

- 21 -

Claims

1. A storage vessel for storing compressed gas, comprising:
a wellbore provided in a subsurface;
a casing placed within the wellbore and cemented to surrounding rock
5 formations, the cased wellbore defining a volumetric space for storing
the compressed gas; and
at least one gas flow regulator sealed at a top end of the casing for
selectively injecting the compressed gas into the space or discharging
the compressed gas from the volumetric space.
10
2. The storage vessel of claim 1, wherein an effective volume capacity of
the well is 1-8 m³/100 meter of well length.
3. The storage vessel of claim 2, wherein a total volume of the well is
15 50-100 m³.
4. The storage vessel of claim 1, where the wellbore has a vertical,
inclined or horizontal profile in the subsurface.
- 20 5. The storage vessel of claim 1, wherein the stored compressed gas has
a pressure of 5 MPa to 100 MPa, and a temperature of 50 °C to 250
°C.
- 25 6. The storage vessel of claim 1, wherein each of the casing and cement
is corrosion resistant and can sustain a pressure in the range of 5MPa-
100 MPa and a temperature in a range of 50°-250° Celsius.
- 30 7. The storage vessel of claim 1, further comprising a basal plug or
bottom seal to seal a bottom end of the casing against release of the
compressed gas.

- 22 -

8. The storage vessel of claim 1, wherein the casing further comprises multitude sections comprising progressively smaller diameter casing as the wellbore length is extended.
- 5 9. The storage vessel of claim 1, further comprising a top seal placed at a top portion of the casing and at least one tubing placed through the top seal and connected to at least one valve to allow the compressed gas to be injected into or discharged from the volumetric space in said storage vessel.
- 10 10. The storage vessel of claim 1, wherein at least one gas flow regulator is a valve of a wellhead that allows for injection and production of the compressed gas.
- 15 11. The storage vessel of claim 1, wherein the compressed gas is compressed air.
- 20 12. The storage vessel of claim 1, wherein the compressed gas has a pressure of 50MPa.
- 25 13. The storage vessel of claim 1, wherein the cased wellbore has a volumetric capacity of $7\text{m}^3/100\text{m}$ of length, a depth of 1000 meters, and a total volume of 70m^3 .
- 30 14. A system for storing energy in a form of compressed gas comprising: one or more energy storage vessels for storing compressed gas, said energy storage vessels each comprising:
 a wellbore provided in a subsurface;
 a casing placed within the wellbore and cemented to surrounding rock formations, the casing defining a volumetric space for storing the compressed gas; and

- 23 -

- at least one gas flow regulator sealed at a top end of the casing
for selectively injecting the compressed gas into the space or
discharging the compressed gas from the volumetric space,
at least one surface gas compressor in sealed, fluid communication
5 with the one or more energy storage vessels for compressing the gas
and for injecting the compressed gas therein; and
at least one surface gas expander system in sealed, fluid
communication with the one or more energy storage vessels for
generating electricity from the compressed gas discharged from one
10 or more energy storage vessels.
15. The system of claim 14, wherein the casing and cement are adapted
to withstand cyclic pressures up to 100MPa and temperatures up to
250° Celsius, and are corrosion resistant.
15
16. The system of claim 14, wherein the one or more energy storage
vessels comprise a plurality of energy storage vessels and any
adjacent energy storage vessels are in fluid communication with each
other.
20
17. The system of claim 14, wherein the compressed gas is air.
18. The system of claim 14, wherein an effective volume capacity of the
storage vessel is 1-8 m³/100 meter of cased wellbore length.
25
19. The storage vessel of claim 18, wherein a total volume of the well is
50-100 m³.
20. The system of claim 15, wherein the system is configured to provide a
30 maximum pressure in the one or more energy storage vessels of
about 100 MPa per energy storage vessel.

- 24 -

21. The system of claim 16, where the plurality of energy storage vessels form an array that is in fluid connection to collectively provide a cumulative storage capacity for energy storage.
- 5 22. The system of claim 16, wherein any number of energy storage vessels are in fluid communication with each other.
23. The system of claim 14, further comprising a heat recovery system configured to remove surplus heat generated during a gas
10 compression process and to provide and restore at least some of the removed heat to the compressed gas during an expansion process.
24. The system of claim 23, wherein said heat recovery system includes a heat sink.
15
25. A method for storing energy storage, comprising:
forming at least one storage vessel by cementing a casing in a wellbore in the subsurface,
compressing gas on the surface; and
20 injecting compressed gas into the at least one storage vessel.
26. The method of claim 25, further comprising:
discharging compressed gas from at least one storage vessel; and
expanding the compressed gas in an expander system for generating
25 electricity.
27. The method of claim 25, further comprising forming an additional storage vessel by drilling an additional wellbore in the subsurface and cementing an additional casing in the additional wellbore.