

# The idea of reducing the carbon content in the air is to collect carbon dioxide by low-temperature liquefaction

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**Summary:** Carbon dioxide is liquefied at minus 58 degrees. Large refrigeration equipment is used to cool down in extreme cold areas such as the Arctic. In extreme cold areas, it can reach minus 60 degrees as long as it is reduced by a few degrees, so as to liquefy carbon dioxide. It can also be combined with pressurization to accelerate carbon dioxide liquefaction. It can be transported and stored for chemical synthesis polycarbonate, beverage processing, etc., and gas fertilizer for greenhouse planting, Can increase production by at least 50%. Carbon dioxide is collected only in extremely cold areas, but not in other areas. The gas partial pressure of carbon dioxide can make a large amount of carbon dioxide move to the collection area

**Key words:** carbon dioxide liquefaction, carbon dioxide collection, carbon neutralization

The liquefaction of carbon dioxide is related to temperature and pressure. The lower the temperature is, the easier it is to liquefy. It can be liquefied under minus 58 °C and normal pressure, and it can be liquefied at - 20 °C with only 1.97 MPa. The greater the pressure, the easier it is to liquefy. It can liquefy at 14 °C under the pressure of 4.966mpa. Therefore, the method of cooling + pressurization can liquefy carbon dioxide for canning, transportation or storage. What is the specific cooling temperature and pressurization pressure to MPa? It depends on the cost and economic benefits.

In extremely cold areas, the air temperature is low, and the cost of low-temperature liquefaction of carbon dioxide is low.

## 1、Carbon dioxide collection by low temperature liquefaction

Carbon dioxide is liquefied at minus 58 degrees. Large refrigeration equipment is used to cool down in extreme cold areas such as the Arctic. In extreme cold areas, it can reach minus 60 degrees as long as it is reduced by a few degrees, so as to liquefy carbon dioxide. It can also be combined with pressurization to accelerate carbon dioxide liquefaction. It can be transported and stored for chemical synthesis polycarbonate, beverage processing, etc., and gas fertilizer for greenhouse planting, The output can be increased by at least 50%. If it is considered that carbon dioxide can only be collected in extremely cold areas, it can not be collected in other areas, and the carbon dioxide concentration in other areas can not be reduced. Firstly, the gas partial pressure of carbon dioxide can make a large amount of carbon dioxide move to the collection area. Secondly, a refrigerator can be used to liquefy and collect nitrogen in extremely cold areas, transport liquid nitrogen to other areas, and use liquid nitrogen to produce carbon dioxide in low-temperature liquefied air. Genetically

modified organisms make the best use of carbon dioxide, but it is difficult to achieve in the near future. The technology of refrigeration and pressurization equipment is mature and readily available. See Figure 1

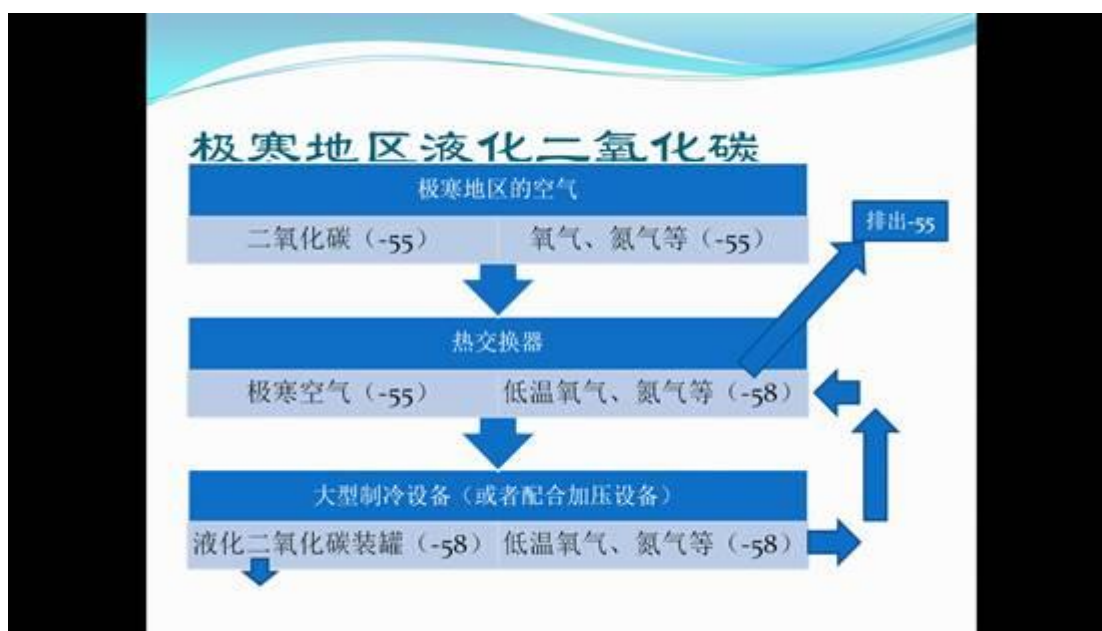


Figure 1

## 2、 Carbon accounting of carbon dioxide collection by low temperature liquefaction method

Low temperature refrigeration equipment is installed behind the large boiler discharging carbon dioxide to directly liquefy carbon dioxide with pressurized equipment. The average density of air is  $1.2\text{kg/m}^3$ , the specific heat of air is  $0.24\text{ cal / g} \cdot \text{degree}$ , 100 cubic meters of air,  $100 \times 1.2 \times 1000 \times 0.24 = 28800\text{cal}$   $28800 \times 4.2 = 120960\text{j}$ , 1000 watts of electrical appliances, and the energy required to turn on for one hour is 3600000 joules, that is, the energy of one degree of electricity.

100It takes  $120960 / 3600000\text{ kwh}$ , about 0.03 kwh, for cubic meters of air to cool down. 100 cubic meters of air needs 0.3 kwh of electricity to reduce 10 degrees. The carbon dioxide content of the air is 0.03%. 100 cubic meters of air contains 0.03 cubic meters of carbon dioxide. According to the data of the national energy information platform: in 2019, German coal power generation will emit 401g of carbon dioxide per kilowatt hour, 1946g of carbon dioxide per cubic meter and  $1946 \times 0.03 = 58.38\text{g}$  of carbon dioxide per cubic meter, That is, 0.3 kwh of electricity is consumed to produce  $0.3 \times 401 = 120.3\text{ g}$  of carbon dioxide, and 58.38 g of carbon dioxide can be collected in an area of minus 50 °C. The discharged air is only 3 degrees higher than the outside air through the heat exchanger, so 100 cubic meters of air only consumes 0.09 degrees of electricity,  $0.09 \times 401 = 36\text{ grams}$  of carbon dioxide, that is, 36 grams of carbon dioxide generated by coal power can collect 58.38 grams of carbon dioxide. If the temperature of the discharged air is 2 degrees higher than the outside world through the heat exchanger, the power consumed is only 0.06 degrees, Then  $0.06 \times$

401 = 24.06 g of carbon dioxide will be generated. It would be better if nuclear power was used. Additional pressurization can greatly reduce power consumption.

The above is the carbon accounting calculated according to the reduction of ten degrees. If it is minus 55 degrees, it only needs to reduce three degrees or pressurize to liquefy carbon dioxide, and the power consumption is much less. In extremely cold areas, sometimes the temperature is close to minus 60 degrees, and the temperature in the south pole is lower. However, it is difficult to transport Antarctic power from Australia. If a nuclear power plant is built in Antarctica, the power problem will be solved, and nuclear power ships can also.

The heat generated by liquefied carbon dioxide refrigeration equipment in extremely cold areas can be used for temperature difference power generation and greenhouse planting.

### 3、 Direct liquefaction of carbon dioxide discharged from the plant

To set up liquefied carbon dioxide equipment in plants with concentrated carbon dioxide emissions such as thermal power plants, the combination of low temperature and pressure can be used to liquefy carbon dioxide, or only cooling and refrigeration can be used, combined with efficient heat exchangers to heat the waste gas of the plant with cold air and save electricity. See Figure 2

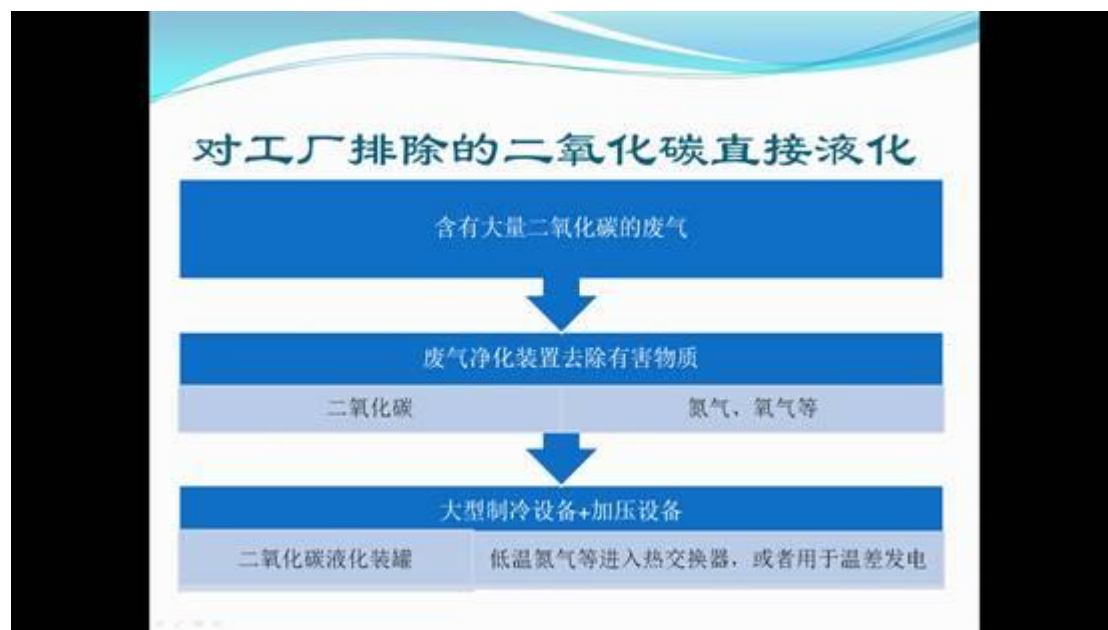


Figure 2