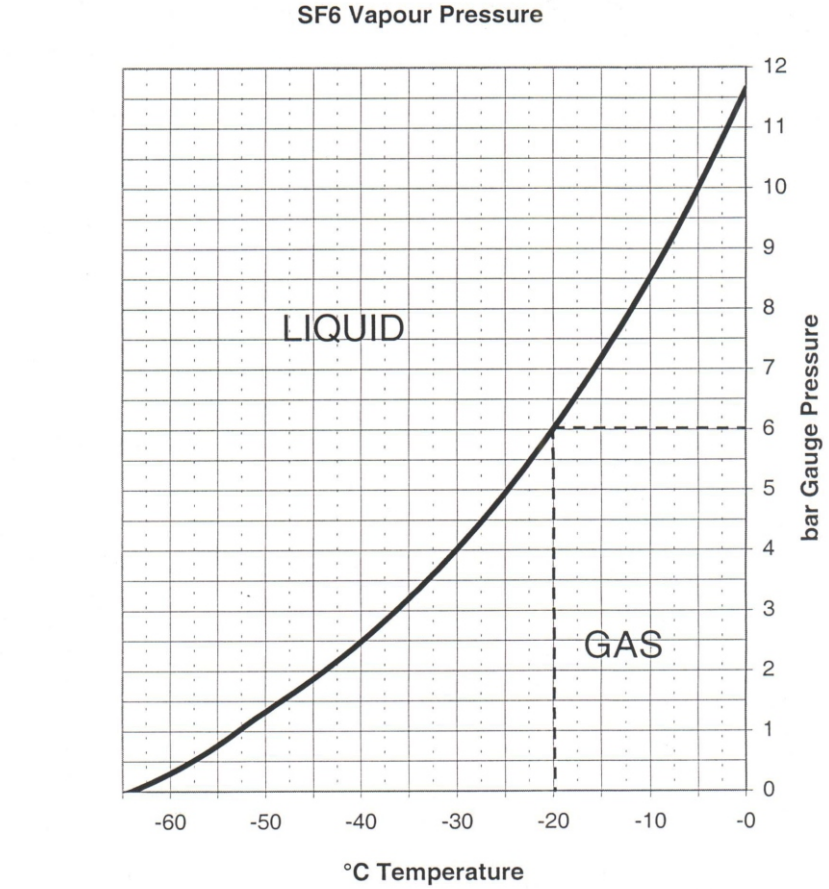
10.2 The Relationship Between Gas And Pressure (SF_6)

When the gas is in the temperature below the condensing point, dew point measurement is not available. This gas condenses on the mirror, the figure below indicates the relationship between gas (SF_6) and pressure.



Example: 6 bar overpressure = Liquefaction at -20°C

Fig. 10.2 The Relationship Between Gas and Pressure (SF_6)

Chilled Mirror Dew Point Instrument

- ☐ DP29-40
- ☐ DP29-60
- ☐ DP29-SF6

Contents

1 Introduction 1
2 Specifications 1
3 Measuring Principle 2
4 Panel Description 3
4.1 Front Panel 3
4.2 Back Panel 5
5 Start-up Commissioning 5
5.1 Device State 5
5.2 Mirror Cleaning 5
5.3 Test Gas Supply System (Sample Gas Injection Tube) 6
5.4 Testing Field Installation 6
6 Measurement 6
6.1 Preparation 6
6.1.1 Device Connection 6
6.1.2 Measurement Under System Pressure 6
6.1.3 Measurement Under Barometric Pressure 6
6.2 Measurement 6
7 Refrigeration Check 7
8 Mirror Check And Lamp Brightness Adjustment 7
9 Fault Analysis 8
10 Appendix 9
10.1 Moisture Content Conversion Of ***SF₆***(PPM) 9
10.2 The Relationship Between Gas And Pressure (***SF₆***) 10

Continued

Factors Causing Measurement Error	Solutions
9. The Mirror Check Indicator light is not stable, the light fluctuates in the contaminated area, dew point is displayed unstably. (Probably ***SF₆*** is in a liquefied state)	If possible, measure under atmospheric pressure. (See **Fig. 10.2**)

10 Appendix

10.1 Moisture Content Conversion Of ***SF₆***(PPM)

Note, 1Mpa=10bar, 1ppmg=ppmv/8.1

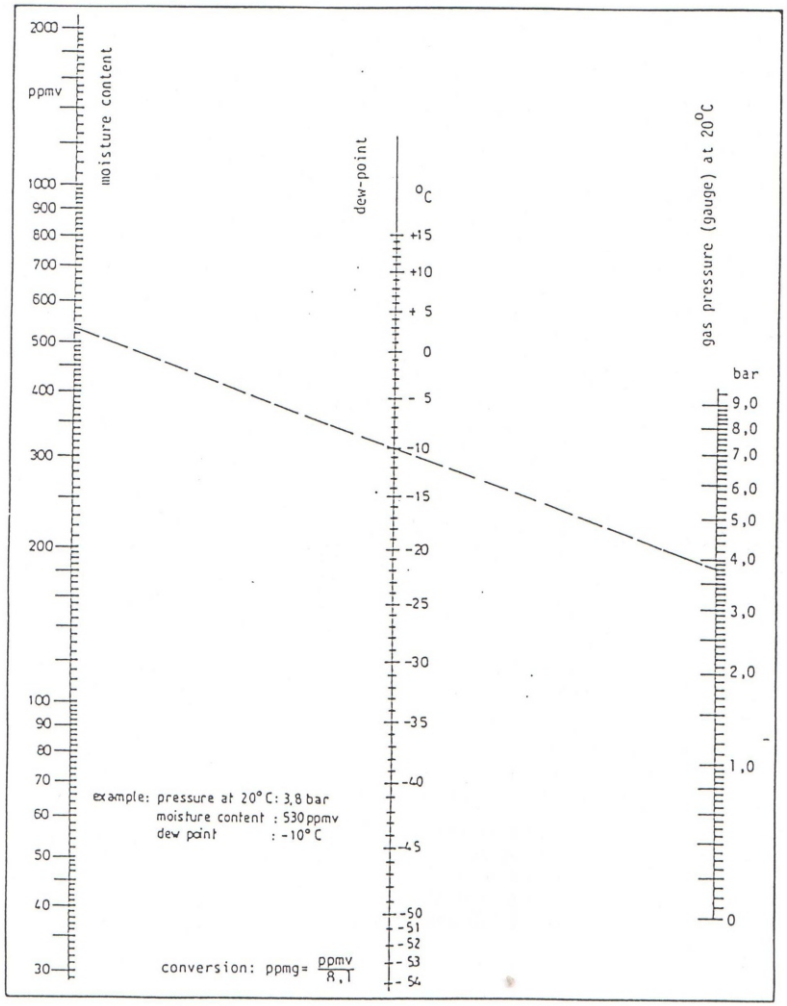


Fig. 10.1 Moisture Content Conversion Of *SF₆*

3. Clean the **Mirror**.
4. Re-install the **Measurement Probe**.
5. If the **Mirror Check Indicator** light in the clean area (clean), the cleaning process is completed. If it is still in the contaminated area or edge of the clean area, continue to the following operation (6).
6. Adjust the **Light Intensity Hole** so that the **Mirror Check Indicator** light is in the middle of the clean area.
7. If the operation does not work (the **Light Intensity Adjusting Hole** does not make a difference), it is necessary to clean the **Lamp** and the **LDR** photosensitive resistance inside the **Measurement Probe**.

9 Fault Analysis

Factors Causing Measurement Error	Solutions
1. There is undercooling point in the system, (below the dew point) condensation inside the instrument.	Dry the system with gas. (Instrument temperature should not be lower than environment temperature)
2. The Inlet Tube is damp.	Blow the tube with dry air for more than 10 minutes.
3. The Connector is damp.	Blow-dry the connector. (Above 60℃)
4. There is greasy dirt inside the Inlet Tube or the Connector.	Clean them with ***Acetone***, then dry with compressed gas.
5. Temperature leak out of the instrument.	Use soap-suds to check whether each connector is installed correctly.
6. Quality of inlet gas is not good.	Do not use the tubes made of ***Rubber***, ***Nylon*** or ***PVC***. When the tested dew point is as low as -40℃, ***Polyethylene*** or ***Brass*** tube is available. When the dew point is as low as -40℃, ***FEP*** (***Fluorinated Ethylene Propylene***), ***PTFE*** (***Polytetrafluoroethylene***) or ***Stainless Steel*** tube is available.
7. Pressure Influence	See **Fig. 10.2**
8. The change of gas flow	The slight fluctuations of gas flow will not affect the measurement results (about 20-50L/HR). If the gas flow is too high, can cause some loss of accuracy. If the gas flow is too low, the measurement time will be extend.

To see the next page, continued

1 Introduction

DP29 is a multifunctional, portable dew point humidity meter, especially designed for field use. The typical application of this equipment is the dew point measurement of ***SF_6*** gas. The pressure range is from 10mbar to 10bar (1kPa to 1Mpa) when measuring. The differential pressure between inlet and outlet is 10mbar (1kPa), it is effective for the sample gas measurement. If the gas pressure is too low or the sample gas was measured in a closed pipeline, choose a pump for measurement.

The measurement is based on the principle of chilled mirror. Due to the elimination of the error caused by inertia and lagging of the system, the actual temperature measurement of direct and accurate is guaranteed. The system is stable, does not need to be repeatedly calibrated. In Freezing point detecting method, only need to simply press button, the equipment is able to self-test of accuracy at 0°C.

Standard configuration of **DP29** equipment includes a prepositive tight pressure measuring probe with three-stage ***Peltier*** cooling. As for the corrosive gas, pipeline should be made of ***PTFE*** or stainless steel. There is a built in electronic flow meter, monitoring sample gas flow. The system provides a ±10mv/°C analog output for recording or remote controlling.

DP29-40 is specifically designed for air dew point measurement. It is applicable to standard reference for electronic component durability, dew point control for firing furnaces, dew point control for fuel cell test system, etc.

DP29-SF6 is specially for the measurement of ***Sulfur Hexafluoride (SF_6)***.

DP29-60 is a standard type. It applies to standard reference for laboratory calibration, moisture control for ceramic firing furnaces, humidity control for thermo-hygrostat chamber.

NOTICE The application above is for reference only, model selection depends on the specific situation.

2 Specifications

Measurement Range:

Surrounding Temperature	Measurement Range		
	DP29-40	DP29-60	DP29-60
5℃	-40℃	-50℃	-50℃
10℃	-40℃	-50℃	-50℃
20℃	-35℃	-45℃	-45℃
35℃	-30℃	-40℃	-40℃

Accuracy: ≤±0.2℃, ±1 Digit
Repeatability: ≤±0.1℃, ±1 Digit
Display: Digital
Resolution: 0.1℃
Default Output: USB
Optional Output: ±10mv/℃, (0℃=0mv) or 4-20mA
Measurement Principle: Chilled Mirror
Refrigeration: Semiconductor Refrigeration
Inlet Flow: 15-60L/h , Generally 30-40L/h
Inlet Pressure: 10mbar-10bar(1kpa-1Mpa)
Response Time: 2℃/Second (Maximum)
Pump: Optional Accessory
Mirror Check: Press the Mode Conversion Key to mirror check mode ('CH' on the display), and check manually.
Instrument Check: Press the Test Cooling Key, open the measurement probe, and check manually at mirror check mode.

Voltage: 220VAC±10% , 50/60HZ
Power Consumption: About 160 Watts
Surrounding Temperature: 0-50℃
Surrounding Humidity: <90% , No Condensation
Weight: About 7.22kg
Dimension: 342(W)x140(H)x326(D) mm
The standard configurations of SF_6 dew point instrument are as follows:
* Main Unit
* Inlet Tube (***FEP***, 3m), With Connector
* Instruction Manual
* Packaging Box

Notice: The equipment with standard configuration is able to measure SF_6 and air only, for H_2 or other gas might need extra order.

3 Measuring Principle

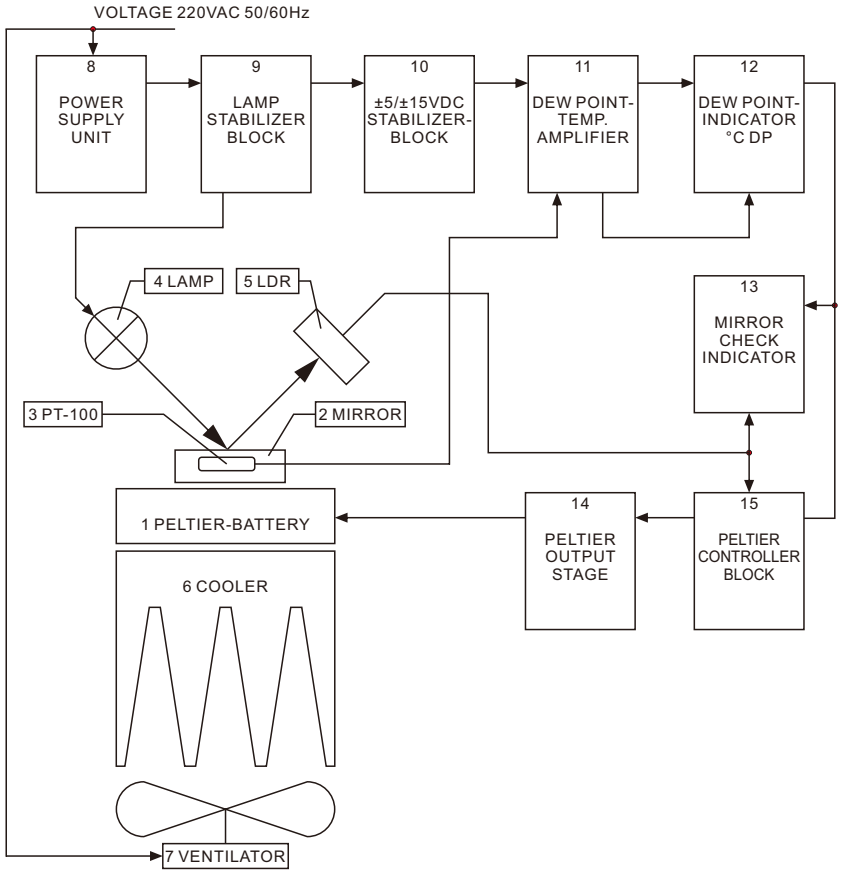


Fig. 3 Measurement Principle

* Check the mirror condition, the **Mirror Check Indicator** should be in the middle of the clean area.
* Press the **Mode Conversion Key** to ME Mode. The device begins to chill down to the dew point, the **Mirror Check Indicator** moves toward the contaminated area.
* Wait for the reading on the Dew Point Indicator stable.
* Read.

Focus: When testing more than one spot, it is necessary to confirm every spot. Because in the environment with high humidity, when the measuring spot is changed, the gas sampling tube loop and the ambient air are still closed.

It takes a little longer time for ultra low dew point temperature measurement. In normal measurement, the reading will shock 1-3 times around the real dew point

7 Refrigeration Check

A simple test can be used to check the measurement accuracy. If the measured results and predicted values differ too far, or consider that the instrument has fault. It is necessary to test.

Procedure:

1. Disconnect the gas sampling tube or close the **Sleeve Control Valve**.
2. Fully open the **Flow Control Valve**.
3. Remove the **Measurement Probe**.
4. Plug in and switch on.
5. Press and hold the **Test Cooling Key** and drop the mirror temperature in the range of -25℃ to -30℃ (see the **Dew Point Indicator**).
6. Blow at the mirror to frost.
7. Release the **Mode Conversion Key** to rise the mirror temperature.
8. If the mirror temperature rises too fast, the current mirror temperature indication will lag behind. Therefore, rise the mirror temperature slowly before reaching 0℃, and cool for a while.
9. Watch the **Mirror** and the **Temperature Indicator** carefully. The frost layer on the **Mirror** should be melted into drops of water at 0℃. If this phenomenon appears, the device indicates temperature correctly.

8 Mirror Check And Lamp Brightness Adjustment

The **Mirror** must be cleaned regularly. When the **Mirror Check Indicator** is in the contaminated area (in the Mirror Check Mode), indicating the **Mirror** is contaminated, it is necessary to clean the **Mirror**. Either Lens tissue or cotton is available to wipe the **Mirror**, while wet towel is not available. If necessary, high purity alcohol is admitted. For the light source **Lamp** and the photosensitive resistance **LDR**, soft cotton swab (Q shaped swab) is available.

Procedure:

1. Close the **Sleeve Control Valve**.
2. Open the **Measurement Probe**.

5.3 Test Gas Supply System (Sample Gas Injection Tube)

The material selection of gas injection tube and proper installation are important.
Improper material of gas injection tube effects gas temperature, causing incorrect test results.

* ***Rubber***, ***Nylon*** or ***PVC***, material which is permeable to water vapor is not available.
* When tested dew point is as low as -40℃, ***Polyethylene*** or ***Brass*** tube is available.
* When the maximum operating pressure is 10bar, use ***PE (Polyethylene)***, ***FEP*** or ***PTFE*** tube. (diameter 4 X 6mm)
* The maximum operating pressure for Stainless Steel tube is 250bar (25 Mpa).

The sampling gas injection tube should be as short as possible. The temperature of tube must be higher than the dew point of the inlet gas, even in extreme conditions (condensation in tube = false measurement).

5.4 Testing Field Installation

A typical installation for SF_6 measurement is as below.

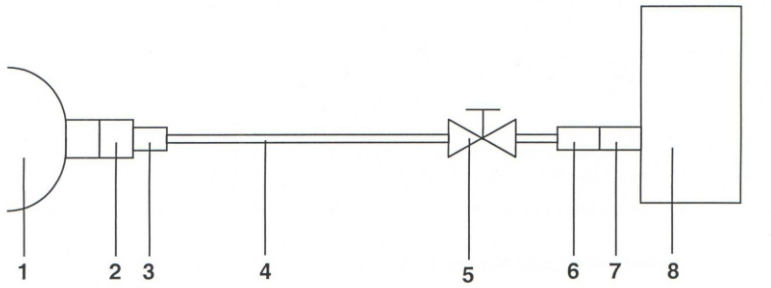


Fig. 5 A Typical Installation For SF_6 Measurement

1. Gas Containers (High Pressure Switch, Gas Cylinders Etc.)
2. Sampling Connector
3. Adapter
4. Sampling Tube
5. Sleeve Control Valve
6. Connector (Socket)
7. Connector (Plug)
8. The Dew Point Instrument

6 Measurement

6.1 Preparation

6.1.1 Device Connection

Firstly connect the instrument with the sampling spot, and plug it in.

6.1.2 Measurement Under System Pressure

* Close the **Flow Control Valve** fully.
* Open the **Sleeve Control Valve** fully.
* Open the **Flow Control Valve** slowly till the gas flow indicated gets in the range of 30-40L/HR.

6.1.3 Measurement Under Barometric Pressure

* Close the **Sleeve Control Valve** fully.
* Open the **Flow Control Valve** fully.
* Open the Sleeve **Control Valve** slowly till the gas flow indicated gets in the range of 30-40L/HR.

6.2 Measurement

* Press the **Power Switch Key** to switch on.
* Press the **Mode Conversion Key** to the CH Mode.

The measurement probe mainly consists of ***Peltier-Battery*** (Thermoelectric heating pump) (1), **Mirror** (2), **Pt-100 Sensor** (3). The temperature sensor is inside the mirror, connected with the refrigeration side of ***Peltier-Battery***.

The heat generated by refrigeration of ***Peltier-Battery*** is rejected by the **Cooler** (6) and the adjacent **Ventilator** (7). Dew point detection is carried out by the optical system consists of **Lamp** (4) and photosensitive resistance **LDR** (5). The ***Peltier Controller*** (15) process signals generated by the photosensitive resistance and transmit them to the ***Peltier Output Stage*** (14), so as to form a layer of dew on the mirror.

Temperature signal produced by **PT-100 Sensor** (3) is transmitted to the **Dew Point-Temp. Amplifier** (11). The measurement result is displayed on the **Dew Point-Indicator** ℃ **DP** (12).

The slight and tiny difference in brightness of **Lamp** (4) will actually change the measurement result. In order to avoid a mistake, **Lamp Stabilizer-Block** (9) provides an accurate voltage supply. The additional **Stabilizer-Block** (10) changes AC to DC and generates the required ±15V DC voltage for sub-controlling.

The **Power Supply** (8) is composed of transformer and rectifier.

4 Panel Description

4.1 Front Panel

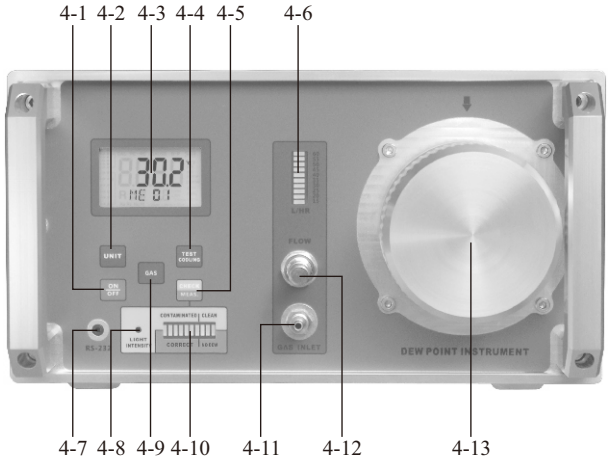


Fig. 4.1 Front Panel Diagram

4-1	Power Switch Key	4-6	Flow Indicator	4-10	Mirror Check Indicator
4-2	Unit Conversion Key	4-7	RS-232 Interface	4-11	Gas Inlet
4-3	Dew Point Indicator	4-8	Light Intensity Hole	4-12	Flow Control Valve
4-4	Test Cooling Key	4-9	Gas Selection Key	4-13	Measurement Probe
4-5	Mode Conversion Key				

4-1 Power Switch Key

Press the Power Switch Key to switch on the instrument.

4-2 Unit Conversion Key

Press the Unit Conversion Key to perform unit conversion.

4-3 Dew Point Indicator (℃ Dew Point)

The Dew Point Indicator display the actual dew point temperature in centigrade.

4-4 Test Cooling Key

The key is used to test the accuracy of instrument at 0℃. For details see 7 Refrigeration Check.

4-5 Mode Conversion Key (CH / ME)

The key mode conversion (CH / ME). In the mode of ME, the ***Peltier Cooling System*** begins to chill down. While in the mode of CH, the ***Peltier Cooling System*** stops working.

4-6 Flow Indicator

Indicating light display the flow in L/HR (Litre/Hour). If the flow is less than 15 L/HR, the indicator light blinks at 15. If the flow is greater than 60 L/HR, the indicator light blinks at 60.

4-7 RS-232 Interface

Using RS-232 data cable for connection, data transmission between the instrument and PC is available.

4-8 Light Intensity Hole

In the CH Mode after the mirror is wiped up, if the light of Mirror Check Indicator is not in the middle of the clean area, insert a screwdriver into the hole for adjustment, so as to turn the indicating light to the clean area. (area division of Mirror Check Indicator see 4-10)

4-9 Gas Selection Key

When measuring different kinds of gas, press the key for selection.

4-10 Mirror Check Indicator

Inside the measurement probe, the light, generated by luminous tubes and reflected by the mirror, is transmitted to the photosensitive resistance, the indicator is divided into clean area and contaminated area (the left 7 grids represent contaminated area, the right 3 grids represent clean area). If the indicator lights in the middle of the clean area, indicating total reflection, the mirror is clean when condensing. The weaker is the reflected light (the higher degree is the mirror polluted), the more close to the contaminated area is the indicator.

When the instrument is in the CH Mode, the indicator light must be in the middle of the clean area. If contaminated, the mirror must be cleaned, then adjust the light intensity hole for correction.

When the instrument is in the ME Mode, the mirror starts to chill down. When the temperature drops to dew point, dew or frost column crystal is formed, the indicating light moves to contaminated area from clean area.

4-11 Gas Inlet

The Gas Inlet Tube is connected with the Connector on the device.

4-12 Flow Control Valve

The valve controls present gas flow.

4-13 Measurement Probe

After the loop pressure of gas in the instrument is released, anti-clockwise rotate the measuring probe to open it, the internal ***PTFE*** tube is also removable. The Photosensitive Resistor is connected on left, and the Lamp is connected on the right. The Mirror is installed between the gas inlet (top) and the gas outlet (bottom).

4.2 Back Panel

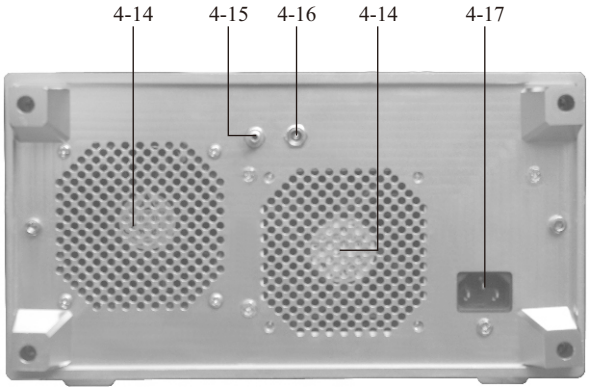


Fig. 4.2 Back Panel Diagram

4-14	Ventilator	4-16	DC Power Output 12V
4-15	Gas Outlet	4-17	220V Power Socket

4-14 Ventilator

The Ventilator is used to cool down the Measurement Probe. When the device is electrified, the Ventilator rotates continuously.

4-15 Gas Outlet

For the measurement of air and harmless gas, the gas outlet is open to the atmosphere. For the measurement of corrosive gas or toxic gas, it is better to take measurement in closed loop, the gas outlet should be connected with the corresponding gas tube.

4-16 DC Power Output 12V

The output of DC power supply.

4-17 Power Socket

For the connection between the instrument and power source.

5 Start-up Commissioning

5.1 Device State

If the instrument has not been used for a period of time, it is necessary to adjust before use. All of the tubes and the connecting sleeve can not be sealed or filled with dry gas, however, must be blown for 10 minutes with dry N_2, O_2 or SF_6 (the maximum pressure 10bar/Mpa). Open the **Flow Control Valve** completely, slowly open the **Sleeve Control Valve** for 40L/HR gas flow required. Use the electrical drier to blow-dry connectors and connections.

5.2 Mirror Cleaning

Before use, swab the mirror with neutral tissue paper or cotton (without any solvent). And then re-install the front part of the Measurement Probe, connect the power supply and switch on, press the Mode Conversion Key to CH Mode. The indicating light should be in the middle of clean area. If necessary, adjust the light intensity hole so that the indicating light is in the appropriate position. (see 8)