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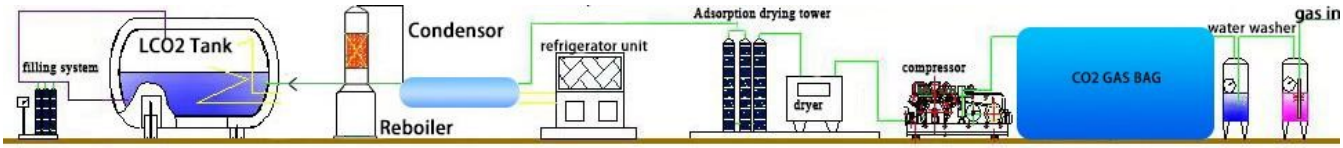
EN Technical solution

Carbon dioxide capture devices

(From Bioethanol fermentation gas)

1000KG/H

1000kg/h automatic control CO2 recovery device system



CO2 liquefaction and purification system

1. Introduction:

Carbon dioxide is a highly valuable carbon resource with a wide range of applications. It is essential in various industries, including beer bottling, fruit and vegetable preservation, pharmaceuticals and healthcare, chemical synthesis, mechanical protection and welding, metal casting and processing, agricultural fertilization, oil extraction, and firefighting. The sources of carbon dioxide are diverse: grain fermentation for alcohol production, hydrogen production and ethylene glycol manufacturing in organic chemical plants, shift gas and ammonia production in inorganic chemical plants, decomposition of calcium and magnesium ores, boron ore carbonization, associated gas from oil fields, and flue gases from coal or heavy oil combustion all contain significant amounts of carbon dioxide. If large amounts of CO2 are released into the atmosphere, it not only causes severe air pollution and the formation of a terrifying greenhouse effect but also wastes this precious carbon resource.

Alcohol plants mainly produce edible alcohol with starchy raw materials. CO2 is the most important by-product produced in the fermentation process of alcohol production, and has high utilization value. It is known that the production process of alcohol fermentation is to obtain alcohol from starch of cereals (wheat, corn) through saccharification and fermentation, and at the same time produce a large amount of CO2.

2. Introduction of carbon dioxide recovery device

Our company specializes in the supply of gas purification and separation equipment. By absorbing advanced technologies from foreign companies, we continuously innovate and develop a high-purity CO2 recovery system. This system comprises several units: water washing tower 1,

potassium washing tower, water washing tower 2, air bag, compression, cold dryer (cooling), adsorption, cold dryer (cooling), drying, refrigeration, purification, storage tank, and filling. It is designed to recover carbon dioxide generated during alcohol fermentation and purify it for use.

Process summary:

2-1. The fermentation gas, rich in CO2, from the alcohol plant's fermentation tank serves as the gas source for this system. The gas first enters a water washing tower equipped with a circulation system to recover alcohol and wash away water-soluble impurities. It then moves into a potassium washing tower, where potassium permanganate's strong oxidizing properties effectively oxidize organic impurities in the CO2 gas. Finally, it returns to the water washing tower to remove any remaining oxidants and soluble impurities. Our company's water washing tower uses advanced filling and special nozzles, ensuring excellent cleaning performance.

2-2. The airbag acts as a buffer for the gas processing equipment. The washed gas enters the compression system, which is equipped with a dedicated CO2 compressor unit. In this system, the gas is pressurized to 1.5-1.8Mpa. The refrigerated dryer serves as the cooling and dehumidification device of the apparatus, ensuring the gas outlet temperature is maintained between 2~4℃. Installing a cold dryer not only cools the gas but also enhances the dryer's efficiency.

2-3. The gas after cold drying will enter the activated carbon adsorber to further remove organic impurities and odor. After being cooled and dried by the cold dryer, it will enter the dryer for deep drying. The atmospheric pressure dew point temperature of the treated gas can reach below-60℃, and the adsorption and dryer are automatically controlled by PLC.

2-4. The CO2 liquefaction system of this device consists of an CO2 evaporative condenser and a condensing unit. After deep drying, CO2 gas is liquefied at a low temperature (-18℃) in the CO2 evaporative condenser. During the liquefaction and impurity removal process, N2.O2 and other gaseous impurities are removed as non-condensable gases, thereby enhancing the purity of the CO2. The liquefied CO2 liquid is stored in a double-layer vacuum vertical tank, which provides excellent insulation without taking up much space. The storage tank system

includes automatic venting, safety venting, and level display subsystems, ensuring high reliability. The stored CO2 liquid can be transported by pump to tank trucks or filled into C02 cylinders for sale on-site.

The control system of this device contains display instruments for detection parameters and main operating parameters, and the compressor unit and refrigeration unit are equipped with independent control and fault stop system. The system can automatically run or automatically stop and protect in case of failure.

3. Technical performance and parameters of carbon dioxide recovery device

3-1. Ambient temperature (maximum): 32℃

3-2. Processing raw gas volume: 600 Nm3/h;

3-3. Intake pressure: 0.1-0.5Kpa

3-4. Raw material CO2 content: more than 97%;

3-5. Recovery rate: 75%;

3-6. Product purity: CO2 food grade liquid with purity of 99.99% or more; in line with the latest national standard GB10621-2006

3-7. Vertical double-layer vacuum storage tank: 150m^3

3-8. Hourly output: 1000kg/h;

3-9. Power supply: 380V 50-60HZ total power: about 260 kW;

3-10. Water consumption: 8m3/h;

4. Configuration scheme of carbon dioxide recovery device

4-1. Primary purification system: water washing tower 1#, potassium washing tower, water washing tower 2#, circulating water pump, air bag, water seal, pipeline valve and instrument

4-1-1. Washing tower 1#

The raw gas enters from the bottom of the scrubber tower, passes through the filling layer, and exchanges with the washing water to remove alcohol and suspended particles. After washing, the alcohol water in CO2 gas can be recycled or discharged.

Scope of supply ：

Pneumatic disc valve 2 (automatic air intake and exhaust)

Washing tower 304

Dew eliminator, water distributor, 304 filling

View mirror, water level gauge, high water level alarm device

Automatic water inlet valve

Piping, solenoid valve

Automatic drain valve

Related valves pressure gauge

4-1-2. Potassium washing tower

The strong oxidant (KMNO4) in potassium washing tower can oxidize and remove organic impurities in fermentation.

Potassium washing tower Material: 304

Stainless steel potassium addition tank 304

Pump meter 400L/h

Potassium circulation pump Southern 304

Washing dispenser, 304 filling

Level glass

High and low level meters

Automatic fluid replenishment valve

Automatic blowdown valve

After passing through the No.1 washing tower and potassium washing tower, the raw gas enters from the bottom of the No.2 washing tower, and flows with the washing water through the filling layer to remove the residual oxidant and soluble impurities in the gas. At the bottom of the washing tower, there is an external water seal to protect the airbag from overpressure.

Scope of supply ：

Washing tower 304, demister, water distributor, 304 filling

View mirror, water level gauge, high water level alarm device

Automatic water inlet valve

Water pipes

Gas-liquid separator, filter, solenoid valve

Draw off valve

Related valves pressure gauge

Characteristics of high efficiency scrubber: the tower uses high efficiency filling, water washing efficiency is greatly improved, effectively remove organic impurities —— hydrogen sulfide, dimethyl sulfide, ethanol and other organic matter. Organic impurities removal rate is more than 99%.

4-1-4. airbag

The purpose of the air bag is to provide a buffer between CO2 raw gas and the compressor, prolong the service life of the compressor, so that the compressor does not frequently open and close, and can effectively ensure the continuous production of CO2 compressor.

The material is made of double axially impregnated high strength film imported from Korea, with a long service life and a lower limit alarm structure for the airbag. When the lower limit is reached, the PLC control center will issue instructions to stop the compressor and refrigeration dryer in standby state, so that it will not run idle.

Scope of supply ：

Air sac

A bracket for hanging

CO2 Compressor load control elements and cables

Sensors, weights, signal cables, etc. are used to control the load of CO2 compressor

Interface flange

Water seal, used to protect the airbag from overpressure

Characteristics of the primary purification system: high efficiency washing, high degree of automation, reliable operation of the primary purification system.

4-2. Compressor system: compressor

CO2 Compressor

CO2 The compressor, installed on the frame, is a three-stage oil-free piston compressor. It features independent intermediate and rear coolers, a water separator, and an automatic condensate drainage system. The load control device adjusts the compressor's load based on the airbag's inflation status. The compressor is controlled by a PLC, which operates automatically

according to a preset program, eliminating the need for manual intervention. The system includes automatic fault detection and alarms, as well as interlocked shutdowns to prevent ice blockages and damage to substandard products and equipment.

4-3. Purification system: adsorber, dryer, pipeline valve, instrument PLC control

4-3-1, No.1 cold dryer

The temperature of CO2 gas coming out of the compressor is 25℃ --60℃, which is cooled to 2℃ --6℃ again through the refrigeration dryer (which plays a role in initial cooling), and then discharged into the adsorption tower after removing water in the gas.

4-3-2 Activated carbon adsorber

The double tower type activated carbon adsorber is equipped with activated carbon in each adsorption tower. The double tower structure automatically switches regularly, one tower works while the other tower is regenerated.

The activated carbon in the adsorption tower is used to remove residual alcohol and odors. Each regeneration cycle, which can be adjusted, lasts approximately 24 hours. The regeneration gas is sourced from the non-condensable gases of the CO2 condenser and the vent valve at the top of the storage tank. The regeneration temperature is set to 160℃ (adjustable), and the high-temperature CO2 also serves as a sterilizing agent during the process.

The activated carbon adsorption tower is mounted on the rack.

4-3-3, No.2 cold dryer

The temperature of CO2 gas coming out of the adsorption tower is 25℃ --60℃. After being cooled by the refrigeration dryer (which plays a role in initial cooling), it is cooled to 2℃ --6℃ again. At the same time, the water in the gas is discharged and then it enters the drying tower.

Characteristic：

A. Reduce the burden of the drying tower in the later process by cooling and draining water. With the decrease of gas temperature, the life of the molecular sieve in the drying tower can be improved.

B. It can prolong the dryer regeneration cycle and reduce the gas consumption during regeneration. Without the cold dryer, the gas consumption during regeneration is about 10%,

and with the cold dryer, the gas consumption during regeneration is about 6%

C. Avoid the occurrence of ice blockage in the rear section CO2 condensation and liquid storage system.

D. Fully automated unmanned operation, automatic sewage discharge and drainage.

E. The cold dryer can effectively remove more than 80% of the water.

4-3-4. Dryer

The double-tower drying adsorber contains desiccant to remove moisture from CO2 (using a Sino-foreign joint venture brand molecular sieve or imported active alumina). Thanks to the pre-dehumidification, the moisture content entering the dryer is significantly reduced. The gas entering the drying tower undergoes deep drying, resulting in a pressure dew point of-60℃.

The dryer uses the air released from the CO2 condenser for automatic regeneration. Each run and regeneration cycle lasts 24 hours, and the regeneration gas is heated non-condensable gas.

The twin tower dryer is mounted on the frame.

Advantages:

(1) Because the friction between CO2 gas and filling is easy to produce dust particles, a dust filter is added at the outlet of the adsorption tower and drying tower to filter out dust particles. The filter core in the filter should be replaced regularly.

(2) Advantages of built-in heating

A. The adsorption tower does not need to use steam regeneration, reducing the chance of contact with oxygen.

B, easy and simple maintenance.

C. The temperature of the heated gas source is stable.

D. There is no blind area during regeneration, and the temperature is uniform from top to bottom.

E. Sterilization of the tower is carried out at high temperature at the same time.

4-4, condensing liquefaction system: refrigeration machine, CO2 evaporative condenser, purification, pipeline, valve, instrument

4-4-1 Refrigeration unit, 1 set

Refrigerator cooling mode: water cooling

Type of refrigeration compressor: screw compressor (2 units in parallel)

The refrigeration unit consists of a rack-mounted refrigeration system for liquefying gas CO2

The refrigerant is R22 or R404A

4-4-2 CO2 Condenser

The horizontal shell and tube heat exchanger is placed at an Angle of 5° to improve the separation of non-condensable gas. A non-condensable gas collection port is set at the top, and the automatic emptying of the gas with low purity can be completed by PLC control. The non-condensable gas can be used as the regeneration gas source for the adsorption drying tower.

A gas phase balance valve is installed between the condenser and the storage tank to maintain the internal pressure balance of the system.

Characteristics of liquefaction system:

1.CO2 The system pressure is 1.5-1.8Mpa, which effectively reduces the solubility of O2 in CO2 liquid, ensuring the purity of CO2 liquid and the yield of CARBON dioxide.

2.CO2 The evaporative condenser is inclined at 5 degrees, and the automatic exhaust device is installed at the installation time. The high point vent is used to effectively discharge O2, N2 and other non-condensable gas.

4-4-3. CO2 Purification system:

The core principle involves adding numerous CO2 gas-liquid interfaces between the liquefier and the storage tank. The CO2 purification system consists of a reboiler and a purification tower. Before liquefaction, some gases pass through the reboiler to vaporize the liquid, producing a higher purity gas. This gas then moves upward through the purification tower, where it comes into contact with the liquid coming out of the liquefier and flowing downward. The liquid forms a film on the filling material (stainless steel) inside the purification tower, allowing the gas to pass through the film and undergo mass transfer. Impurities in the CO2 are transferred from the high-concentration side to the low-concentration side, and this

process is repeated to achieve the goal of liquid purification. The purification system functions as a distillation unit, ensuring high purity of the CO2 liquid entering the storage tank without additional energy consumption. When the CO2 liquid in the reboiler reaches a certain level, it is automatically pumped to the storage tank by a pump, which is controlled by the liquid level. The addition of the pump makes the installation of the storage tank more convenient, allowing it to be placed outdoors, and eliminating the need to place the liquefier above the storage tank, thus reducing on-site installation work.

Purification tower filling: overflow liquid distributor and overall high efficiency stainless steel inlet filling

Characteristics of the liquid storage and purification system: reliable performance, stable quality —— the most advanced CO2 purification device in China. The system pressure is controlled below 1.5~1.8Mpa, and the CO2 liquid purity is more than 99.99%

4-5. CO2 liquid storage tank; pipeline valves and instruments;

Volume of CO2 liquid storage tank: 150m3

Equipped with a level gauge, the level of the tank can be observed very intuitively.

Overpressure automatic venting system, the safety valve adopts double safety valve and three-way valve connection form to ensure the safe operation of equipment.

4-6. Filling unit:

4-6-1. Filling of tank truck: the shielding pump is used to transport to the tank truck for convenient transportation;

4-6-2. Cylinder filling: high pressure metering pump is used to convey the cylinder to the filling head, and 4 filling heads are equipped with a heavy scale for measurement;

4-7. Control system: 1 compressor cabinet and 1 CO2 cabinet

Control section ：

The control box is equipped with Siemens PLC and the output signal terminal of the I/O equipment to the motor control center CO2.

The control panel is equipped with an operation screen, so that the operator can monitor the

operation of CO2 equipment at any time, and it is a Chinese interface.

Operation control status information:

1# and 2# water level high and low limit

High and low limits of potassium washing tower water level

1# and 2# washing tower washing water circulation pump is running and stopping

The flow valve of washing water in the scrubber is open and closed

Airbag level display and setting

Compressor motor overload alarm

Compression oil pressure alarm

Cooling water shortage alarm

High temperature alarm for the first, second and third stages of the compressor

High pressure alarm for the first, second and third stages of the compressor Level

alarm of three-stage water separator

High alarm for third level outlet temperature

Adsorber operating status

Drier operating status

Operation status of refrigeration compressor

Overload alarm of refrigeration compressor

Low suction pressure alarm of refrigeration compressor

Chilled oil compressor oil pressure system alarm

The operation status of the purification device and the shielding pump CO2

Condenser evaporation temperature state

CO2 Pressure display of the recovery system

CO2 High and low pressure alarms for the recovery system Tank

level display

Operation status of tank truck pump Operation

status of cylinder filling pump

5. List of carbon dioxide recovery system

order number	name	specifications and models	quantity	remarks
1	1# washing tower	Φ400×4500	1	Material: 304 filler: 304
2	Potassium washing tower	Φ400×4500	1	Material: 304 filler: 304
3	2# washing tower	Φ400×4500	1	Material: 304 filler: 304
4	Catch water	Φ500×1000	1	Material: 304
5	Air sac	60m³	1	Imported food rubber
6	Compression engine	10m3/min 120KW	1	Jiangya / Nanya
7	1# cold dryer	10m³/min	1	Hangzhou Laoda
8	Absorption column	Φ377×2400	2	Fully automatic regeneration material: 304
9	2# cold dryer	10m³/min	1	Laoda, Hangzhou
10	Drying column	Φ377×2400	2	Fully automatic regeneration material: 304
11	CO2 Filter	1000kg/h	1	Shanghai/Hangzhou
12	Condensator	1000kg/h	1	304
13	Refrigerator	HSN7471-75 55KW*2	2	Germany's Bier
14	Purifying plant	1000Kg/h	1	
15	Double-layer vertical storage tank	150m3		Material: 16MnDR
16	Filler unit one	Filling pump	1	Canned cylinders
17	Filler unit two	Canned-motor pump	1	Transfer the infusion to the tank car

18	Water washing tower filling	304	1	304
19	Adsorption tower filling	Active carbon	1	Shanghai
20	Drying tower filling	Molecular sieve	1	Shanghai New Ao
21	Pipes, valves and fittings	304	1	Pneumatic ball valve ZIPSON
22	Instrumenttation	Pressure, temperature, liquid level, etc	1	Appearance
23	Electronic control system	Electric control cabinet imitates Weitu cabinet	1	Siemens PLC S7-200 Siemens 10-inch touch screen Domestic high quality electrical components

6. Commercial offer for carbon dioxide recovery device

6-1. The services provided to Party A include:

Technical guidance for debugging and on-site training for operators. A complete set of technical information

6-2. File package content:

6-2-1. Engineering flow sheet

6-2-2. Electronic control schematic

6-2-3. Layout

6-2-4. Equipment base diagram

6-2-5. Process description, electronic control description

6-3. operative norm：

The device is designed, manufactured and inspected according to the following standards:

6-3-1, GB150-1998 "Steel pressure vessels"

6-3-2. Safety Technical Supervision Regulations for Pressure Vessels of the State Bureau of

Technical Supervision (1999 edition)

6-4. Personnel training: On-site personnel training, including theoretical introduction and practical operation guidance, to ensure that the equipment personnel assigned by your factory can master the skills of independent operation and system maintenance.

6-5. Warranty service: We provide warranty service with a one-year warranty period (after successful debugging). During the warranty period, our company will provide free service and maintenance. The manufacturer guarantees the technical performance and equipment reliability of CO2 recovery system, implements long-term warranty for the products, and charges cost fee as appropriate.

6-6. Supply cycle and requirements:

Manufacturing time: within 120 calendar days after the contract becomes effective.

Construction site: the buyer shall provide the manufacturing site free of charge, and the buyer shall be responsible for the positioning and installation of the equipment, and provide water, electricity, gas, etc. free of charge, and connect them to the workshop.

6-7. Packaging standard: the standard is to ensure that the equipment is delivered to the factory in good condition.