CLAIMS

1. A method for recovering organic compounds from produced water, the method comprising:

providing produced water to a produced water source of a processing system comprising:

a processing vessel having a vessel inlet in fluidic communication with the produced water source and a first vessel outlet;

a filtration layer in the processing vessel between the vessel inlet and the first vessel outlet, the filtration layer comprising a filtration material; and

a cleaning system that provides a washing solution to the filtration material during a cleaning cycle of the processing system, wherein:

the filtration layer is configured in the processing vessel such that at least a portion of produced water from the produced water source that enters the processing vessel through the vessel inlet during a processing cycle of the processing system passes through the filtration layer before leaving the processing vessel through the first vessel outlet as filtered produced water;

the filtration material is a metal compound that is substantially insoluble in aqueous solution, the metal compound being chosen from metal hydroxides, metal oxohydroxides, or combinations thereof;

the washing solution comprises a reducing reagent; and

the metal compound is reducible by the reducing agent during the cleaning cycle to form a reduced metal compound that is soluble in aqueous solution;

initiating a processing cycle;

passing the produced water through the filtration layer during the processing cycle until the organic compounds collect within filtration layer;

initiating a cleaning cycle to provide the washing solution to the filtration material of the filtration layer, whereby the metal compound is reduced to a reduced metal compound that is soluble in the washing solution;

removing the washing solution from the processing vessel, the washing solution removed from the processing vessel containing dissolved reduced metal compound and the organic compounds; and

separating the organic compounds from the washing solution.

2. The method of claim 1, wherein the organic compounds comprise crude oil.

3. The method of claim 1, further comprising recovering the reduced metal compound from the washing solution removed from the processing vessel.

4. The method of claim 3, further comprising:

oxidizing the reduced metal compound recovered from the washing solution to reform the metal compound; and

transferring the reformed metal compound to the processing vessel.

5. The method of any one of the preceding claims, wherein:

the processing system further comprises a ceramic membrane between the filtration layer and the first vessel outlet;

the filtration layer comprises a coating layer of the metal compound on a coated surface of the ceramic membrane; and

the coating layer of the metal compound is dissolved away from the ceramic membrane when the metal compound is reduced during the cleaning cycle.

6. The method of claim 5, further comprising:

coating a surface of a fresh ceramic membrane with the reduced metal compound;

oxidizing the reduced metal compound on the fresh ceramic membrane to form a regenerated coating layer of the metal compound on the surface of the fresh ceramic membrane; and

inserting the fresh ceramic membrane into the processing vessel before or after the reduced metal compound is oxidized.

7. The method of claim 1, wherein:

the metal hydroxides are selected from the group consisting of iron (III) hydroxide, copper (II) hydroxide, manganese (III) hydroxide, chromium (III) hydroxide, and combinations thereof; and

the metal oxohydroxides are selected from the group consisting of iron (III) oxohydroxide (ferrihydrite), manganese (III) oxohydroxide, chromium (III) oxohydroxide, and combinations thereof.

8. The method of claim 1, wherein the reducing reagent is chosen from hypophosphorous acid or salts thereof, phosphorous acid or salts thereof, oxalic acid or salts thereof, formic acid or salts thereof, aqueous ammonia, ammonium salts, hydroxylamine, hydrogen in basic conditions, metal thiosulfates, metal sulfites or alkali metal sulfites, hydrides, sodium borohydride, sodium bisulfite, disodium sulfite, aqueous sulfur dioxide, sulfurous acid or salts thereof, or any combination thereof.

9. The method of claim 1, wherein the reducing reagent comprises aqueous sulfur dioxide, sulfurous acid, or a salt of sulfurous acid.

10. The method of claim 1, wherein the metal compound is ferrihydrite.

11. The method of claim 1, wherein the filtration layer comprises a particle bed supported by a screen within the processing vessel inlet and the first vessel outlet, the particle bed comprising particles of the metal compound.

12. The method of any of claims 1 to 4 and 7 to 11, wherein the metal compound is selected from the group consisting of iron (III) hydroxide, ferrihydrite, and combinations thereof.