US008936074B2

(12) **United States Patent**
Kim et al.

(10) **Patent No.: US 8,936,074 B2**
(45) **Date of Patent: Jan. 20, 2015**

(54) **APPARATUS FOR DISTRIBUTING CARBON DIOXIDE WITH ADVANCED FUNCTION OF ADJUSTING PRESSURE AND TEMPERATURE OF CARBON DIOXIDE FOR GEOLOGIC INJECTION OF CARBON DIOXIDE**

(75) Inventors: **Tae-Hee Kim**, Daejeon (KR); **Ki-Sung Sung**, Incheon (KR); **Jeong-Chan Kim**, Daejeon (KR)

(73) Assignee: **Korea Institute of Geoscience and Mineral Resources (Kigam)**, Daejeon (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 692 days.

(21) Appl. No.: **13/234,327**

(22) Filed: **Sep. 16, 2011**

(65) **Prior Publication Data**

US 2012/0073799 A1 Mar. 29, 2012

(30) **Foreign Application Priority Data**

Sep. 28, 2010 (KR) 10-2010-0093847

(51) **Int. Cl.**
E21B 43/00 (2006.01)
E21B 36/04 (2006.01)
G05D 23/19 (2006.01)
G05D 7/06 (2006.01)

(52) **U.S. Cl.**
CPC ***G05D 23/19*** (2013.01); ***G05D 7/0641*** (2013.01)
USPC **166/90.1**; 166/402; 166/303; 166/57

(58) **Field of Classification Search**
USPC 166/90.1, 402, 303, 57
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,108,636 A * 10/1963 Peterson 166/308.1
2004/0168811 A1* 9/2004 Shaw et al. 166/368
2009/0200011 A1* 8/2009 Decker 166/90.1

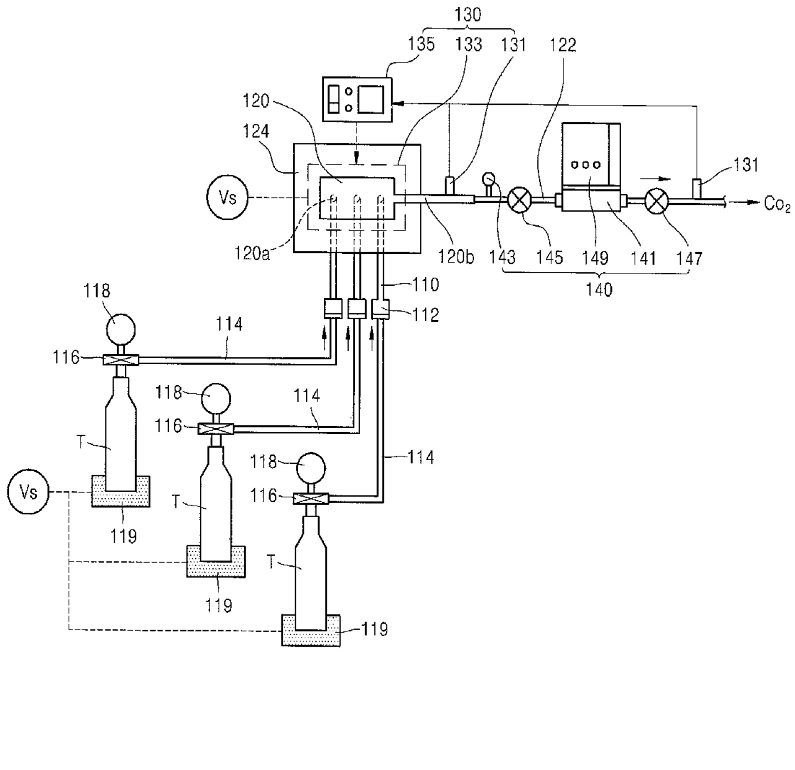
* cited by examiner

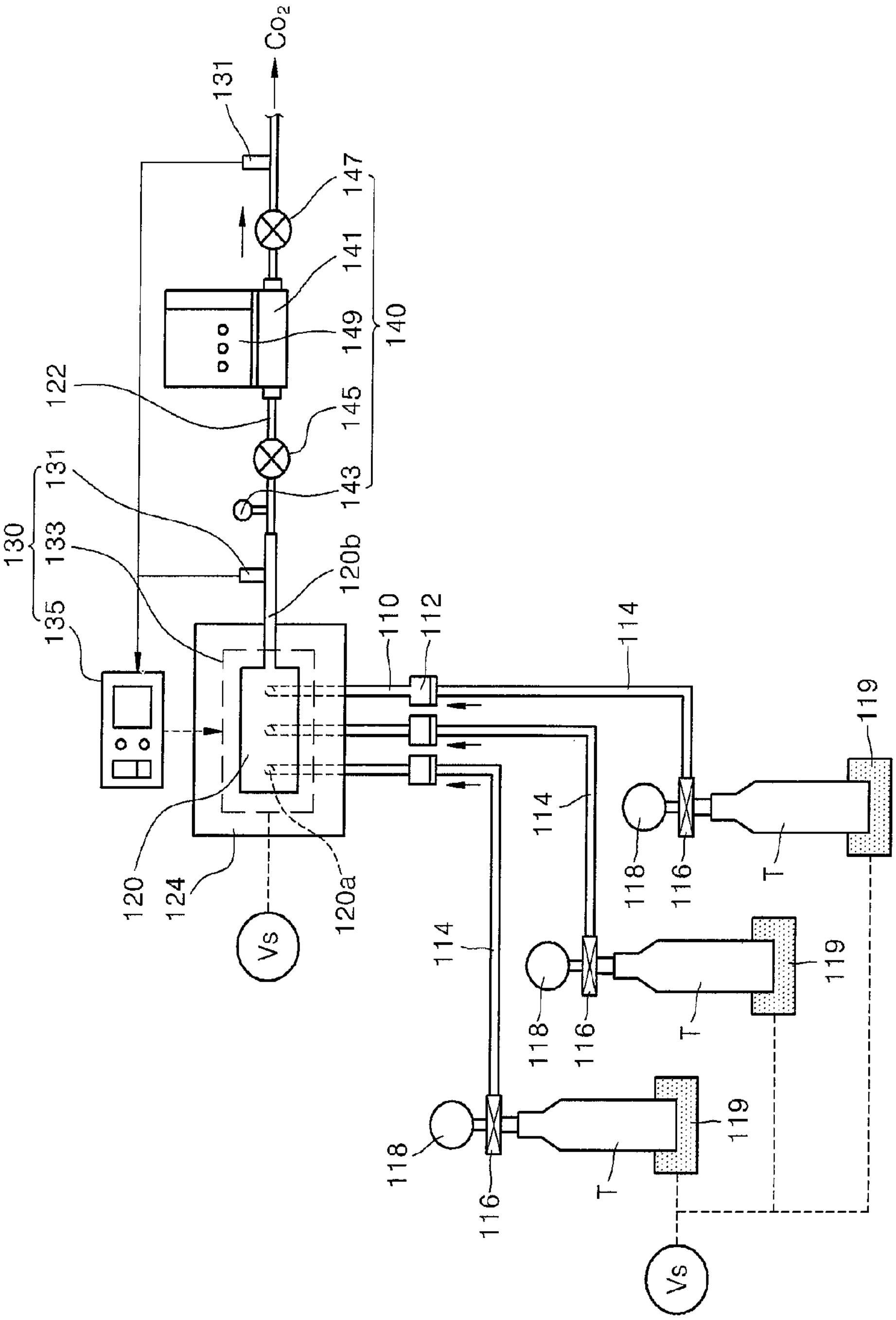
Primary Examiner — Giovanna Wright
(74) *Attorney, Agent, or Firm* — Chapin IP Law, LLC

(57) **ABSTRACT**

An apparatus for distributing CO_2 with an advanced function of adjusting the pressure and temperature of CO_2 for geologic injection includes a manifold including a plurality of branching pipes to receive carbon dioxide for geologic injection from a plurality of storage tanks, a distribution chamber having an inlet communicating with the manifold and an outlet connected to an injection pipe extending to an underground tubular well, so that the carbon dioxide, which has been received through the manifold, is supplied through the injection pipe, a temperature adjusting part to adjust the temperature of the carbon dioxide introduced into the distribution chamber, and a flow rate and hydraulic pressure adjusting part to adjust a flow rate and a hydraulic pressure of the carbon dioxide injected into an underground through the distribution chamber. The temperature and pressure conditions of CO_2 on geologic injection are controlled through a user interface.

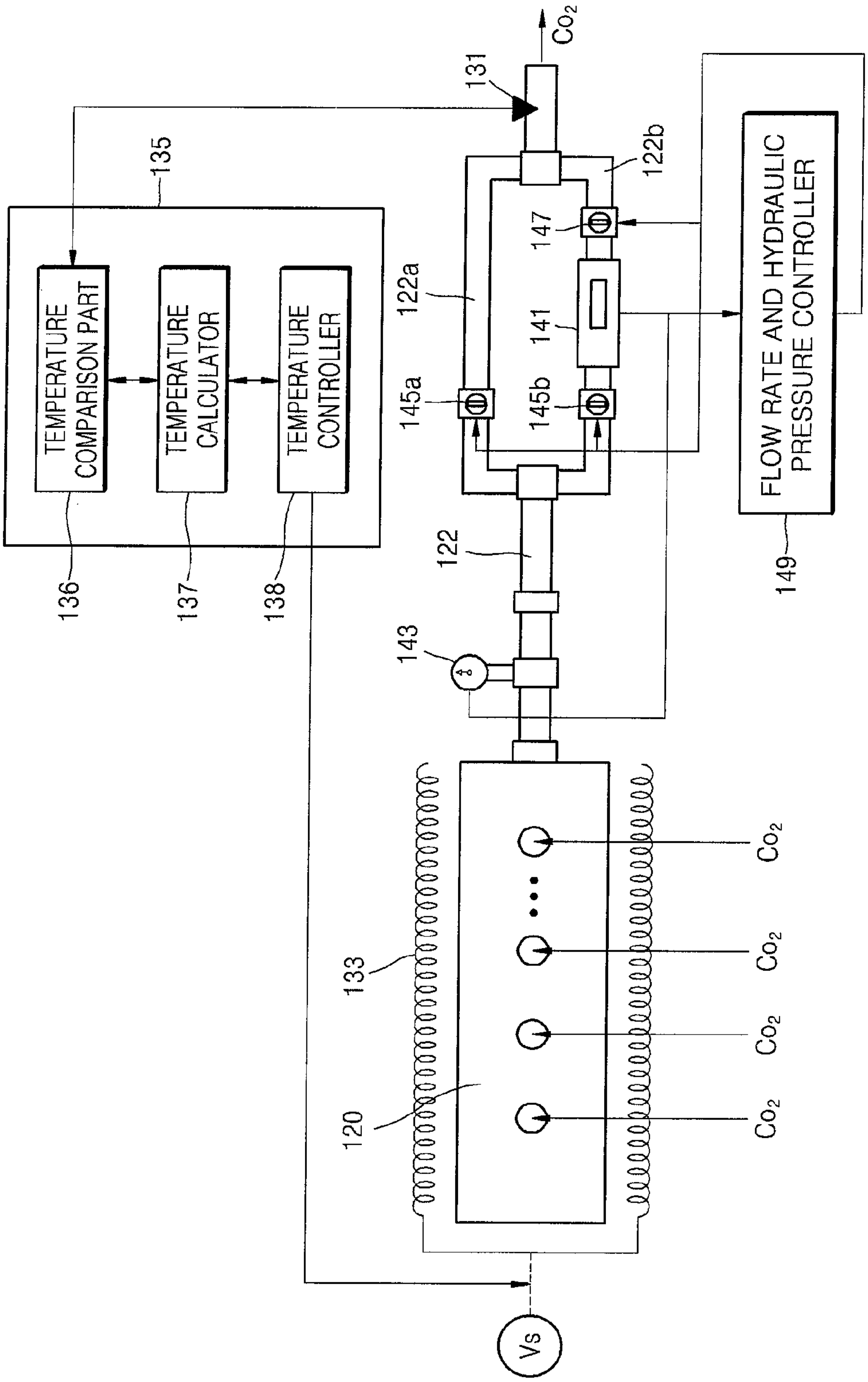
11 Claims, 5 Drawing Sheets





Co2
131
147
141
149
140
122
145
143
130
133
131
135
120b
110
112
114
114
114
119
119
119
118
118
118
116
116
116
T
T
T
120
124
120a
Vs
Vs

Fig. 1



CO_2
131
135
122b
TEMPERATURE COMPARISON PART
TEMPERATURE CALCULATOR
TEMPERATURE CONTROLLER
147
122a
141
145a
145b
FLOW RATE AND HYDRAULIC PRESSURE CONTROLLER
136
137
138
122
149
143
133
120
CO_2
CO_2
CO_2
CO_2
Vs

Fig. 2

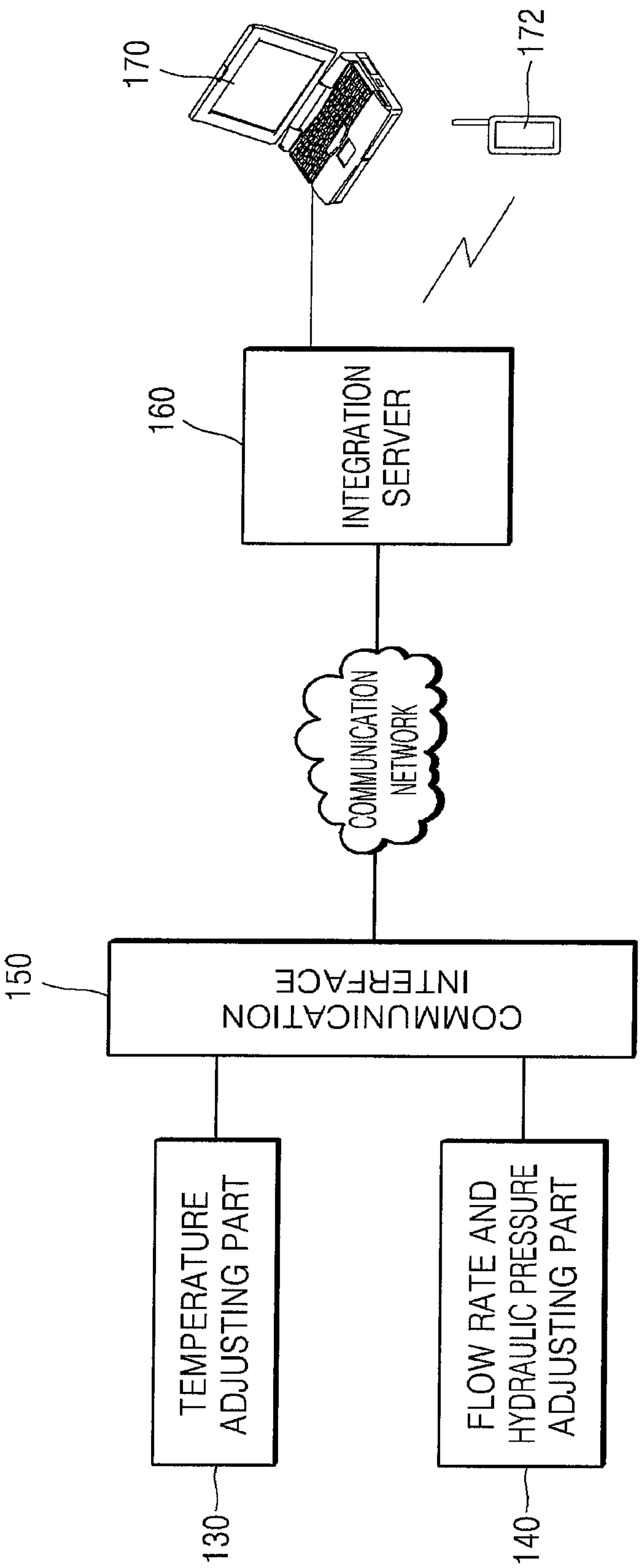

170
172
160
INTEGRATION SERVER
COMMUNICATION NETWORK
150
COMMUNICATION INTERFACE
TEMPERATURE ADJUSTING PART
FLOW RATE AND HYDRAULIC PRESSURE ADJUSTING PART
130
140

Fig. 3

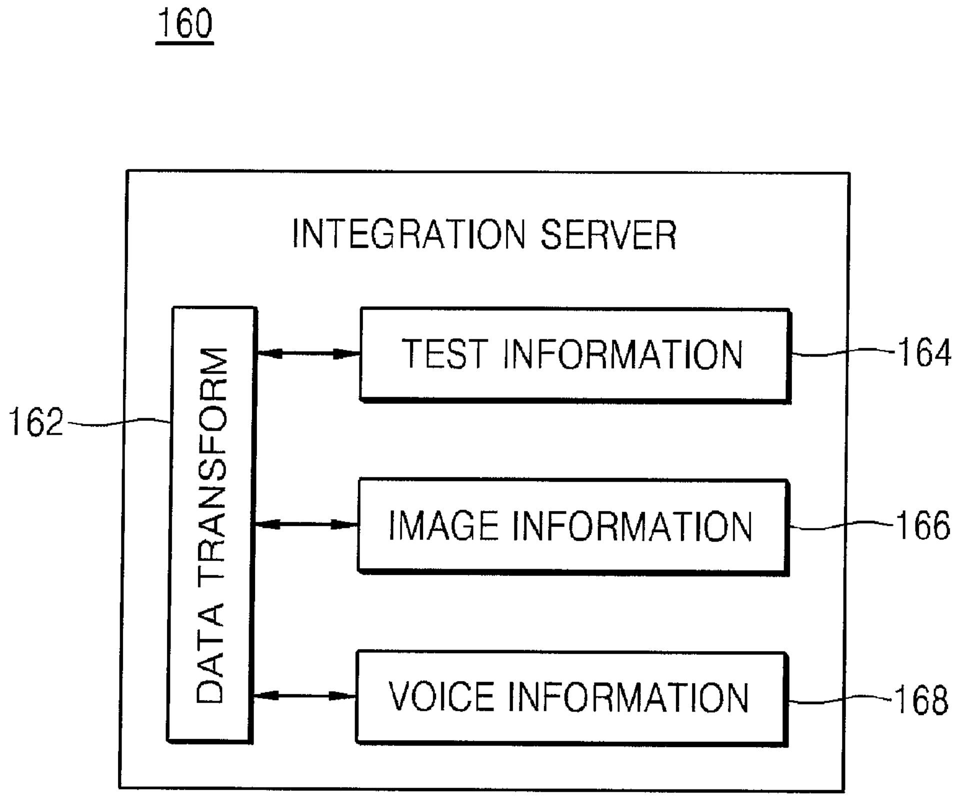

160
INTEGRATION SERVER
DATA TRANSFORM
TEST INFORMATION
IMAGE INFORMATION
VOICE INFORMATION
162
164
166
168

Fig. 4

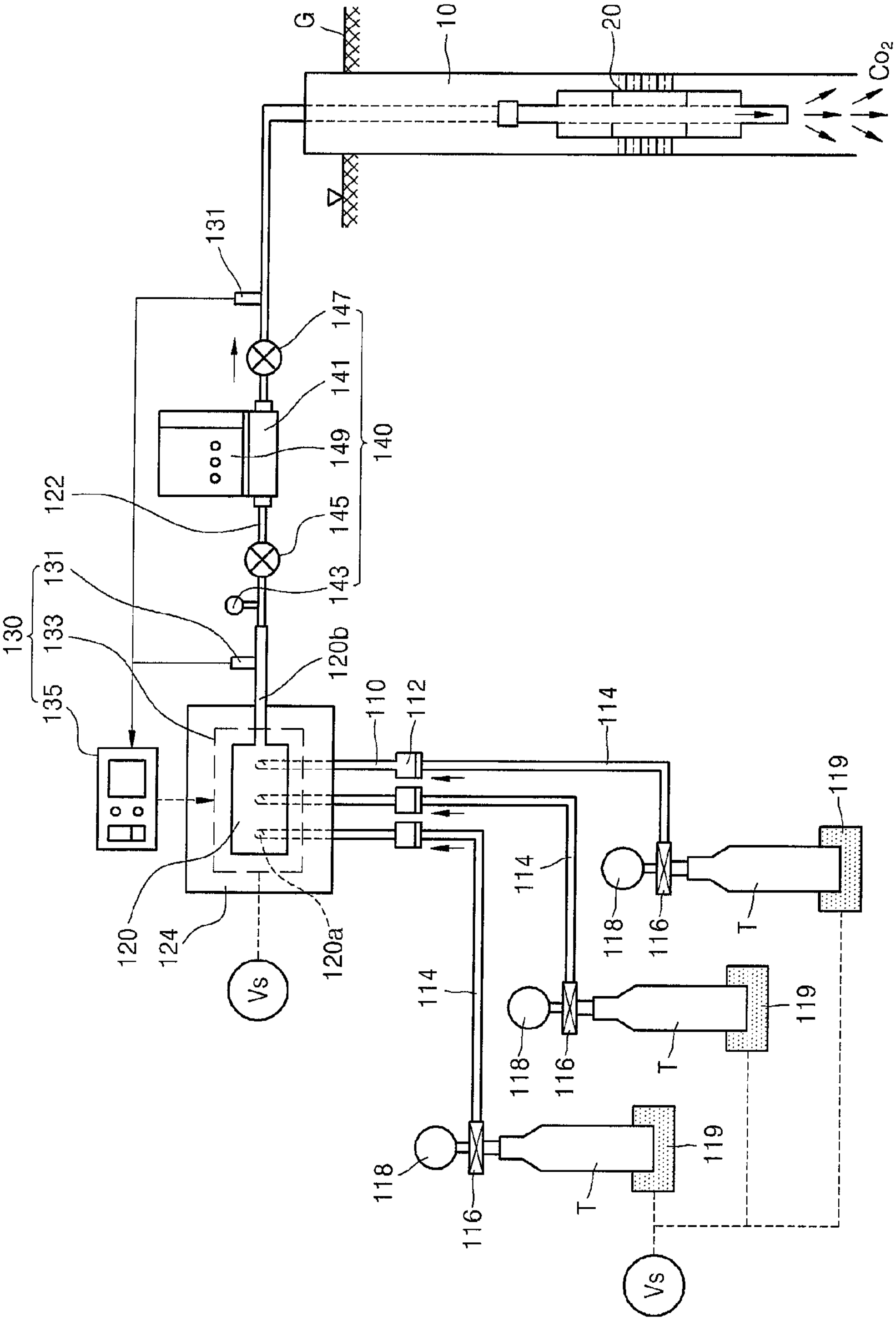

G
10
20
CO_2
131
147
141
149
140
122
145
143
131
133
130
135
120b
110
112
114
120
124
120a
Vs
118
116
T
119

Fig. 5

APPARATUS FOR DISTRIBUTING CARBON DIOXIDE WITH ADVANCED FUNCTION OF ADJUSTING PRESSURE AND TEMPERATURE OF CARBON DIOXIDE FOR GEOLOGIC INJECTION OF CARBON DIOXIDE

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to Korean Patent Application No. 10-2010-0093847 filed on Sep. 28, 2010 in the Korean Intellectual property, the disclosure of which is entirely incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to an apparatus for distributing carbon dioxide with an advanced function of adjusting a pressure and a temperature of the carbon dioxide for geologic injection of the carbon dioxide. More particularly, the present invention relates to an apparatus for distributing carbon dioxide with an advanced function of adjusting a pressure and a temperature of the carbon dioxide for the geologic injection of the carbon dioxide, capable of optimizing the pressure and the temperature of the carbon dioxide while monitoring the pressure and the temperature of the carbon dioxide, so that the stability for the geologic injection of the carbon dioxide can be ensured.

2. Description of the Related Art

Carbon dioxide (CO_2) storage technologies include an ocean storage technology and a mineral carbonation technology in addition to a geologic storage technology.

Among them, the ocean storage technology is to store CO_2 in a gas, liquid, solid, or hydrate state into an ocean or an ocean floor. However, the ocean storage technology is not performed yet due to the worries about the destruction of the ocean ecosystem and the instability for the long-term storage of CO_2.

In addition, the mineral carbonation technology is to store CO_2 in the state of an insoluble carbonate mineral by allowing the CO_2 to be subject to chemical reaction with metallic oxides such as Ca and Mg mainly. According to the mineral carbonation technology, a great amount of reaction energy may be required and environment pollution may be caused when the carbonate mineral is stored and treated. Accordingly, realizing the mineral carbonation technology is difficult currently. Therefore, until now, the geologic storage technology is regarded as the most effective storage technology of CO_2.

The geologic storage technology is to store CO_2 into a proper geologic formation placed at the depth of about 750 m to about 1000 m from the ground (or geologic formation placed on the ocean floor).

Since the CO_2 injected at the depth of about 750 m to about 1000 m exists in a supercritical fluid state, the behavior of the CO_2 is very slow, and the CO_2 reacts with the fluid around the geologic formation or under the ground, so that the CO_2 is fixed or melted. To this regard, the geologic storage technology is called a geologic sequestration technology.

According to the geologic storage technology for CO_2, in order to effectively and stably inject CO_2 by using injection facilities such as a pressure device after stably constructing a long-depth bore hole to a geologic formation for geologic storage having the depth of several Kms, ground facilities for high-pressure injection must be designed and managed, and the gas leakage must be prevented. In particular, when injecting CO_2, the phase change of CO_2 according to the temperature and the pressure corresponds to an important management factor.

Therefore, an apparatus for distributing CO_2 by more effectively adjusting the temperature and the pressure of CO_2 in the geologic injection of CO_2 is required.

SUMMARY OF THE INVENTION

Accordingly, the present invention has been made keeping in mind the above problems occurring in the prior art, and an object of the present invention is to provide an apparatus for distributing carbon dioxide, capable of optimizing a pressure and a temperature of the carbon dioxide in geologic injection of the carbon dioxide.

Another object of the present invention is to provide an apparatus for distributing carbon dioxide with a monitoring device capable of effectively watching and supervising the temperature and the pressure of carbon dioxide injected into the underground through the apparatus for distributing the carbon dioxide.

To accomplish these objects, according to one aspect of the present invention, there is provided an apparatus for distributing carbon dioxide with an advanced function of adjusting a pressure and a temperature of the carbon dioxide for geologic injection. The apparatus includes a manifold part including a plurality of branching pipes to receive carbon dioxide for geologic injection from a plurality of storage tanks, a distribution chamber part having an inlet communicating with the manifold part and an outlet connected to an injection pipe extending to an underground tubular well, so that the carbon dioxide, which has been received through the manifold part, is supplied through the injection pipe, a temperature adjusting part to adjust the temperature of the carbon dioxide introduced into the distribution chamber part, and a flow rate and hydraulic pressure adjusting part to adjust a flow rate and a hydraulic pressure of the carbon dioxide injected into an underground through the distribution chamber part.

Preferably, the temperature adjusting part includes a temperature sensor mounted on the injection pipe to detect the temperature of the carbon oxide to be injected into the underground from the distribution chamber part, and a heating part surrounding an outer circumferential portion of the distribution chamber part to heat the carbon dioxide introduced into the distribution chamber part, so that the temperature of the carbon dioxide is increased.

The temperature adjusting part includes a temperature comparison part to compare the temperature of the carbon dioxide to be injected into the underground, which is detected by the temperature sensor, with a preset reference value, a temperature calculator to calculate a compensation value for the temperature of the carbon dioxide to be increased by the heating part based on the comparison with the reference value, and a temperature controller to control an operation of the heating part so that the temperature of the carbon dioxide in the distribution chamber part is increased by the compensation value.

Preferably, the heating part includes an induction heater.

In addition, preferably, the flow rate and hydraulic pressure adjusting part includes a flow rate detector mounted on the injection pipe to detect the flow rate of the carbon dioxide to be injected into the underground, a hydraulic pressure detector mounted on the injection pipe to detect the hydraulic pressure of the carbon dioxide to be injected into the underground, and a valve part mounted on the injection pipe to adjust the flow rate and the hydraulic pressure of the carbon dioxide to be injected into the underground from the distribution chamber part.

The flow rate and hydraulic pressure adjusting part may further include a flow rate and hydraulic pressure controller to compare the flow rate and the hydraulic pressure of the carbon dioxide, which are detected through the flow rate detector and the hydraulic pressure detector, with preset reference values, respectively, and to control an open/closing operation of the valve part, so that the carbon dioxide to be injected into the underground is supplied at a proper hydraulic pressure and at a proper flow rate.

Preferably, the apparatus further includes a socket provided at one side of the manifold part and having a shape of an expanded tube connected with the storage tanks through pipes.

In addition, the apparatus may further include electric heating devices provided at lower portions of the storage tanks to heat the carbon dioxide stored in the storage tanks, so that the carbon dioxide is maintained at a predetermined temperature.

Preferably, the apparatus further includes stop valves and pressure gauges provided at outlets of the storage tanks. Each stop valve is closed and open to adjust flow of carbon dioxide to be supplied into the distribution chamber part, and each pressure gauge detects a hydraulic pressure of the carbon dioxide to be supplied to the distribution chamber part.

In addition, preferably, the apparatus may further include a communication interface used to transmit operating signals of the temperature adjusting part and the flow rate and hydraulic adjusting part through a wire/wireless communication network in real time, for each time, or upon user's request, and an integration server to transmit data, which are received through the communication interface, to a remote user terminal, to receive a feedback command requested from the user, and to apply the command the temperature adjusting part and the flow rate and hydraulic pressure adjusting part through the communication interface.

The integration server may include a data log part to record data received through the communication interface into an additional record medium.

In this case, data transmitted to a remote user through the integration server are converted into at least one of text information, image information, and voice information, so that the transmitted data are receivable in a user terminal.

As described above, according to the apparatus for distributing CO_2 with an advanced function of adjusting the pressure and the temperature of CO_2 for CO_2 geologic injection, when distributing CO_2, the temperature and the pressure of CO_2 are optimized, so that the phase change of the CO_2 for geologic injection can be stably maintained.

In addition, according to the apparatus for distributing CO_2 with an advanced function of adjusting the pressure and the temperature of CO_2 for CO_2 geologic injection, a user can monitor all information about the temperature of CO_2 and the pressure control of the CO_2 in real time, thereby effectively managing and supervising the geologic injection of CO_2.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a schematic view showing an apparatus for distributing CO_2 with an advanced function of adjusting a pressure and a temperature of CO_2 for geologic injection of CO_2 according to one embodiment of the present invention;

FIG. **2** is a view showing a function of adjusting a temperature, a flow rate, and a hydraulic pressure of CO_2 for geologic injection in the apparatus for distributing the CO_2 with the advanced function of adjusting the pressure and the temperature of the CO_2 for geologic injection of CO_2 according to one embodiment of the present invention;

FIG. **3** is a view showing a remote monitoring device adaptable for the apparatus for distributing CO_2 with an advanced function of adjusting the pressure and the temperature of the CO_2 for the geologic injection of the CO_2 according to one embodiment of the present invention;

FIG. **4** is a block diagram showing a detailed structure of an integration server based on the embodiment of FIG. **3**; and

FIG. **5** is a view showing a case in which the apparatus for distributing CO_2 with an advanced function of adjusting the pressure and the temperature of the CO_2 for the geologic injection of the CO_2 according to one embodiment of the present invention is applied to a bore hole to store the CO_2.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, an apparatus for distributing carbon dioxide with an advanced function of adjusting a pressure and a temperature of the carbon dioxide for the geologic injection of the carbon dioxide according to the exemplary embodiments of the present invention will be described.

The advantages, the features, and schemes of achieving the advantages and features will be apparently comprehended by those skilled in the art based on the embodiments, which are detailed later in detail, together with accompanying drawings.

The present invention is not limited to the following embodiments but includes various applications and modifications. The embodiments will make the disclosure of the present invention complete, and allow those skilled in the art to completely comprehend the scope of the present invention. The present invention is defined only by the scope of the appended claims.

If it is determined that description about well known functions or configurations may make the subject matter of the present invention unclear, the details thereof will be omitted.

FIG. **1** is a schematic view showing an apparatus for distributing carbon dioxide (CO_2) with an advanced function of adjusting a pressure and a temperature of the CO_2 for geologic injection of the CO_2 according to one embodiment of the present invention. FIG. **2** is a view showing a function of adjusting a temperature, a flow rate, and a hydraulic pressure of CO_2 to be subject to the geologic injection according to one embodiment of the present invention. FIG. **3** is a view showing a remote monitoring device adaptable for the apparatus for distributing the CO_2 with an advanced function of adjusting the pressure and the temperature of the CO_2 for the geologic injection of the CO_2 according to one embodiment of the present invention. FIG. **4** is a block diagram showing a detailed structure of an integration server based on the embodiment of FIG. **3**. FIG. **5** is a view showing a case in which the apparatus for distributing the CO_2 with an advanced function of adjusting the pressure and the temperature of the CO_2 for the geologic injection of the CO_2 according to one embodiment of the present invention is applied to a bore hole to store the CO_2.

FIGS. **1** to **5** are schematic views showing only features of the present invention in order to clearly explain the configuration, the operation, and the effects of the present invention. Therefore, the accompanying drawings may be expected to have various modifications, and the present invention is not limited by specific modifications.

Hereinafter, the detailed structure of the apparatus for distributing CO_2 with an advanced function of adjusting the pressure and the temperature of the CO_2 for the geologic injection of the CO_2 according to an exemplary embodiment of the present invention will be described with reference to FIG. **1**.

As shown in FIG. **1**, the apparatus for distributing the CO_2 according to the exemplary embodiment of the present invention includes a manifold part **110** including a plurality of branching pipes to receive CO_2 for geologic injection from a storage tank, a distribution chamber part **120** to supply the CO_2, which has been received through the manifold part **110**, to a underground tubular well through an injection pipe **122** connected to the tubular well, a temperature adjusting part **130** to adjust the temperature of the CO_2 introduced into the distribution chamber part **120**, and a flow rate and hydraulic pressure adjusting part **140** to adjust the flow rate and the hydraulic pressure of CO_2 to be injected into the underground through the distribution chamber part **120**.

Hereinafter, the manifold part **110** will be described.

The manifold part **110** refers to a pipe member to integrally transfer stored CO_2 from a plurality of storage tanks T, which are separately provided, into the distribution chamber part **120**.

To this end, the manifold part **110** is preferably prepared in form of a manifold in which pipes are branched in a plurality of rows so that the pipes are prevented from interfering with each other. Preferably, the number of the pipes arranged in a plurality of rows corresponds to the number of the storage tanks T. Therefore, the present invention is not limited to three pipes.

In other words, the storage tanks T provided at separate places to store CO_2 have outlets connected to pipes **114**, respectively, to effectively transfer the CO_2. The manifold part **110** combines distributed CO_2, which has been transferred through the pipes **114**, in the distribution chamber part **120**.

In addition, preferably, the manifold part **110** further includes a socket **112** prepared as an expanded tube at one side of a connection part between the manifold part **110** and the pipe **114** connected with each storage tank T, so that the manifold part **110** can be conveniently coupled with the pipe **114**.

Hereinafter, the structure of the storage tanks T will be described in detail.

The storage tanks T refers to a container to temporarily store CO_2. Preferably, the storage tanks T include compressive tanks to easily store a greater amount of CO_2 within a predetermined internal volume.

Preferably, an electric heating device **119** is provided below each storage tank T to maintain CO_2 stored in the storage tank T at a desirable temperature. For example, the electric heating device **119** may include an induction heating coil to receive external voltage Vs to provide a heat generation function.

A stop valve **116** and a pressure gauge **118** may be further provided at the outlet of each storage tank T.

The stop valve **116** is open and closed to intermittently adjust the flow of an internal fluid. In detail, the stop valve **116** is open and closed to adjust the flow of CO_2 toward the distribution chamber part **120** from each storage tank T. In addition, the pressure gauge **118** detects the hydraulic pressure of CO_2 to be supplied to the distribution chamber part **120** from each storage tank T.

Although the temperature and pressure of CO_2 to be discharged from each storage tank T are set to 50° C. and 40 bar according to the present invention, the setting temperate and pressure may be selected as a proper value according to the conditions and environment to perform the present invention.

Although the CO_2 stored in the storage tanks T flows through the pipes **114**, which are separately provided, the CO_2 is combined in the distribution chamber part **120** through the manifold part **112**.

The distribution chamber part **120** has an inlet **120**_a_ communicating with an output opening of the manifold part **110** and an outlet **120**_b_ connected to an injection pipe **122** extending toward the underground tubular well, that is, a bore hole. Accordingly, the distribution chamber part **120** supplies CO_2, which has received therein through the manifold part **110**, through the injection pipe **122**.

In detail, the distribution chamber part **120** serves as a CO_2 distributor to combine CO_2 received from the storage tanks T through the manifold part **110** and supply the combined CO_2 to the underground tubular well through the injection pipe **122** provided at an output side of the distribution chamber part **120**.

In order to more stably combine and distribute CO_2, an outer portion of the distribution chamber part **120** includes a casing **124** having the form of a pressure container. A heating part **133** serving as a component of a temperature adjuster **130** to be described later may be provided on an outer peripheral portion of the distribution chamber part **120** in such a manner manner that the heating part **133** can be accommodated in the casing **124**. The heating part **133** heats CO_2 contained in the distribution chamber part **120** to increase the temperature of the CO_2 to a temperature set by a user.

Hereinafter, the temperature adjuster **130** will be described.

The temperature adjuster **130** adjusts the temperature of CO_2 introduced into the distribution chamber part **120** as described in brief.

To this end, the temperature adjuster **130** may include a temperature sensor **131** to detect the temperature of CO_2 for geologic injection, a heating part **133** for heating CO_2 introduced into the distribution chamber part **120** to adjust the increase of the temperature of the CO_2, and a controller **135** (see FIG. **2**) to perform a comparison operation for the temperature of CO_2 detected by the temperature sensor **131**, calculate a compensation value for the temperature of the CO_2 to be increased, and control the operation of the heating part **133**.

The configuration of the controller **135** (see FIG. **2**) will be described in detail later with reference to FIG. **2**, and only the configurations of the temperature sensor **131** and the heating part **133** will be described in detail in the following description.

The temperature sensor **131** is mounted on the injection pipe **122**, which is connected to the outlet **120**_b_ of the distribution chamber part **120** and extends toward the underground tubular well, and is a sensing device to measure a real temperature of CO_2 supplied to the underground tubular well. As examples of the temperature sensor **131**, various types of thermometers may be used.

In addition, the heating part **133** surrounds the outer peripheral portion of the distribution chamber part **120** as described above in brief in the description about the distribution chamber part **120**.

The heating part **133** heats CO_2 introduced into the distribution chamber part **120** within the predetermined temperature range. According to the present embodiment, CO_2 may be maintained at the temperature of about 50° C. Such a temperature condition does not restrict the present invention.

As an example, the heating part **133** may include an inductor heat to increase the temperature of the CO_2 contained in the distribution chamber part **120** by generating resistance heat after receiving external voltage Vs. The present invention is not limited thereto, but may include various forms of heating part according to various embodiments.

The temperature adjuster **130** may be described in more detail with reference to FIG. **2**. Referring to FIG. **2**, the temperature adjuster **130** includes the controller **135**. The controller **135** actively controls the temperature sensor **131** and the heating part **133** such that the CO_2 temperature detection by the temperature sensor **131** can be incorporated with the operation of the heating part **133**.

In other words, the controller **135** which serves as an additional component of the temperature adjuster **130** includes a temperature comparison part **136** to compare the temperature of CO_2 detected in the temperature sensor **131** with a preset reference value, a temperature calculator **137** to calculate a compensation value for the temperature of the CO_2 to be increased by the heating part **133** through the comparison between the reference value and the detected CO_2 temperature, and a temperature controller **138** to control the operation of the heating part **133** so that the temperature of the CO_2 contained in the distribution chamber part **120** is increased by the compensation value.

In this case, the preset reference value refers to a temperature value of CO_2 to be injected into the underground tubular well, which is preset by a user. If the temperature of CO_2 detected in the temperature sensor **131** is lower than the reference value, the temperature of the CO_2 is increased by the compensation value corresponding to the difference between the detected CO_2 temperature and the reference value by controlling the operation of the heating part **133**.

The controller **135** further includes the temperature comparison part **136**, the temperature calculator **137**, and the temperature controller **138**, so that the temperature adjusting function according to the present invention will be more actively controlled.

Hereinafter, the flow rate and hydraulic pressure adjusting part **140** will be described with reference to FIG. **1** again.

The flow rate and hydraulic pressure adjusting part **140** adjusts the flow rate and hydraulic pressure of CO_2 for geologic injection through the distribution chamber part **120**.

As shown in FIG. **1**, the flow rate and hydraulic pressure adjusting part **140** includes a flow rate detector **141** to detect the flow rate of CO_2 for geologic injection through the distribution chamber part **120**, a hydraulic pressure detector **143** to detect the hydraulic pressure of CO_2 for geologic injection through the distribution chamber part **120**, and valve parts **145** and **147** closed and open to adjust the flow rate and the hydraulic pressure of CO_2 for geologic injection through the distribution chamber part **120**.

As shown in FIG. **1**, the flow rate detector **141** and the hydraulic pressure detector **143** are provided on the injection pipe **122** to effectively detect the flow rate and the hydraulic pressure of CO_2 flowing out of the distribution chamber **120**. The arrangement of the flow rate detector **141** and the hydraulic pressure detector **143** is only one exemplary embodiment, but the present invention is not limited thereto. Therefore, according to other embodiments, the flow rate detector **141** and the hydraulic pressure detector **143** may have various arrangement forms according to positions, environments, and various conditions for the present invention.

The flow rate detector **141** refers to a typical flow meter. Accordingly, the flow rate detector **141** may include variously-released common flow meters. In addition, the hydraulic pressure detector **143** refers to a typical hydraulic gauge. Therefore, the hydraulic pressure detector **143** may include also variously-released common hydraulic gauges. Accordingly, the details thereof will be omitted.

In addition, the present invention may include various arrangement forms of the valve parts **145** and **147**. In other words, the valve parts **145** and **147** shown in FIG. **1** are separately arranged about the flow rate detector **141**. Differently, the valve parts **145***a*, **145***b*, and **147** shown in FIG. **2** are installed on dual pipes branching from a portion of the injection pipe **122** according to an arrangement form different from the arrangement form of FIG. **1**.

The flow rate and hydraulic pressure adjusting part **140** may further include a flow rate and hydraulic pressure controller **149** except for the flow rate detector **141**, the hydraulic pressure detector **143**, and the valve parts **145** and **147**.

The function and the role of the flow rate and hydraulic pressure controller **149** can be recognized in detail through FIG. **2**.

In other words, the flow rate and hydraulic pressure controller **149** compares data about the flow rate and the hydraulic pressure of CO_2 detected through the flow rate detector **141** and the hydraulic pressure detector **143** with the preset reference values and controls the closing and opening of the valve parts **145***a*, **145***b*, and **147** so that CO_2 to be injected into the underground is supplied at the proper flow rate and the proper hydraulic pressure. Although the pressure of CO_2 to be injected into the underground is preset to about 40 bar, the pressure may be preset to a different value by a user.

The flow rate and hydraulic pressure controller **149** actively controls the flow rate detector **141** and the hydraulic pressure detector **143**, and the valve parts **145***a*, **145***b*, and **147** closing and opening in cooperation with the flow rate detector **141** and the hydraulic pressure detector **143**, so that CO_2 can be distributed more quickly and exactly.

Hereinafter, a remote monitoring device adaptable for the apparatus for distributing CO_2 with an advanced function of the pressure and temperature of the CO_2 for the geologic injection of the CO_2 according to the preferred embodiment of the present invention will be described with reference to FIGS. **3** and **4**.

Referring to FIG. **3**, the remote monitoring device is additionally applied to the apparatus for distributing CO_2 with an advanced function of the pressure and temperature of the CO_2 for the geologic injection of the CO_2 according to the preferred embodiment of the present invention.

In other words, as shown in FIG. **3**, the temperature data, the flow rate data, and the hydraulic pressure data of $C0_2$ detected by the temperature adjusting part **130** and the flow rate and hydraulic pressure adjusting part **140**, and all signals for the operations of the heating part **133** and the valve parts **145** and **147** according to the data can be transmitted to the integration server **160** through a communication interface **150** over a wire/wireless communication network.

The integration server **160** transmits data, which has been received therein through the communication interface **150**, to a remote user terminal such as a user PC **170** or a user smart phone **172**, and applies a command, which has been received from the user through feedback, to the temperature adjusting part **130** and the flow rate and hydraulic pressure part **140** through the communication interface.

In addition, the integration server **160** may further include a data log part (not shown) to record the data received through the communication interface **150** in an additional recording medium.

Data transmitted to a remote user through the integration server **160** are converted into at least one of text information, image information, and voice information, so that the data can have the form receivable in the user terminal (such as the user

PC **170** or the smart phone **172**). Accordingly, remote monitoring and supervising in the process of distributing CO_2 can be conveniently performed, and these functions help systematic integral management of the CO_2 distribution process.

FIG. **5** is a view showing a case in which the apparatus for distributing CO_2 with an advanced function of the pressure and temperature of the CO_2 for the geologic injection of the CO_2 is applied to a bore hole to store the CO_2.

Referring to FIG. **5**, through the apparatus for distributing CO_2 according to the present invention, CO_2 stored in the storage tanks T is integrally combined with each other through the manifold part **110** and the distribution chamber part **120**. Thereafter, the CO_2 is injected into the tubular well under the ground G in a state that the CO_2 is maintained at a proper temperature and at a proper pressure according to the functions of a temperature adjusting part **130** and the flow rate and hydraulic pressure adjusting part **140**. In this case, the position of the injection pipe **122** may be fixed by a packer **20** fixed onto the bore hole **10**, so that the CO_2 can be more stably injected into the underground.

As described above according to the apparatus for distributing CO_2 with an advanced function of adjusting the pressure and temperature of the CO_2 for geologic injection, as the temperature and the pressure of CO_2 are optimized in the distribution of CO_2, the CO_2 for geologic injection are optimized, the CO_2 for the geologic injection can be maintained in a stable phase change. In addition, a remote supervisor can monitor all information, which is obtained in the process of the geologic injection of CO_2, in real time, so that the management and supervising of CO_2 can be more effectively performed.

As described above, the exemplary embodiment of the apparatus for distributing CO_2 with an advanced function of the pressure and temperature of the CO_2 for the geologic injection of the CO_2 has been described.

Although a preferred embodiment of the present invention has been described for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

What is claimed is:

1. An apparatus for distributing carbon dioxide with an advanced function of adjusting a pressure and a temperature of the carbon dioxide for geologic injection, the apparatus comprising:

a manifold part including a plurality of branching pipes to receive carbon dioxide for geologic injection from a plurality of storage tanks;

a distribution chamber part having an inlet communicating with the manifold part and an outlet connected to an injection pipe extending to an underground tubular well, so that the carbon dioxide, which has been received through the manifold part, is supplied through the injection pipe;

a temperature adjusting part to adjust the temperature of the carbon dioxide introduced into the distribution chamber part; and

a flow rate and hydraulic pressure adjusting part to adjust a flow rate and a hydraulic pressure of the carbon dioxide injected into an underground through the distribution chamber part

wherein the temperature adjusting part includes a temperature sensor mounted on the injection pipe to detect the temperature of the carbon oxide to be injected into the underground from the distribution chamber part; and

a heating part surrounding an outer circumferential portion of the distribution chamber part to heat the carbon dioxide introduced into the distribution chamber part, so that the temperature of the carbon dioxide is increased.

2. The apparatus of claim **1**, wherein the temperature adjusting part includes:

a temperature comparison part to compare the temperature of the carbon dioxide to be injected into the underground, which is detected by the temperature sensor, with a preset reference value;

a temperature calculator to calculate a compensation value for the temperature of the carbon dioxide to be increased by the heating part based on the comparison with the reference value; and

a temperature controller to control an operation of the heating part so that the temperature of the carbon dioxide in the distribution chamber part is increased by the compensation value.

3. The apparatus of claim **1**, wherein the heating part includes an induction heater.

4. The apparatus of claim **1**, wherein the flow rate and hydraulic pressure adjusting part includes:

a flow rate detector mounted on the injection pipe to detect the flow rate of the carbon dioxide to be injected into the underground;

a hydraulic pressure detector mounted on the injection pipe to detect the hydraulic pressure of the carbon dioxide to be injected into the underground; and

a valve part mounted on the injection pipe to adjust the flow rate and the hydraulic pressure of the carbon dioxide to be injected into the underground from the distribution chamber part.

5. The apparatus of claim **4**, wherein the flow rate and hydraulic pressure adjusting part further includes a flow rate and hydraulic pressure controller to compare the flow rate and the hydraulic pressure of the carbon dioxide, which are detected through the flow rate detector and the hydraulic pressure detector, with preset reference values, respectively, and to control an open/closing operation of the valve part, so that the carbon dioxide to be injected into the underground is supplied at a proper hydraulic pressure and at a proper flow rate.

6. The apparatus of claim **1**, further comprising a socket provided at one side of the manifold part and having a shape of an expanded tube connected with the storage tanks through pipes.

7. The apparatus of claim **1**, further comprising electric heating devices provided at lower portions of the storage tanks to heat the carbon dioxide stored in the storage tanks, so that the carbon dioxide is maintained at a predetermined temperature.

8. The apparatus of claim **1**, further comprising stop valves and pressure gauges provided at outlets of the storage tanks, wherein each stop valve is closed and open to adjust flow of carbon dioxide to be supplied into the distribution chamber part, and each pressure gauge detects a hydraulic pressure of the carbon dioxide to be supplied to the distribution chamber part.

9. The apparatus of claim **1**, further comprising a communication interface used to transmit operating signals of the temperature adjusting part and the flow rate and hydraulic adjusting part through a wire/wireless communication network in real time, for each time, or upon user's request; and

an integration server to transmit data, which are received through the communication interface, to a remote user terminal, to receive a feedback command requested from the user, and to apply the command the temperature adjusting part and the flow rate and hydraulic pressure adjusting part through the communication interface.

10. The apparatus of claim **9**, wherein the integration server includes a data log part to record data received through the communication interface into an additional record medium.

11. The apparatus of claim **9**, wherein data transmitted to a remote user through the integration server are converted into at least one of text information, image information, and voice information, so that the transmitted data are receivable in a user terminal.

* * * * *