CLAIMS

1. A pumped hydro storage system comprising:

a first reservoir;

a second reservoir, the second reservoir disposed below the first reservoir;

a turbine unit, the turbine unit includes a first turbine unit flow port and a second turbine unit flow port;

a penstock which is in fluid communication with the first and the second reservoirs, the penstock includes a first portion which is coupled to the first reservoir and the first turbine unit flow port and a second portion which is coupled to the second reservoir and the second turbine unit flow port, wherein the turbine unit is disposed proximate to the second reservoir;

a slurry circulating through the system, wherein the slurry comprises a high-density fluid, and wherein the high-density fluid comprises a high-density slurry which has a density greater than that of water;

wherein the slurry flows through the turbine unit in a first direction from the first reservoir to the second reservoir to cause the turbine unit to generate energy and the slurry flows through the turbine unit in a second direction from the second reservoir to the first reservoir to recharge the system; and

wherein the high-density slurry increases power output of the system as compared to water.

2. The system of claim 1 wherein the high-density slurry comprises a density which is ≥ about 3 times of that of water.

3. The system of claim 2 wherein the power output of the system is ≥ about 3 times when using the high-density slurry instead of water.

4. The system of claim 1 wherein the high-density slurry comprises a magnetite slurry with magnetite particles.

5. The system of claim 4 wherein a volume percent of magnetite particles in the magnetite slurry is about 50%.

6. The system of claim 5 wherein a volume percent of magnetite in the magnetite particles in the magnetite slurry is about 50 - 85%.

7. The system of claim 4 wherein a particle size of magnetite particles in the magnetite slurry is in a sub-micron regime.

8. A pumped hydro storage system comprising:

a first reservoir, wherein the first reservoir is configured to contain a high-density fluid and includes a first reservoir flow port disposed at a bottom of the first reservoir;

a second reservoir, wherein the second reservoir is configured to contain a lower-density fluid which has a density lower than that of the high-density fluid, and includes a second reservoir flow port disposed at a bottom of the second reservoir;

a cavity tank disposed at a cavity tank elevation, wherein first and second elevations of the first and second reservoirs are higher than the cavity tank elevation of the cavity tank, wherein the cavity tank is configured with an upper cavity tank port and a lower cavity tank port, wherein the upper cavity tank port is disposed above the lower cavity tank port;

a turbine unit, the turbine unit includes a first turbine unit flow port and a second turbine unit flow port, wherein the second turbine unit flow port is coupled to the second reservoir flow port;

a penstock, wherein the penstock includes

a first portion penstock coupled to the first reservoir flow port and the lower cavity tank port, wherein a lowest port of the first portion penstock is below the cavity tank, and

a second portion penstock coupled to the upper cavity tank port and the first turbine unit flow port;

wherein

in power generation mode, the high-density fluid is configured through the penstock towards through the cavity tank and towards the first reservoir, forcing the lower-density fluid to flow through the turbine and into the second reservoir, the lower-density fluid turns the turbine unit in a first direction to generate power, and

in recharge mode, the turbine unit pumps the lower-density fluid from the second reservoir through the penstock towards the first reservoir, forcing the high-density fluid back into the first reservoir; and

wherein the lower-density fluid and high-density fluid are configured to prevent the high-density fluid from passing through the turbine unit.

9. The system of claim 8 wherein the first elevation of the first reservoir is higher than the second elevation of the second reservoir.

10. The system of claim 8 wherein the first and second elevations of the first and second reservoirs are at about the same altitude.

11. The system of claim 8 wherein the first and second reservoirs comprise cylindrical atmospheric tanks.

12. The system of claim 8 wherein the high-pressure cavity tank comprises a spherical high-pressure cavity tank.

13. The system of claim 8 wherein the high-density fluid comprises a slurry with particles.

14. The system of claim 8 wherein the high-density fluid comprises water.

15. The system of claim 8 wherein the high-density fluid has a density which is at least 3 times greater than that of the lower-density fluid.

16. The system of claim 8 wherein the slurry comprises metal oxide particles.

17. The system of claim 8 wherein the slurry comprises magnetite particles to form a magnetite slurry.

18. The system of claim 16 wherein:

the slurry comprises 50 – 85% particles; and

sizes of the particles range from several microns to several hundred microns.

19. A method for generating power from a pumped hydro storage system comprising:

providing a first reservoir containing a high-density fluid, a second reservoir containing a lower-density fluid, a cavity tank disposed at a cavity tank elevation which is below a first reservoir elevation of the first reservoir and a second reservoir elevation of the second reservoir, a turbine unit coupled proximately to the second cavity tank, and a penstock to provide fluid communication within the system;

in power generation mode, flowing the high-density fluid from the first reservoir towards the second reservoir to force the lower-density fluid into the second reservoir which turns the turbine in a first direction to generate power;

in recharging mode, pumping, by the turbine unit, the lower-density fluid towards the first reservoir to force the high-density fluid into the first reservoir to recharge the system; and

wherein when the lower-density fluid and high-density fluid circulate through the system, the high-density fluid is configured to avoid passing through the turbine unit.

20. The method of claim 19 wherein the high-density fluid has a density which is at least 3 times greater than that of the lower-density fluid.

CLAIMS

1. A pumped hydro storage system comprising:

a first reservoir, wherein the first reservoir is configured to contain a high-density fluid and includes a first reservoir flow port disposed at a bottom of the first reservoir;

a second reservoir, wherein the second reservoir is configured to contain a lower-density fluid which has a density lower than that of the high-density fluid, and includes a second reservoir flow port disposed at a bottom of the second reservoir;

a cavity tank disposed at a cavity tank elevation, wherein first and second elevations of the first and second reservoirs are higher than the cavity tank elevation of the cavity tank, wherein the cavity tank is configured with an upper cavity tank port and a lower cavity tank port, wherein the upper cavity tank port is disposed above the lower cavity tank port;

a turbine unit, the turbine unit includes a first turbine unit flow port and a second turbine unit flow port, wherein the second turbine unit flow port is coupled to the second reservoir flow port;

a penstock, wherein the penstock includes

a first portion penstock coupled to the first reservoir flow port and the lower cavity tank port, wherein a lowest port of the first portion penstock is below the cavity tank, and

a second portion penstock coupled to the upper cavity tank port and the first turbine unit flow port;

wherein

in power generation mode, the high-density fluid is configured to flow through the penstock towards the cavity tank and towards the second reservoir, forcing the lower-density fluid to flow through the turbine and into the second

reservoir, the lower-density fluid turns the turbine unit in a first direction to generate power, and

in recharge mode, the turbine unit pumps the lower-density fluid from the second reservoir through the penstock towards the first reservoir, forcing the high-density fluid back into the first reservoir; and

wherein the lower-density fluid and high-density fluid are configured to prevent the high-density fluid from passing through the turbine unit.

2. The system of claim 1 wherein the first elevation of the first reservoir is higher than the second elevation of the second reservoir.

3. The system of claim 1 wherein the first and second elevations of the first and second reservoirs are at about the same altitude.

4. The system of claim 1 wherein the first and second reservoirs comprise cylindrical atmospheric tanks.

5. The system of claim 1 wherein the high-pressure cavity tank comprises a spherical high-pressure cavity tank.

6. The system of claim 1 wherein the high-density fluid comprises a slurry with particles.

7. The system of claim 6 wherein the slurry comprises metal oxide particles.

8. The system of claim 7 wherein:

the slurry comprises 50-85% particles; and

sizes of the particles range from several microns to several hundred microns.

9. The system of claim 6 wherein the slurry comprises magnetite particles to form a magnetite slurry.

10. The system of claim 1 wherein the high-density fluid comprises water.

11. The system of claim 1 wherein the high-density fluid has a density which is at least 3 times greater than that of the lower-density fluid.

12. The system of claim 1 wherein the second reservoir elevation of the second reservoir is placed at about the same altitude as the cavity tank elevation.

13. The system of claim 1 wherein the second reservoir elevation of the second reservoir is placed at a higher altitude than the cavity tank elevation.

14. The system of claim 1 wherein the turbine unit includes a turbine and a pump.

15. A method for generating power from a pumped hydro storage system comprising:

providing a first reservoir containing a high-density fluid, a second reservoir containing a lower-density fluid, a cavity tank disposed at a cavity tank elevation which is below a first reservoir elevation of the first reservoir and below a second reservoir elevation

of the second reservoir, a turbine unit coupled proximately to the second reservoir, and a penstock to provide fluid communication within the system, wherein the penstock comprises

a first penstock portion coupling the first reservoir to a lower portion of the cavity tank, and

a second penstock portion coupling an upper portion of the cavity tank to the turbine unit and the second reservoir;

in power generation mode, flowing the high-density fluid from the first reservoir towards through the penstock to the second reservoir to force the lower-density fluid into the second reservoir which turns the turbine in a first direction to generate power;

in recharging mode, pumping, by the turbine unit, the lower-density fluid towards the first reservoir through the penstock to force the high-density fluid into the first reservoir to recharge the system; and

wherein when the lower-density fluid and high-density fluid circulate through the system, the high-density fluid is configured to avoid passing through the turbine unit.

16. The method of claim 15 wherein the high-density fluid has a density which is at least 3 times greater than that of the lower-density fluid.

17. The method of claim 15 wherein the first reservoir elevation of the first reservoir is higher than the second reservoir elevation of the second reservoir.

18. The method of claim 15 wherein the first reservoir elevation of the first reservoir is at about the same altitude as the second reservoir elevation of the second reservoir.

19. The method of claim 15 wherein the second reservoir elevation of the second reservoir is placed at about the same altitude as the cavity tank elevation.

20. The method of claim 15 wherein the second reservoir elevation of the second reservoir is placed at a higher altitude than the cavity tank elevation.