

A SEAWATER COOLING SYSTEM AND AN UNDERGROUND STORAGE SYSTEM

Field of Invention

5 The invention relates to a seawater cooling system and an underground storage system with the seawater cooling system. The underground storage system may be used to provide an energy saving and environmentally friendly facility for data center and/or cold storage.

Background

10 Underground Space (UG) has become a well-known new dimension of land creation in the world, especially in some land-scare countries, e.g. Singapore. Use of UG space has been elevated to a strategic level in Singapore as recommended by the government's Economic Strategies Committee (ESC) in 2010. Going underground is a paradigm shift of Singapore infrastructure development.

15 UG may be used for building an underground data center. It has been reported that the data center market continues to show promising growth due to the great demand from various users, e.g. government users, banks, commercial cloud data providers, etc. The data center users covering national information, financial information and public information have top stringent requirement of
20 security including physical security/protection and information security. This is

exactly an obvious advantage of an underground data center over the traditional aboveground option.

However, one critical challenge of the existing underground data center, especially when the underground data center is developed in a tropical country, e.g. Singapore, is the high consumption of electricity required for computer server operation and system cooling (heat dissipation) and generation of high carbon footprint as the data center operation generates substantial heat, which is usually dissipated by means of a cool air /water circulation system.

Similarly, when UG is used for cold storage, high consumption of electricity is also required to maintain the temperature in the underground space by means of an air conditioning system.

It is therefore desirable to provide a solution to reduce the consumption of electricity and generation of carbon foot required for maintaining temperature of an underground enclosed space for data center and/or storage system.

15 **Summary of Invention**

Embodiments of the invention propose a seawater cooling system for lowering temperature in an underground enclosed space by low-temperature seawater at a certain depth below the sea level. The underground enclosed space may be used to build an energy saving and environmentally friendly underground data center and/or cold storage space.

According to a first aspect of the embodiments of the invention, a seawater cooling system for an underground enclosed space is provided. The seawater cooling system comprises a seawater pipeline having a seawater intake portion, a cooling portion, and a seawater discharging portion,

5 wherein the seawater intake portion has an inlet which is disposed at a predetermined depth below a sea level and a part of the seawater intake portion and a part of the cooling portion forms a substantial inverted U-shape structure to allow seawater at the predetermined depth to enter into the cooling portion;

10 the cooling portion is disposed in the underground enclosed space to lower temperature in the underground enclosed space by the seawater from the seawater intake portion; and

15 the cooling portion and the seawater discharging portion forms a substantial U-shape structure and the seawater discharging portion has an outlet which is disposed on or close to a sea surface so that the seawater in the seawater pipeline to be brought close to the sea surface.

According to a second aspect of the embodiments of the invention, an underground storage system is provided. The underground storage system comprises:

an underground enclosed space;

20 an access shaft connected to the underground enclosed space with an aboveground opening to allow access to the underground enclosed space; and

a seawater cooling system comprising a seawater pipeline having a seawater intake portion, a cooling portion and a seawater discharging portion,

wherein the seawater intake portion has an inlet which is disposed at a predetermined depth below a sea level and a part of the seawater intake portion and a part of the cooling portion forms a substantial inverted U-shape structure to allow seawater at the predetermined depth to enter into the cooling portion;

the cooling portion is disposed in the underground enclosed space to lower temperature in the underground enclosed space by the seawater from the seawater intake portion; and

the cooling portion and the seawater discharging portion forms a substantial U-shape structure and the seawater discharging portion has an outlet which is disposed on or close to a sea surface so that the seawater in the seawater pipeline to be brought close to the sea surface.

According to a third aspect of the embodiments of the invention, a method for building an underground storage system for data center is provided. The method comprising: constructing an underground enclosed space for data center; and providing a seawater cooling system proposed in embodiments of the invention to lower temperature in the underground enclosed space.

The seawater cooling system proposed in embodiments of the invention forms an energy saving seawater cooling circulation system, which uses the proposed seawater pipeline to allow low-temperature seawater at a certain depth

below the sea level to lower temperature in the underground enclosed space and bring the seawater with a higher temperature from the cooling portion close to the sea surface, which will be discharged back into the sea through the outlet of the seawater discharging portion. With this seawater cooling system, the electricity
5 consumption and thus carbon footprint can be substantially reduced.

Brief Description of the Drawings

The invention will be described in detail with reference to the accompanying drawings, in which:

Figure 1 is a schematic diagram showing the structure of a seawater cooling
10 system for an underground enclosed space according to one embodiment of the invention;

Figure 2 is a schematic diagram showing an alternative structure of the cooling portion of the seawater cooling system shown in Figure 1;

Figure 3 is a schematic diagram showing the structure of an underground
15 storage system with a seawater cooling system according to one embodiment of the invention.

Detailed Description of Embodiments of the Invention

In the following description, numerous specific details are set forth in order to provide a thorough understanding of various illustrative embodiments of the
20 invention. It will be understood, however, to one skilled in the art, that embodiments of the invention may be practiced without some or all of these

specific details. It is understood that the terminology used herein is for the purpose of describing particular embodiments only and is not intended to limit the scope of the invention.

Embodiments described in the context of one of the systems or methods
5 are analogously valid for the other systems or methods. Similarly, embodiments described in the context of a method are analogously valid for a system, and vice versa.

Features that are described in the context of an embodiment may correspondingly be applicable to the same or similar features in the other
10 embodiments. Features that are described in the context of an embodiment may correspondingly be applicable to the other embodiments, even if not explicitly described in these other embodiments. Furthermore, additions and/or combinations and/or alternatives as described for a feature in the context of an embodiment may correspondingly be applicable to the same or similar feature in
15 the other embodiments.

As used herein, the articles “a”, “an” and “the” as used with regard to a feature or element include a reference to one or more of the features or elements.

As used herein, the term “configured to” is interchangeable with “operative to” or “adapted to”.

20 As used herein, the term “coupled to” refers to connecting to an element with or without a coupling means.

Embodiments of the invention provide a seawater cooling system suitable for cooling an underground enclosed space. The seawater cooling system comprises a seawater pipeline having a seawater intake portion, a cooling portion and a seawater discharging portion.

5 To form a cooling circulation system, the seawater intake portion has an inlet which is disposed at a predetermined depth below a sea level, e.g. 200 meters below the sea level, and a part of the seawater intake portion and a part of the cooling portion forms a substantial inverted U-shape structure to allow seawater at the predetermined depth to enter into the cooling portion.

10 The cooling portion between the seawater intake portion and the seawater discharging portion is disposed in the underground enclosed space to lower temperature in the underground enclosed space by the seawater from the seawater intake portion.

 The cooling portion and the seawater discharging portion forms a
15 substantial U-shape structure and the seawater discharging portion has an outlet which is disposed on or close to a sea surface so that the seawater in the seawater pipeline to be brought close to the sea surface.

 It is well known that the seawater temperature decreases with depth. For example, in Singapore, the sea surface water temperature is 28°C in January to
20 30°C in May and June, while the sea subsurface water temperature may drop to less than 10°C or even lower. Therefore, with the seawater cooling system proposed by embodiments of the invention, the low-temperature seawater/cold

seawater, at a certain depth below the sea level can be used to efficiently cool an underground enclosed space, e.g. an underground data center. In one embodiment, the inlet of the seawater intake portion may be disposed at about 200 meters below the sea level where the temperature of the seawater may be less than 10°C. It should be noted that the seawater intake depth, i.e. the predetermined depth below the sea level, may be adjusted depending on the seawater thermal profile with depth.

In some embodiments, to avoid any ocean pollution or any impact on ocean ecosystem due to the difference in temperature between the ward seawater, i.e. the seawater discharged from the seawater discharging portion, and in-situ seawater at the outlet of the seawater discharging portion, the temperature of the seawater discharged from the seawater cooling system may be controlled to be substantially equal to the in-situ seawater at the outlet.

In some embodiments, a part of the seawater intake portion may be disposed in an access shaft connected to the underground enclosed space; and a part of the seawater discharging portion may be disposed in the access shaft and the outlet of the seawater discharging portion is disposed out of the access shaft. A ventilation system for ventilating the underground enclosed space may be also installed in the access shaft. In one example, the access shaft may be connected to an openable door of the enclosed space to allow users to enter and exit from the underground enclosed space.

In some embodiments, the seawater cooling system further comprises a pump station installed in the access shaft connected to the underground enclosed space and configured to pump seawater in the seawater pipeline to allow the seawater to be discharged back into the sea.

5 During the circulation of the seawater in the seawater cooling system, the Gravitational Potential Energy may be partially lost due to the friction within the pipelines of the cooling system. Therefore, the pump station may be provided to offset the loss of Gravitational Potential Energy so that the seawater from the cooling portion can be discharged when needed. It should be noted that typically,
10 more than one access shaft is provided for an underground enclosed space to satisfy safety requirements. The parts or components of the seawater cooling system may be disposed in any of the access shaft.

In some embodiments of the invention, the underground enclosed space may be provided in a rock cavern below the sea level/surface. As the rock quality
15 housing a rock cavern at a depth of 100 meters below a sea level/surface may be stronger than concrete, in one embodiment, the underground enclosed space may be provided in a rock cavern at a position about 100m meters below the sea surface. Alternatively, in some embodiments of the invention, the underground enclosed space may be constructed at a location by the sea. It should be noted
20 that in some embodiments of the invention, the depth of rock cavern may be adjusted according to the actual geological rock condition and needs and/or parameters of the required underground enclosed space, e.g. the size and internal structure of the underground enclosed space.

In some embodiments, the cooling portion arranged in the underground enclosed space may include a substantial U-shape structure. It should be noted that in other embodiments of the invention, the structure, shape and arrangement of the cooling portion may be adjusted according to the actual needs and/or parameters of the underground enclosed space, e.g. the size and internal structure of the underground enclosed space, etc.

In some embodiments of the invention, the seawater intake portion may be formed integral with the cooling portion or the seawater intake portion may be coupled to the cooling portion with or without a coupling means.

10 In some embodiments of the invention, the cooling portion may be formed integral with the seawater discharging portion or the cooling portion may be coupled to the seawater discharging portion with or without a coupling means.

In one example, the seawater pipeline of the seawater cooling system may be formed by an integral pipeline. In another example, the seawater pipeline of the seawater cooling system may include more than one separate portions coupled to each other with or without a coupling means. For example, the seawater intake portion may be coupled to the cooling portion with or without a coupling means, and/or the cooling portion may be coupled to the warm seawater discharging portion with or without a coupling means. In one example, the coupling means for coupling the different portion of the cooling system may include a coupling seawater pipeline.

In one embodiment of the invention, the top end of the inverted substantial U-shape pipe formed by the part of the seawater intake portion and the part of cooling portion may be disposed close to the sea surface.

In some embodiments of the invention, the underground enclosed space
5 may include a data centre and/or a cold storage space. The underground cooling system may be used to lower temperature in the data center and/or a cold storage built in the enclosed space.

Embodiments of the invention also provide an underground storage system with a seawater cooling system as described above. The underground storage
10 system may be used to build an underground data center and/or a cold storage space.

The underground storage system includes an underground enclosed space; an access shaft connected to the underground enclosed space with an aboveground opening to allow access to the underground enclosed space; and a
15 seawater cooling system as described above. It should be noted that to satisfy safety requirements, an underground storage system typically includes at least two access shafts to allow access and ventilation to the underground enclosed space. Although in embodiments of the invention, only one access shaft is described, it is not intended to limit the scope of the invention. The components or
20 portions of the seawater cooling system proposed in embodiments of the invention may be disposed in any one of the access shafts built for the underground enclosed space.

In some embodiments of the invention, the underground enclosed space may be provided in a rock cavern below a sea level. In one embodiment, the underground enclosed space may be provided in a rock cavern at about 100 meters below the sea level as the rock quality of the rock cavern at this position
5 may be stronger than concrete.

Figure 1 is a schematic diagram showing the structure of a seawater cooling system 10 for an underground enclosed space according to one embodiment of the invention. In this embodiment, the seawater cooling system 10 includes a seawater pipeline having a seawater intake portion 101, a cooling portion 102 and
10 a seawater discharging portion 103.

As shown in Figure 1, the seawater intake portion 101 has an inlet 101a which is disposed at a first position A with a predetermined depth below the sea level, e.g. a depth about 200 meters below the sea level. The temperature of the seawater at the first position A is low enough to cool the underground enclosed
15 space 100. The cooling portion 102 between the seawater intake portion 101 and the seawater discharging portion 103 is disposed in the underground enclosed space 100, and a part of the seawater intake portion 101 and a part of the cooling portion 102 forms an substantial inverted U-shape structure. This substantial inverted U-shape structure is provided to allow the low temperature seawater at
20 the first position A to enter into the cooling portion 102 in the enclosed space 100 to lower temperature in the enclosed space 100.

The cooling portion 102 and the seawater discharging portion 103 forms a substantial U-shape structure and the seawater discharging portion 103 has an outlet 103a which is disposed at the second position B close to the sea surface so that the seawater in the seawater pipeline to be brought close to the sea surface.

5 The second position B is out of the underground enclosed space 100. In this embodiment, the second position B is below the sea surface. However, it should be noted that in other embodiments of the invention, the second position B may be above the sea surface.

10 In this embodiment, the underground enclosed space 100 is provided in a rock cavern below the sea level. In other embodiments of the invention, the underground enclosed space may be an enclosed space below the ground surface. It is easier and more cost-efficient to construct an underground enclosed space in a rock cavern below the sea level, compared to an enclosed space generated below a ground surface.

15 In this embodiment, the cooling portion 102 includes a substantial U-shape pipe, one end of the substantial U-shape pipe coupled to the seawater intake portion 101, the other end of the substantial U-shape pipe coupled to the seawater discharging portion 103. It should be noted that in other embodiments of the invention, the seawater cooling system 10 may be formed by an integral pipeline
20 including the seawater intake portion 101, the cooling portion 102 and the seawater discharging portion 103.

As shown in Figure 1, the seawater cooling system 10 further includes a pump station 104 installed in an access shaft 105 connected to the underground enclosed space 100. The pump station 104 is configured to pump the seawater in the seawater pipeline of the seawater cooling system 10 to allow the warm
5 seawater from the cooling portion 102 to be discharged when needed.

As shown in Figure 1, the underground enclosed space 100 includes a data center 100a and a cold storage space 100b.

Figure 2 is a schematic diagram showing an alternative structure of the cooling portion 102 in Figure 1. It should be noted that the structure, shape and
10 arrangement of the cooling portion 102 of the seawater pipeline of the seawater cooling system 10 may be adjusted according to actual needs and/or parameters of the underground enclosed space, e.g. the size and internal structure of the enclosed space, ect.

Figure 3 is a schematic diagram showing the structure of an underground
15 storage system 3 with a seawater cooling system 30 according to one embodiment of the invention. As shown in Figure 3, the underground storage system 3 includes an underground enclosed space 300, a seawater cooling system 30, an access shaft 305 connected to the underground enclosed space 300 with an aboveground opening to allow access to the underground enclosed space 300, and a pump
20 station 304 installed in the access shaft 305. It should be noted that the access shaft 305 shown in Figure 3 is for illustration purpose only, not intended to limit the

scope of the invention. The underground storage system 3 may include more than one access shaft in this and other embodiments of the invention.

5 The underground enclosed space 300 is provided in a rock cavern at about 100 meters below the sea level/surface. A data center is hosted in the enclosed space 300.

The access shaft 305 with an aboveground opening is connected to the underground enclosed space 300 to allow entry and exit from the enclosed space 300. A ventilation system for ventilating the enclosed space 300 is also provided in the access shaft 305.

10 The seawater cooling system 30 includes a seawater pipeline having a seawater intake portion 301, a cooling portion 302 and a seawater discharging portion 303.

15 The seawater intake portion 301 has an inlet 301a which is disposed at a first position A' which has a predetermined depth of about 200 meters below the sea level. The temperature of the seawater at the first position A' may be less than 10°C which is low enough to cool the temperature in the enclosed space 300.

20 The cooling portion 302 between the seawater intake portion 301 and the seawater discharging portion 303 is disposed in the underground enclosed space 300. A part of the seawater intake portion 301 is disposed in the access shaft 305 and forms a substantial inverted U-shape structure together with a part of the cooling portion 302 to allow seawater at the first position A' to enter into the cooling

portion 302 so that the temperature of the enclosed space 300 to be lowered by the cold seawater in the cooling portion 302. The top end of the substantial inverted U-shape structure is disposed close to the sea surface.

5 The cooling portion 302 and the seawater discharging portion 303 forms a substantial U-shape structure and the seawater discharging portion 303 has an outlet 303a which is disposed at the second position B' out of the enclosed space 300 and the access shaft 305. The second position B' is close to the sea surface so that the seawater in the seawater pipeline to be brought close to the sea surface. It should be noted that in other embodiments of the invention, the outlet
10 of the seawater discharging portion 303 may be disposed on the sea surface or above the sea surface.

In this embodiment, the seawater intake portion 301 may be connected/coupled to the cooling portion 302 in the underground enclosed space 300 with or without a coupling means. It should be noted that the seawater intake
15 portion 301 may be formed integral with the cooling portion 302 in this or other embodiments of the invention.

In this embodiment, the cooling portion 302 includes a substantial U-shape pipe with one end connected/coupled to the seawater intake portion 301, and the other end connected/coupled to the seawater discharging portion 303. It should
20 be noted that the structure of the cooling portion 302 in this embodiment is only for illustrative purpose without limiting the scope of the invention. In other

embodiments of the invention, the cooling portion 302 may have a different structure.

In this embodiment, a pump station 304 is disposed in the access shaft 305 above the sea surface and configured to pump the seawater in the seawater
5 pipeline to be discharged when needed.

It should be noted that the embodiments shown in Figure 1 to Figure 3 are only for illustrative purpose without limiting the scope of the invention. In other embodiments of the invention, the structure and parameters of the seawater cooling system may be adjusted according to actual needs or other conditions as
10 long as the seawater cooling circulation can be formed to cool the enclosed space by the cold seawater and discharge the generated warm seawater back into the sea. The parameters of the seawater cooling system include but not limited to the position of the inlet of the seawater intake portion, the shape, arrangement and position of the seawater intake portion, the shape, arrangement and structure of
15 the cooling portion in the enclosed space, the position, arrangement and shape of the seawater discharging portion, and the position of the outlet of the seawater discharging portion.

Embodiments of the invention also provide a method for building an energy saving underground storage system with a seawater cooling system as proposed
20 in some embodiment of the invention. The method at least includes: constructing an underground enclosed space for data center; and providing a seawater cooling

system as proposed by embodiments of the invention to lower temperature in the underground enclosed space.

In one embodiment of the invention, the method for building an underground storage system comprises:

5 constructing an underground enclosed space for data center;

 providing an access shaft connected to the underground enclosed space to allow access to the enclosed space; and

 providing a seawater cooling system which comprises seawater pipeline having a seawater intake portion, a cooling portion and a seawater discharging
10 portion, wherein the seawater intake portion has an inlet which is disposed at a predetermined depth below a sea level and a part of the seawater intake portion and a part of the cooling portion forms a substantial inverted U-shape structure to allow seawater at the predetermined depth to enter into the cooling portion;

 the cooling portion is disposed in the underground enclosed space to lower
15 temperature in the underground enclosed space by the seawater from the seawater intake portion; and

 the cooling portion and the seawater discharging portion forms a substantial U-shape structure and the seawater discharging portion has an outlet which is disposed on or close to a sea surface so that the seawater in the seawater pipeline
20 to be brought close to the sea surface.

It should be noted that the underground enclosed space may be also used for cold storage.

As will be appreciated from the above, embodiments of the invention provide a seawater cooling system for an underground enclosed space, an energy saving underground storage system with a seawater cooling system, and the method for building an underground storage system with seawater cooling system. The underground storage system may include a data center and/or a cold storage space. The advantages of the proposed systems and method include but not limited to the following aspects:

(1) Maintenance of the existing heritage building and image

The UG development of data centre and/or cold storage will not interfere the aboveground (AG) uses because all the interfaces between UG and AG are hidden and integrated inside the tower building and ventilation shaft building.

(2) Electricity Saving, Carbon Footprint Reduction and Cost Benefits

The critical challenge of the high consumption of electricity required for computer server operation and system cooling/heat dissipation is overcome by the low-temperature seawater at a predetermined depth below the sea level, e.g. about 200m below the sea level, for much efficient cooling and heat-dissipation generated by a data centre, and thus resulting in carbon footprint reduction. Another energy saving of this invention is to utilise the proposed seawater cooling system in driving low-temperature seawater from a position with a high waterhead/pressure in the sea to a position with a lower waterhead/pressure so that the low-temperature seawater can be used to cool the underground enclosed

space, and further the seawater with higher temperature can be brought close to sea surface. Therefore, the operation cost of a data center and/or cold storage is substantially reduced from the saving of electrical consumption in seawater conveying.

5 **(3) Land Saving and Cost Benefits**

In addition to electricity saving, the underground storage system has inherent advantage of land saving. Underground data centres/cold storage space need smaller surface land. The aboveground structures such as surface access shaft and cooling tower take up a certain surface land, but the main underground
10 components such as server rooms and cooling system can cause land saving up to 70%. Such a substantial land saving can directly make a cost saving in the capital investment.

There are two solutions to optimise the land use for underground storage system, e.g. underground data center.

15 Under the circumstance that the surface land is insufficient for locating an aboveground data centre at a strategic location such as the crowded downtown area, underground option can be freely built beneath the existing surface buildings to overcome the challenge. For example, Google had planned to augment Singapore with a data centre in Hong Kong, but that project was cancelled in 2013
20 due to challenges in securing real estate of land.

In the case that the surface land is sufficient for locating an aboveground data centre, underground option can still be chosen to release 70% land for other use. The surface access shaft and cooling tower can be hidden and

integrated inside the existing buildings without giving any impression of an underground storage system, e.g. a data centre.

Underground data centres can also be cheaper in some aspects of real construction cost, as listed below:

5 No expense to construct a hardened concrete shell;

Offer potential savings on disaster-proofing, especially in the tropical areas where constructing severe-weather-proof building above ground may incur extra cost;

10 Save special reinforcement to prevent collapse due to earthquakes. An underground space, unlike the building above ground, does not move and does not need to be reinforced. An earthquake does not affect the enclosure at all.

(4) Location Freedom

Location advantage of underground data centre includes the ability to build in close proximity to or exactly beneath existing buildings or on otherwise
15 unbuildable sites such as crowded downtown CBD area of Singapore. In contrast, aboveground data centre approval from URA of Singapore may be affected by the status of certain locations within the urban area, which may be translated into a premium being paid for a downtown CBD location.

20 (5) Excellent Physical Security

In modern data centres, the security of data on virtual systems is integrated with existing security of physical infrastructures. The super security of a modern data centre must take into account physical security, network security, data and user security. The underground data centres offer an inherently high physical

security in view of being underground hidden in a large depth and has very limited access only.

(6) Disaster Readiness / National Security

For governmental users, national safety or security concerns may be the driving force for construction of underground data centres.

(7) External Fire Resistance

Underground data centres provide a natural protection against external fires. The ground is incombustible and provides excellent thermal isolation to the structure beneath.

(8) Earthquake Resistance

Underground structures have intrinsic advantages of resisting earthquake motions mainly due to moving compatibly with the ground motion and avoiding the presence of amplified surface waves.

(9) Protection from Noise, Vibration and Explosion

The earth absorbs the noise, ground vibrations and shock energy of an explosion. The underground centres are well protected from the possible terrorist attack.

(10) Climate & Flood Isolation

Isolation advantage relates to the physical characteristics of underground rock cavern space and their surrounding ground environment. The ability to isolate data centre facility within a mass of earth will naturally protect the data center from severe weather such as hurricanes, thunderstorms, and floodwaters.

(11) High Flexibility

Underground rock cavern can easily afford a column-free space at 20m-span and 30m-height with unlimited length. Such a column-free large space provide flexibility of accommodating the IT equipment and server racks.

A high cost may incur for constructing “ultra-strong & hard shell” of higher
5 Tiers of data centres such as Tier 4 due to more stringent criteria on physical security. Underground space in depth intrinsically provides the high physical security level and allows the freedom to choose which DC Tier Level is needed. This gives a huge flexibility with regards to underlying business models and cost calculations, since we can use a lower DC TIER for Low Service Level
10 Agreements and higher DC TIERS for high Service Level Agreements.

It is to be understood that the embodiments and features described above should be considered exemplary and not restrictive. Many other embodiments will be apparent to those skilled in the art from consideration of the specification and practice of the invention. The scope of the invention should, therefore, be
15 determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. Furthermore, certain terminology has been used for the purposes of descriptive clarity, and not to limit the disclosed embodiments of the invention.

Claims

1. A seawater cooling system for an underground enclosed space, the system comprising a seawater pipeline having a seawater intake portion, a cooling portion and a seawater discharging portion,

5 wherein the seawater intake portion has an inlet which is disposed at a predetermined depth below a sea level and a part of the seawater intake portion and a part of the cooling portion forms a substantial inverted U-shape structure to allow seawater at the predetermined depth to enter into the cooling portion;

 the cooling portion is disposed in the underground enclosed space to lower
10 temperature in the underground enclosed space by the seawater from the seawater intake portion; and

 the cooling portion and the seawater discharging portion forms a substantial U-shape structure and the seawater discharging portion has an outlet which is disposed on or close to a sea surface so that the seawater in the seawater pipeline
15 to be brought close to the sea surface.

2. The system according to claim 1, wherein a part of the seawater intake portion is disposed in an access shaft connected to the underground enclosed space; and

 a part of the seawater discharging portion is disposed in the access shaft
20 and the outlet of the seawater discharging portion is disposed out of the access shaft.

3. The system according to claim 2, further comprising a pump station installed in the access shaft connected to the underground enclosed space and configured to pump seawater in the seawater pipeline to allow the seawater to be discharged back into the sea.

5 4. The system according to any preceding claim, wherein the underground enclosed space is provided in a rock cavern below a sea level.

5. The system according to claim 4, wherein the underground enclosed space is provided in the rock cavern at about 100 meters below the sea level.

10 6. The system according to any one of claim 1 to claim 5, wherein the seawater intake portion is formed integral with the cooling portion or the seawater intake portion is coupled to the cooling portion with or without a coupling means.

15 7. The system according to any one of claim 1 to claim 6, wherein the cooling portion is formed integral with the seawater discharging portion or the cooling portion is coupled to the seawater discharging portion with or without a coupling means.

8. The system according to any one of claim 1 to claim 7, wherein the underground enclosed space includes a data centre and/or a cold storage space.

9. The system according to any preceding claim, wherein the predetermined depth is about 200 meters below the sea level.

20 10. An underground storage system, the system comprising:

an underground enclosed space;

an access shaft connected to the underground enclosed space with an aboveground opening to allow access to the underground enclosed space; and

a seawater cooling system comprising a seawater pipeline having a seawater intake portion, a cooling portion and a seawater discharging portion,

wherein the seawater intake portion has an inlet which is disposed at a predetermined depth below a sea level and a part of the seawater intake portion and a part of the cooling portion forms a substantial inverted U-shape structure to allow seawater at the predetermined depth to enter into the cooling portion;

the cooling portion is disposed in the underground enclosed space to lower temperature in the underground enclosed space by the seawater from the seawater intake portion; and

the cooling portion and the seawater discharging portion forms a substantial U-shape structure and the seawater discharging portion has an outlet which is disposed on or close to a sea surface so that the seawater in the seawater pipeline to be brought close to the sea surface.

11. The system according to claim 10, wherein a part of the seawater intake portion is disposed in the access shaft connected to the underground enclosed space; and

a part of the seawater discharging portion is disposed in the access shaft and the outlet of the seawater discharging portion is disposed out of the access shaft.

12. The system according to claim 11, wherein the seawater cooling system
5 further comprises a pump station installed in the access shaft connected to the underground enclosed space and configured to pump seawater in the seawater pipeline to allow the seawater to be discharged back into the sea.

13. The system according to any one of claim 10 to claim 12, wherein the underground enclosed space is provided in a rock cavern below a sea level.

10 14. The system according to claim 13, wherein the underground enclosed space is provided in the rock cavern at about 100 meters below the sea level.

15. The system according to any one of claim 10 to claim 14, wherein the seawater intake portion is formed integral with the cooling portion or the seawater intake portion is coupled to the cooling portion with or without a coupling means.

15 16. The system according to any one of claim 10 to claim 15, wherein the cooling portion is formed integral with the seawater discharging portion or the cooling portion is coupled to the seawater discharging portion with or without a coupling means.

20 17. The system according to any one of claim 11 to claim 16, wherein the underground enclosed space includes a data center and/or a cold storage space.

18. The system according to any one of claim 10 to claim 17, wherein the predetermined depth is about 200 meters below the sea level.

19. A method of building an underground storage system for data center, the method comprising:

5 constructing an underground enclosed space for data center; and

 providing a seawater cooling system according to any one of claim 1 to claim 9 to lower temperature in the underground enclosed space.