 wt. % of an inorganic sulfide.

10. The process of claim 1, wherein the aqueous sulfidic solution comprises at least 0.1 wt. % of any of an inorganic polysulfide.

11. The process of claim 1, wherein the produced fluid downstream from the first slug has a mercury concentration of less than 30 % of the first mercury concentration.

12. The process of claim 1, wherein the produced fluid downstream from the first slug has a mercury concentration of less than 10% of the first mercury concentration.

13. The process of claim 1, wherein the transport of the produced fluid is stopped after the first mercury concentration reaches a pre-determined level.

14. The process of claim 1, wherein the transport of the produced fluid is stopped after the produced fluid is transported in the pipeline for a pre-determined period of time.

15. The process of claim 1, wherein the transport of the produced fluid is stopped when the pipeline is scheduled for regular pigging maintenance.

16. The process of claim 1, further comprising:

recovering the aqueous sulfidic solution containing anionic mercury complexes.

17. The process of claim 16, further comprising:

precipitating mercuric sulfide from the aqueous sulfidic solution containing soluble mercury complexes by any of titration, oxidation, stripping, heating, distillation and combinations thereof; and

separating the precipitated mercuric sulfide from the aqueous sulfidic solution; and

recovering the aqueous sulfidic solution.

18. The process of claim 16, further comprising injecting the aqueous sulfidic solution containing soluble mercury complexes into an underground formation.

19. The process of claim 16, further comprising depositing precipitated mercuric sulfide into an underground formation.

20. A process for producing a produced fluid having a reduced concentration of mercury from a pipeline, comprising:

transporting a produced fluid containing mercuric sulfide along the pipeline for a sufficient amount of time for the mercuric sulfide to accumulate in the pipeline as elemental mercury, mercury sulfide and combinations thereof, wherein one of elemental mercury, mercury sulfide and combinations thereof accumulates on the pipeline for the produced fluid to reach a first mercury concentration of one of elemental mercury, mercury sulfide and combinations thereof-at a check point downstream from an entry point of the produced fluid into the pipeline;

stopping the transport of the produced fluid in a section of the pipeline;

injecting a leading pig into the pipeline, wherein the leading pig is propelled by hydraulic pressure or flow of the produced fluid in the pipeline;

injecting a composition comprising at least 0.1 wt. % of an inorganic sulfide, and combinations thereof, forming a first slug at rear of the leading pig, wherein the inorganic

sulfide reacts with the mercuric sulfide accumulated on the pipeline along the first slug forming anionic mercury complexes of HgS_2H^- and HgS_2^{-2};

injecting a first trailing pig into the pipeline at rear of the first slug;

resuming flow of the produced fluid; and

recovering the produced fluid having a mercury concentration of less than 50% of the first mercury concentration at a location downstream from the first slug.

21. A process for producing a produced fluid having a reduced concentration of mercury from a pipeline, comprising:

transporting a produced fluid containing elemental mercury (Hg^0) along the pipeline for a sufficient amount of time for the elemental mercury to accumulate in the pipeline as elemental mercury, mercury sulfide and combinations thereof, wherein one of elemental mercury, mercury sulfide and combinations thereof, accumulates on the pipeline for the produced fluid to reach a first mercury concentration of one of elemental mercury, mercury sulfide and combinations thereof, at a check point downstream from an entry point of the produced fluid into the pipeline;

stopping the transport of the produced fluid in a section of the pipeline; injecting a leading pig into the pipeline, wherein the leading pig is propelled by hydraulic pressure or flow of the produced fluid in the pipeline;

injecting a composition comprising at least 0.1 wt. % of an inorganic polysulfide, and combinations thereof, forming a first slug at rear of the leading pig, wherein the inorganic polysulfide reacts with the elemental mercury accumulated on the pipeline along the first slug forming soluble mercury complexes of HgS_2H^-;

injecting a first trailing pig into the pipeline at rear of the first slug; resuming flow of the produced fluid; and

recovering the produced fluid having a mercury concentration of less than 50% of the first mercury concentration at a location downstream from the first slug.

22. The method of claim 21, wherein the inorganic polysulfide is selected from the group of sodium polysulfide, ammonium polysulfide, potassium polysulfide, calcium polysulfide, sulfanes (H_2S_x), and mixtures thereof.