NHA-500 Automotive Emission Analyzer

Operation Manual

Version 4.2

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1. Summary.

NHA-500 automotive emission analyzer is used to measure the contents of CO, HC and CO_2 in automotive emissions by the principle of non-dividing infrared absorption method, measure the contents of NO and O_2 in emissions by the principle electrochemical battery, and calculate the excessive air coefficient λ based on the contents of CO, CO_2, HC and O_2 measured. This instrument has the optional inductive tachometric jaw and temperature sensor probe for users, to measure the revolving speed of the engine and the temperature of the lubricant while testing the emission.

This instrument is assembled with foreign advanced technology and complete set of sensors (modules), and is equipped with microprocessor and micro printer. It is a kind of portable intellectual instrument with liquid crystal display and English interface.

Besides the real-time test function, this instrument also has the special programs for testing in idling and dual-idling operating modes according to the national standard GB/T 3845-93 "Measurement of Gasoline Automotive Emission – Idling Method", to control the testing progress automatically. Therefore, it is very convenient to make the dual-idling emission measurement. This equipment can be communicated with the control system of the chassis dynamometer to make ASM test. Being small and light, it can store the testing data of over 500 automobiles, and is especially applicable for roadside test. This instrument complies with the regulations of International Measurement Rules OIML R99/1998 (E) made by the Organization of International Measurement Law (OIML) for Class-I instruments, and is applicable for environmental departments, engine vehicle test stations, automobile factories, and automobile repair shops.

2. Specifications and technical parameters.

2.1 Operation environmental condition

Temperature: 5℃～40℃

Relative humidity: ≤ 90%

Atmospheric pressure: 86.0kPa～106.0kPa

Power supply: 187V～242V, 50Hz ± 2%

2.2 Measurement Range

CO: 0～10% (10^{-2}) vol.

HC: 0～10000ppm (10^{-6}) vol., n-hexane equivalent.

CO_2: 0～18% (10^{-2}) vol.

O_2: 0～23% (10^{-2}) vol.

NO: 0～5000ppm (10^{-6}) vol.

Lubricant temperature: 0℃～120℃

Revolving speed: 300r/min～8000r/min.

2.3 Way of measurement.

Emission: insert the probe tube into the emission tube for 400mm for direct sampling. The probe is 900mm long, and the sampling tube is 5m long.

Lubricant temperature: insert the thermometric sensor into the hole on the measuring scale of the engine lubricant. The protective tube is 600mm long, and the lead is 5m long.

Revolving speed: clamp the measuring jaw onto the ignition lead between the distributor and spark plugs on the 1st cylinder of the engine. The lead of the measuring jaw is 5m long.

2.4 Warm up period: ≤ 10 min (ambient temperature ⩾20℃).

2.5 Resolution.

CO: 0.01% vol.

HC: 1 ppm vol., n-hexane equivalent.

CO_2: 0.01% vol.

O_2: 0.01% vol.

NO: 1ppm vol.

2.6 Indicated allowance error.

CO: ± 0.06% vol. (absolute error) or ± 5% (relative error);

HC: ± 12ppm vol. (absolute error) or ± 5% (relative error), n-hexane equivalent;

CO_2: ± 0.5% vol. (absolute error) or ± 5% (relative error);

O_2: ± 0.1% vol. (absolute error) or ± 5% (relative error);

NO: ± 25ppm vol. (absolute error) or ± 4% (relative error).

2.7 Time stability

After warm up, the zero shift and span shift of the instrument of 4h shall not go beyond its indicated allowance error.

2.8 Repeatability

The indicated repeatability of the instrument shall not go beyond 1/2 of its absolute indicated allowance error.

2.9 Output interface

RS232 serial communication.

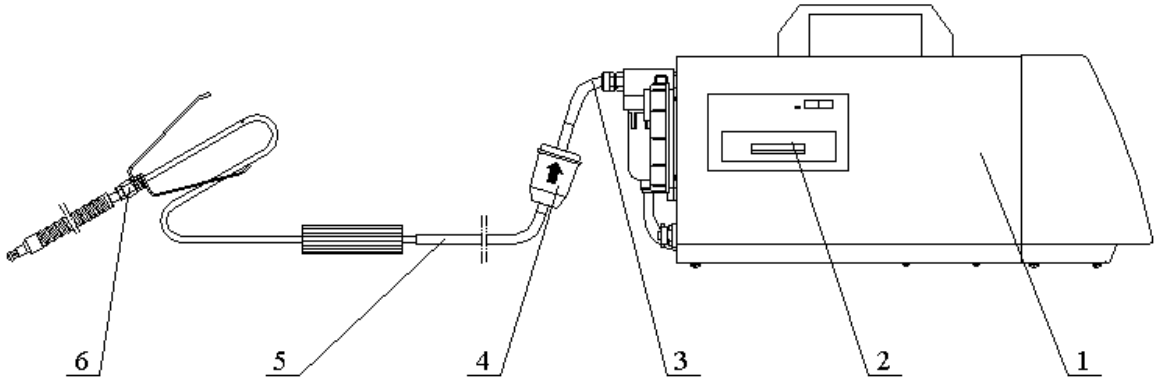
2.10. Outer dimension.

450mm×260mm×180mm (L×W×H)

2.11. Weight: 7kg.

3. Composition of instrument and functions of main keys, switches and components.

As shown in Fig. 1, this instrument is composed of the instrument body, short tube, pre-filter, sampling tube, probe, and built-in micro printer.



1. Instrument body; 2. Micro printer; 3. Short tube; 4. pre-filter;

5. Sampling tube; 6. probe;

Figure 1. Composition of instrument

The front panel of the instrument and all parts on it are shown in Figure 2.

Functions of all parts on front panel:

1. “S” key: horizontally move the cursor (triangular arrowhead) on the liquid crystal display, to select the item required.

2. “K” key: to enter the item selected.

3. “▲” key: move the cursor on the liquid crystal display upward, to select the item required, regulate the contrast of letters and pictures on the display, and modify the setting value of the calibration gas before calibration.

4. “▼” key: move the cursor on the liquid crystal display downward, to select the item required. It other functions are same as “▲” key.

5. Liquid crystal display: display the menu and the measured data.

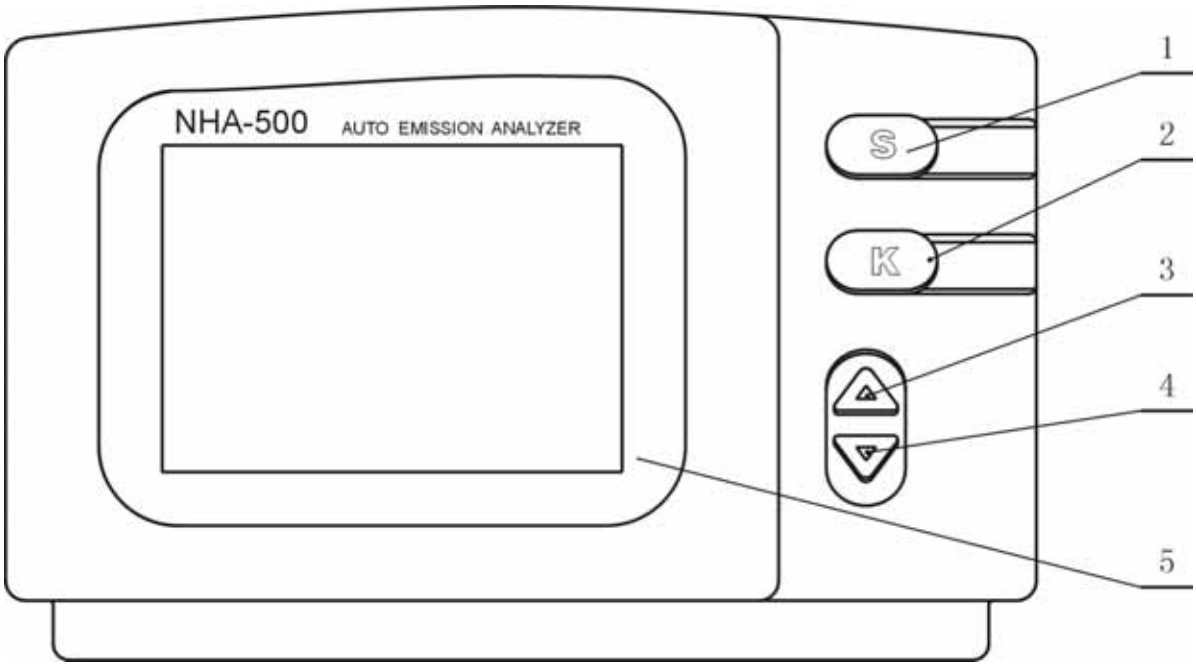
Note: it is able to regulate the contrast of letters and pictures on the display by pressing “▲” or “▼” during the warm up period in the main menu. The user may make the adjustments for clearest display.

The rear panel of the instrument and all parts on it are shown in Figure 3.

Functions of all parts on rear panel:

1 & 13. Fastening bolt: fix the casing of the instrument. The cabinet can be opened so long as the casing is removed.

2. Power socket and switch: the socket is used to input 220V AC supply, and the switch is used to turn on or off the power. There is the built-in 1A fuse and filter for mains noise.



1. “S” key; 2. “K” key; 3. “▲” key; 4. “▼” key; 5. Liquid crystal display.

Figure 2. Front panel of instrument

3-5. Gas outlet: outlet for sampling gas after measurement.

6. Lubricant temperature signal socket: input signal from lubricant temperature sensor.

7. Secondary filter: filter the sampling gas from the water outlet of the water-separating filter.

8. Revolving speed signal socket: signal input from tachometric measuring jaw.

9. Output signal socket: RS232 interface communicated with the external computer and the interface connected with the external printer.

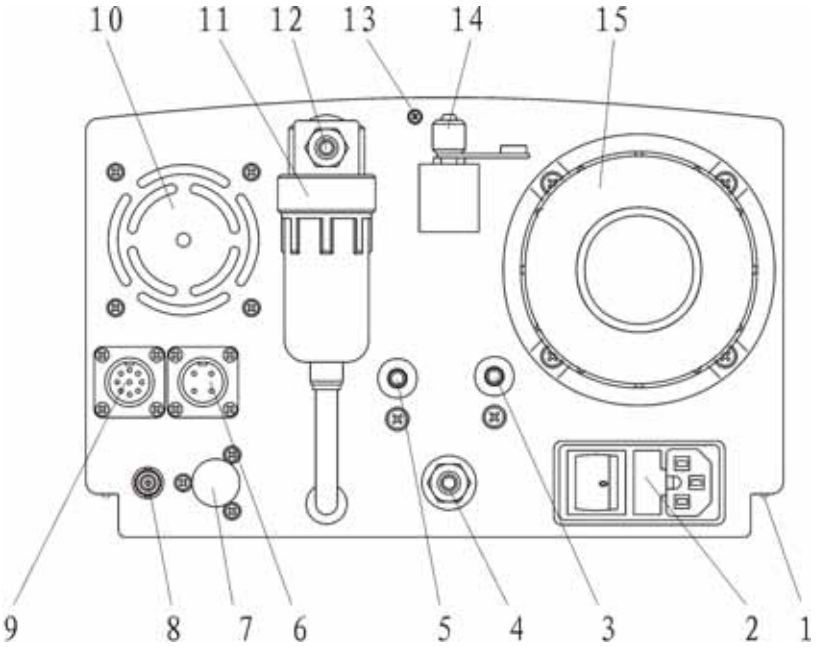
10. Cooling fan: exhaust the air from the emission analyzer to the outside, to prevent the analyzer from internal overheat.

11. Water-separating filter: separate the oil and water in the sampling gas to be measured, and to remove the dust.

12. Sampling gas inlet: connect the outlet of the pre-filter via the short tube, to let the sampling gas in.

14. Standard gas inlet: connect the inlet of standard gas bottle during calibration.

15. Dust filter: paper filter, to eliminate the residual dust in the sampling gas to be measured.



1. Fastening bolt on base plate; 2. Power socket and switch; 3. Gas outlet of O_2 sensor;

4. Main gas outlet; 5. Gas outlet of NO sensor; 6. Lubricant temperature signal socket;

7. Secondary filter; 8. Revolving speed signal socket; 9. Output signal socket;

10. Cooling fan; 11. Water-separating filter; 12. Sampling gas inlet;

13. Fastening bolt on back plate; 14. Standard gas inlet; 15. Dust filter.

Figure 3. Rear panel of instrument

4. Operation.

4.1 Preparation

4.1.1 Installation

a) As shown in Fig. 1, connect one end of the sampling tube with the end of the probe first, and the other end with the inlet of the pre-filter as the accessory. Then, connect one end of the short tube with the outlet of the pre-filter, and the other end with the sampling gas inlet of the instrument. Check all connections and make sure that they are firmly connected without any leakage.

b) Make sure that the clean strainer core and filter paper are put into the pre-filter, water-separating filter, dust filter and secondary filter respectively.

c) Respectively connect the power cord, lubricant temperature measuring probe and tachometric measuring jaw to the power socket, lubricant temperature signal socket and revolving speed signal socket of the instrument.

4.1.2 Warm up .

Insert the power cord into the power socket of 220V AC, and turn on the power switch

to preheat the instrument. " Warm up, Please wait . XXX sec" will appear on the lower part of the liquid crystal display. "XXX" means the warm up period remained by counting down. The total warm up period is 600 seconds (10 minutes).

Note: Warm up period of 600 seconds is only the need of the instrument operating under the ambient temperature of about 20℃. If the ambient temperature is much higher than 20℃, the warm up period will be respectively shortened. And if the ambient temperature is much lower than 20℃, the warm up period will be longer. The instrument will automatically finish the warm up mode so long as it reaches the technical requirements after warm up.

4.1.3 Leak check.

The instrument will automatically enter the sub-menu of "Leak Check" after warm up, to check if the sampling system has any leakage. At this time, a tip will appear on the lower part of the liquid crystal display as "Cover the probe with sheath, Enter by K key". The user shall operate the instrument in accordance with such tip, and press K. then, a tip will appear as "Leak checking XX sec". "XX sec" means the leak checking period remained (by counting down, totally 18 seconds).

After the leak check, if there is any leakage found, a tip will appear as "Leak. Please check, Check again by K key.". The user shall check the sampling system carefully, and get rid of any leakage found. If there is no leakage, "OK, Return by K key." will appear. Press K at this time to enter into auto zeroing.

4.1.4 Auto zeroing.

So long as the instrument enters into auto zeroing, a tip will appear on the lower part of the liquid crystal display as "Zeroing. Please wait ". When the zeroing completes, "OK" will appear on the right lower corner of the display. Several seconds later, a tip on the lower part disappears, and the display is switched to the main menu. For abnormal zeroing, "Zero error. Please check the status" will appear on the lower part of the display, and the display will be switched to the main menu several seconds later.

4.2 Main menu of instrument.

The main menu of the instrument is shown as Fig. 4. The upper part is the area for tips, the middle part is display area for real-time measurement of HC, CO, CO_2, O_2, NO, n (revolving speed), λ (excessive air coefficient) and T(lubricant temperature), and the lower part has five sub-menus including "MEAS", "ZERO", "CAL.", "LEAK" and "SET" for selection.

Press S to move the cursor to the item to be selected, and press K to enter such sub-menu from the main menu. Conversely, every return from the sub-menu will return to the main menu.

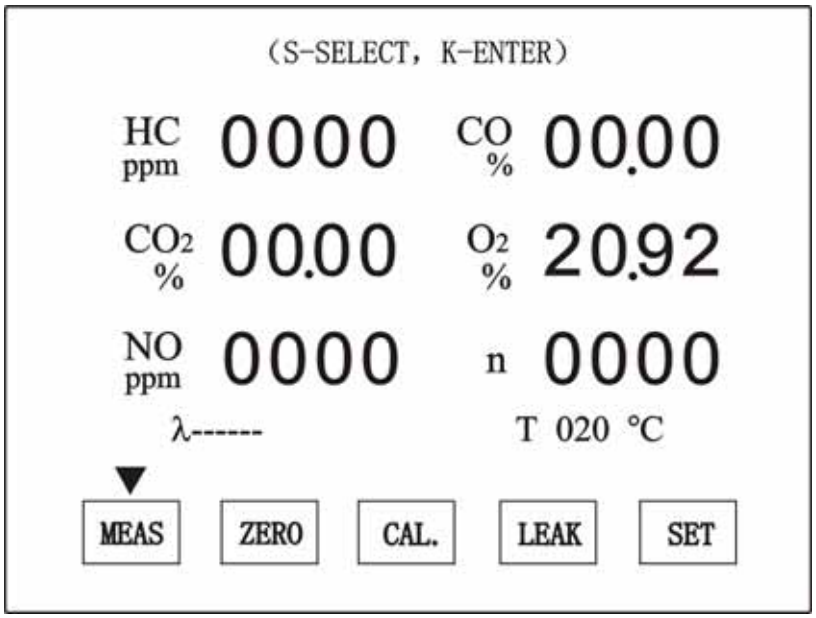


Figure 4. Main menu on display

4.3 Zeroing.

Generally, zeroing is unnecessary for the CO, HC and CO_2 channels of the instrument with the function of auto zeroing, which can make the auto regular calibration to the zero point (once a half hour). However, if it is necessary for zeroing at the decision of the user, return to the main menu from the current sub-menu, press S to move the cursor to "Zero", and press K to enable the instrument to enter into the zeroing program of CO, HC and CO_2 channels. At this time, the sub-menu items on the lower part of the display will change to a tip as "Zeroing. Please wait ". After zeroing, "OK" will appear on the right lower corner of the display. Several seconds later, the five sub-menu items will reappear to take the place of the tips on the lower part of the display.

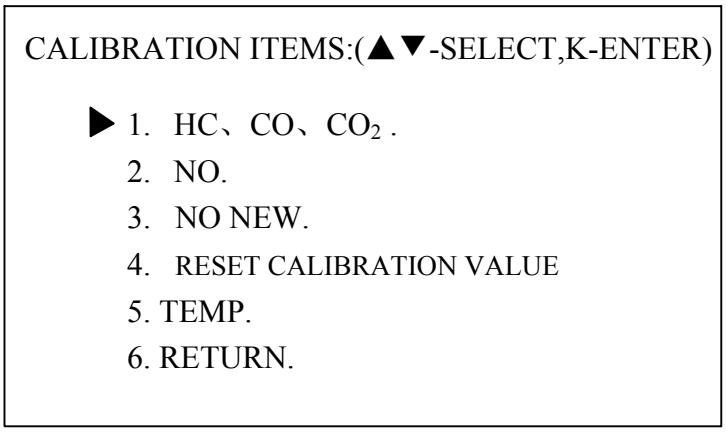


Figure 5. Sub-menu of "Calibration"

4.4 Calibration.

The instrument may shift and the sensor may become old during the service. Therefore, it is necessary to make the span calibration after a period of service of the instrument

(generally 3-6 months). The O_2 sensor and NO sensor shall be replaced after about one year of operation for the sake of aging. Recalibrate such channel after replacement before putting it into service.

4.4.1 Choose the standard gas.

The span calibration use the three components standard gases, with the contents as:

a) Three-component gas

CO: about 3.5% vol.

C_3H_8 (propane): about 2000ppm (0.2%) vol.

CO_2: about 14% vol.

N_2 (nitrogen): residual

b) Single-component gas

NO: about 1000ppm (0.1%) vol.

N_2 (nitrogen): residual

The actual calibration value for calibration shall refer to the value on the tag on the standard gas bottle, without exceeding 15% of the above values. NO calibration gas is excluded in the accessories of this instrument because of its bottle and effectiveness. Please contact us for any need of NO calibration gas.

4.4.2 Span calibration of HC, CO and CO_2 channels.

Follow the calibration steps as below:

a) Zeroing: make zero-point calibration for CO, HC and CO_2 channels in the way described in 4.3.1 before calibration.

b) Press S in main menu to move the cursor to “Cal.”. Then, press K to enter into the sub-menu of “Cal.”.

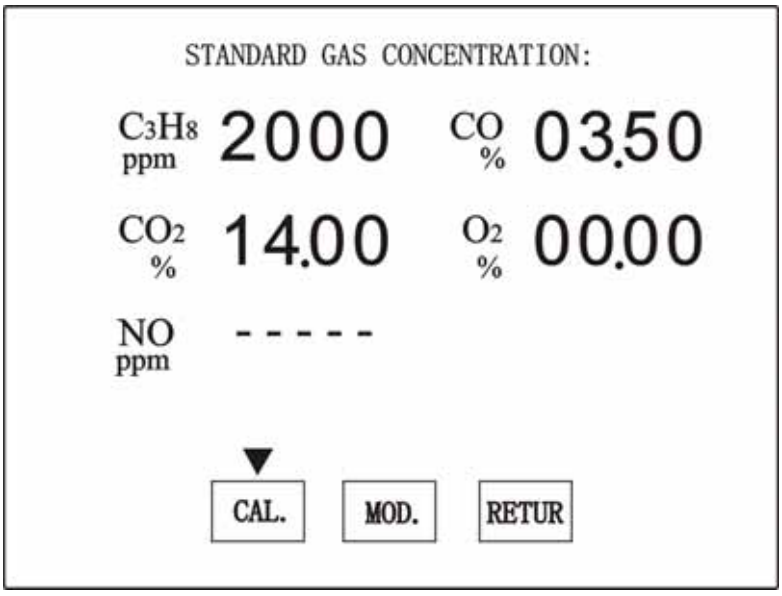


Figure 6. Setting interface of “Concentration of Standard Gas”

c) Press "▲" or "▼" to move the cursor in front of "1. HC, CO and CO_2 ". Then, press K to enter into the setting interface of "Concentration of Standard Gas" (as shown in Fig. 6).

d) The settings value of the calibration gas displayed is the values of the standard gas used for last calibration. If it is different from the values of the three-component standard gas used this time, press S first to move the cursor to "Mod.", and press K to move the cursor "▲" to the C_3H_8. Then, operate as per the tips on the upper part of the display, to modify the setting of C_3H_8 to comply with the value on the gas bottle. After such modification, press S to move the cursor rightward to CO, and modify the setting of CO. By finishing the modification of CO, press S again and move the cursor downward to CO_2 for further modification. In case that all three channels are modified, press S to move the cursor "▲" back to "Cal." and change to "▼"。

e) If the setting value of standard gases in HC, CO and CO_2 channels comply with the values of the three-component gas bottle used, or if all setting value have been modified well, press K when the cursor is at "Cal.". At this time, a tip will appear on the upper part of the display as "Flow standard gas, till stable, hit K key", two items for selection, "Cal." and "retur" will appear on the lower part of the display, and the cursor will automatically move to "Cal.".

f) If the three-component standard gas is inlet to the standard gas inlet of the instrument as indicated in the tip, press K when the readings become stable. Then, a tip will appear on the lower part of the display as "Calibrating ", which will change to "OK" several seconds later, meaning that the span of HC, CO and CO_2 channels have been calibrated. Press any key to return to the main menu.

Once K is pressed without inletting the standard gas to the instrument, a tip will appear on the upper part of the display as "No standard gas. Calibration is failed". Then press any key to return to the main menu.

g) If no calibration is required any more in the sub-menu of "Cal.", press "▼" first to move the cursor downward to "8. return", then press K to return to the main menu.

h) After the calibration, take off the calibration gas bottle before any other operation.

Note: check valve is assembled at the inlet of calibration gas on the instrument. When inletting the calibration gas into the instrument, aim the nozzle of the calibration gas bottle at the inlet of calibration gas on the instrument, and slightly force it downward to open the valve, and the calibration gas will enter into the instrument.

When using any calibration gas bottle other than the mating ones supplied by us, if the nozzle of the gas bottle is inapplicable for this instrument, and is unable to open the check valve, please use the "adapter" in instrument accessories. To use it, fasten it on the inlet of calibration gas, the check valve will open.

4.4.3 Calibrate the NO channel

a) Zeroing: zero in the way described in 4.3.2 before span calibration.

b) Press S in main menu to move the cursor to “Cal.”. Then, press K to enter into the sub-menu of “Cal.”.

c) Press “▲” or “▼” to move the cursor in front of “2. NO”. Then, press K to enter into the setting interface of “Standard Gas Concentration” as shown in Fig. 6.

d) If it is different from the values of the single-component standard gas used this time, press S first to move the cursor to “Mod.”, and press K to move the cursor “▲” to the NO. Then, operate as per the tips on the upper part of the display, to modify the setting value of NO to comply with the value on the single-component gas bottle. After such modification, press S to move the cursor “▲” back to “Cal.” and change to “▼”.

e) If the settings of standard gases comply with the values of the single-component gas bottle used, or if all settings have been modified well, press K when the cursor is at “Cal.”. At this time, a tip will appear on the upper part of the display as “Flow standard gas, till stable, hit K key”, two items for selection, “Cal.” and “retur” will appear on the lower part of the display, and the cursor will automatically move to “Cal.”.。

At this time, if the single-component standard gas is inlet to the standard gas inlet of the instrument as indicated in the tip, press K when the readings become stable. Then, a tip will appear on the lower part of the display as “Calibrating ”, which will change to “OK” several seconds late. Press any key to return to the main menu.

Once K is pressed without inletting the standard gas to the instrument, a tip will appear on the upper part of the display as “No standard gas, Calibration is failed”, and the cursor will move to “retur” automatically. Then press any key to return to the main menu.

Note: inlet the NO standard gas through the sampling gas inlet of the instrument, with the flow within 5～6L/min.

4.4.4 Calibrate the measuring unit for lubricant temperature.

Calibrate the measuring unit for lubricant temperature after a period of service of the instrument, or when it is deemed as necessary.

Calibrate the measuring unit for lubricant temperature as per the following steps:

a) Press S in main menu to move the cursor to “Cal.”. Then, press K to enter into the sub-menu of “Calibration” (as shown in Fig. 5).

b) Press “▼” to move the cursor downward in front of “4. Temp.”, then press K. At this time, the interface of “Temperature calibration” will appear on the display (as shown in Fig. 7).

c) If no temperature sensor is connected to the instrument, the temperature measured by sensor in the interface of “Temperature calibration” as shown in Fig. 7 will be “- - -”. Press K at this time, and a tip as “No temp. sensor, Calibration is failed” will appear on the lower part of the display.

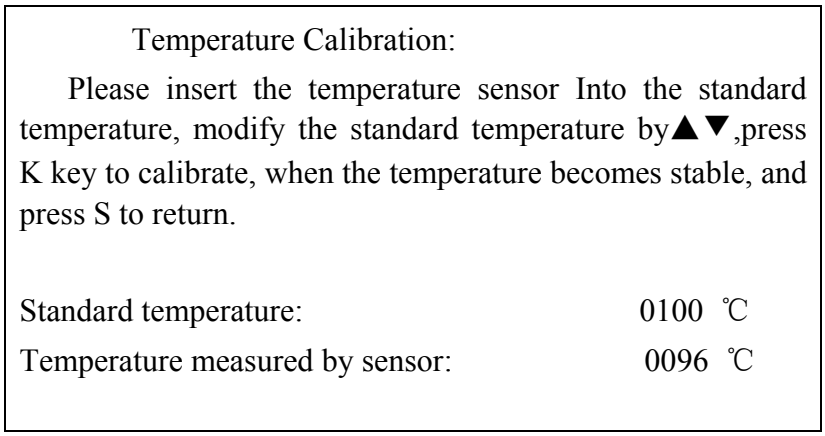


Figure 7. Interface of "Temperature calibration"

d) Insert the temperature sensor into the hot water over 85℃according to the tips on the interface of "Temperature calibration". Take a thermometer with the indicated allowance error ≤ ± 0.5% (relative error) as the standard thermometer, to measure the temperature of the hot water.

e) Press "▲" or "▼" on the instrument to make the "Standard temperature" on the display equal to the water temperature measured by the standard thermometer. Then press K to complete the calibration of high-temperature point. After the calibration, press S to return to the main menu.

f). If the water temperature is below 80℃or if K is pressed without inserting the sensor into the hot water, a tip as "Calibration is fail, return by K key" will appear on the lower part of the display. At this time, press K to return first. Change the water over 85℃or insert the temperature sensor well, and make the calibration again as per the above steps.

4.5 Leak check.

Automatic leak check will be done after warm up of this instrument (as per "setting"). The user may carry out the leak check any time as required.

a) Press S in the main menu to move the cursor to "Leak". Then press K to enter into the sub-menu of "Leak".

b) Follow the tip on the lower part of the liquid crystal display to clog the inlet of the probe by packing gland, and press K then, and the leak check will complete 18s later. If there is any leakage found, a tip will appear as "Leakage. Please check. Press K to check again ". If there is no leakage, "OK, return by K key" will appear.

c) In case of any leakage, check the gas circuit carefully and get rid of it. Otherwise, "Leakage. Please check. Press K to check again " will be always on the display. If there is no leakage, press K to return to the main menu.

4.6 Setting.

To help the user to set the way of measurement, engine stroke and type of fuel easily,

there is a sub-menu of “Set” on this instrument. Press S in the main menu to move the cursor to “Set”, then press K to enter into the sub-menu of “Set”.

4.6.1 Set up the way of measurement.

There are three ways of measurement of this instrument: general measurement, idling measurement and dual-idling measurement.

General measurement is in a way to continuously display the immediate data measured, which is applicable for observing or monitoring the real-time value of automotive emission and for the test in ASM mode.

Idling measurement is in a way prepared according to the provisions for idling measurement program in GB/T 3845/93 “Measurement of Gasoline Automobile Emission – Idling Method”.

Dual-idling measurement is in a way prepared according to the provisions for dual-idling measurement program in Appendix C of GB/T 3845/93 “Measurement of Gasoline Automobile Emission – Idling Method”.

The instrument is set to “General” when leaving the factory.

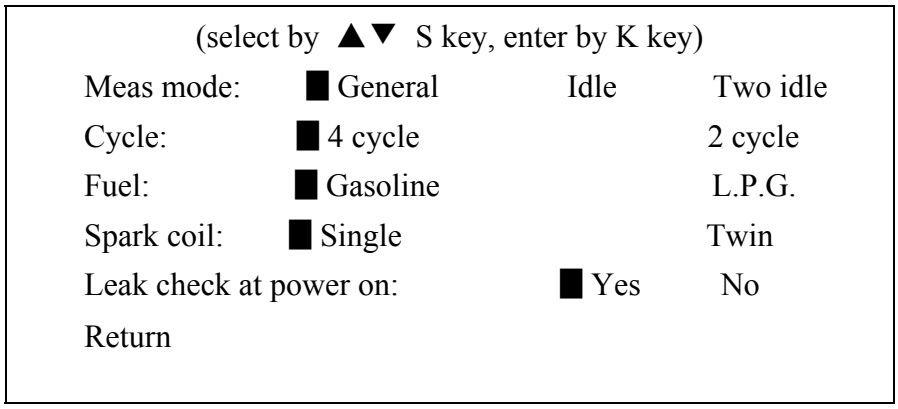


Figure 8. Sub-menu of “Set”

The three ways of measurement are set up as per the following steps:

Press “▲” or “▼” to move the cursor in front of “mase mode” as per the tip on the upper part of the display in the sub-menu of “Set”, and press S with “■” alternatively appearing in front of “General”, “Idle” and “two idle”.

4.6.2 Set up the engine cycle.

Select the engine cycle required in the way described in 4.6.1 according to the tip on the upper part of the display in the sub-menu of “Set”.

The engine cycle of the instrument is set to “4 cycle” when leaving the factory.

4.6.3 Set up the type of fuel.

Select the type of fuel required in the way described in 4.6.1 according to the tip on the upper part of the display in the sub-menu of “Set”.

The type of fuel of the instrument is set to “gasoline” when leaving the factory.

Note: the HC indication of the instrument means the n-hexane equivalent when the type of fuel is set to “gasoline”, and the HC indication of the instrument means the propane equivalent when the type of fuel is set up “L.P.G.”.

4.6.4 Set up the spark coil type.

Select the spark coil required in the way described in 4.6.1 according to the tip on the upper part of the display in the sub-menu of “Set”.

The spark coil of the instrument is set to “single” when leaving the factory.

Note: generally,“single”spark coil is made for engine with “distributor”, and “twin” is made for engine without the “distributor”. The incorrect setting of spark coil may result in the inaccurate or unstable measurement of revolving speed.

4.6.5 Set up leak check at power on.

Select the way of leak check at power on required in the way described in 4.6.1 according to the tip on the upper part of the display in the sub-menu of “Set”. “Yes” means auto leak check at each power on, and “No” means no auto leak check at power on.

The way of leak check at start of the instrument is set to “Yes” when leaving the factory.

4.6.6 Return the sub-menu of “Set”.

Stop setting and return from this sub-menu in the way described in 4.6.1. Press K when the cursor is in front of “return”, to return to the main menu.

4.7 Measurement.

Press S in main menu to move the cursor to “Meas”, and press K then. The instrument will enter into the sub-menu according to the way of measurement already set – “General measurement”, “Idling measurement” or “two-idling measurement”, and start the relevant measurement (refer to 4.7.1, 4.7.2 or 4.7.3).

4.7.1 General measurement.

The sub-menu of “General measurement” (as shown in Fig. 9) is composed of three parts. The upper part shows the name of the sub-menu and the tips for operation, the middle part shows the immediate values measured for HC, CO, CO_2 , O_2 , NO, n (revolving speed), λ (excessive air coefficient) and T (lubricant temperature), and the lower part is for tips and two items for selection. There is a measuring scale indicating the current flow on the right lower corner, which means normal flow in case of three to five measures. In case of one or none measure, it means the flow is insufficient and sampling system is clogged. At this time, the symbol of “Flow” on the lower part of the flow measuring scale will flash (in such circumstance, the user shall remove the clogging immediately in the way described in 6.1 below).

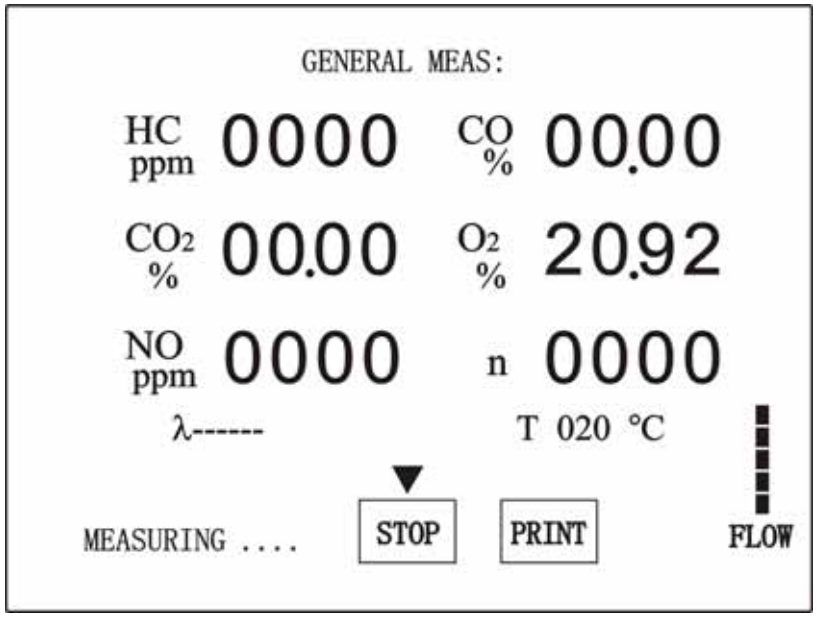


Figure 9. Sub-menu of "General measurement"

The gas pump will start so long as the instrument gets into the way of "General measurement". At this time, insert the probe into the emission tube of the automobile to be tested in the depth of 400mm, and the immediate values of HC, CO, CO_2 , O_2 and NO in the emission and λ will have the real-time display on LCD. If the tachometric jaw and measuring sensor for lubricant temperature are installed well as per the steps described in 4.7.2.1, the immediate values of engine revolving speed (n) and lubricant temperature (T) will also have the real-time display on LCD.

To print the measurement result, press S to move the cursor to "Print", then press K to print the data produced at the time when K is pressed. Later, the cursor will return to "Stop" automatically.

To put the general measurement to an end and return from this sub-menu, press S to move the cursor to "Stop", then press K to return to the main menu.

4.7.2 Idling measurement.

The sub-menu of "Idling standard measurement" is composed of three parts. The upper part shows the name of the sub-menu, the middle part shows the immediate values measured for HC, CO, CO_2 , O_2 , NO, n , λ and T, and the lower part is for tips. There is a measuring scale for flow with a symbol of "Flow" on the right lower corner.

4.7.2.1 Preparation.

Clamp the tachometric measuring jaw onto the ignition lead between the distributor and spark plug of 1st cylinder of the engine. Be careful that the arrowhead of on the back of the jaw shall aim at the spark plug, for the wrong direction of arrowhead may cause the incorrect signal for revolving speed. Then, insert the measuring sensor for lubricant temperature into the lubricant scale hole on the engine until the probe comes into contact with the lubricant.

4.7.2.2 Check for HC residual and warm up of engine.

a) In the sub-menu of "Idling measurement", the instrument starts to check the HC residual first. A tip as "Checking for HC residual XX seconds" appears on the lower part of the display, in which, "XX seconds" means the period remained for check (by counting down, 30 seconds in Max.). In the event that the emission does not pass the check for HC residual at the end of countdown, a check by counting up will be done (30 seconds in Max.). After the check, a tip as "Check for HC residual OK" will appear for a successful check, or a tip as "HC residual is too high, clear the tube…" will appear for failure. In case of the latter, the user may get rid of the trouble immediately in the way described in 6.2.

b) After the check for HC residual, the name of the sub-menu on the upper part of the display will change to a tip as "Rated R.P.M.: 5000 ▲▼ for modify, K for enter". The user shall press "▲" or "▼" to set the rated revolving speed in such tip as the nominal rated revolving speed of the engine on the automobile to be tested (to accuracy of 100r/min), then press K for confirmation.

c) The instrument will get into the warm up stage for engine so long as K is pressed, and the tip on the upper part of the display will change to "Accelerate to 3500r/min". At this time, the driver shall accelerate the engine, and look attentively at the continuously changing revolving speed on the display until it reaches about 3500r/min.

Note: only when the rated revolving speed is 5000r/min, the tip on the display will be "Accelerate to 3500r/min". if the rated revolving speed is any other value, the tip will be "Please accelerate to XXXX r/min", which XXXX equals to 0.7 times of the setting of rated revolving speed. The 2500 r/min described in 4.9.3 below is of the same condition.

d) When the revolving speed reaches 3500 r/min, a tip as "Keep 3500 r/min" will appear on the display, and "XX seconds" by counting down will displayed on the lower part (totally 60 seconds). At this time, the driver shall keep the revolving speed at 3500 r/min until the end of such countdown. The warm up of engine finishes at the end of the countdown, and the instrument shall start the emission measurement.

4.7.2.3 Measure the emission in idle speed.

a) At the end of warm up by counting down of 60 seconds, a tip as "Decelerate to idle…" will appear on the upper part of the display. At this time, the driver shall release the accelerator step to decelerate the automobile. When the revolving speed falls to 1100 r/min or below, the tip on the upper part of the display will change to "Keep idle…", and the tip on the lower part will be "Insert the probe ".

b) When the tip as "Insert the probe " appears, insert the probe of the instrument into the emission tube of the automobile in the depth of 400mm, and keep the idling of the engine at the same time.

c) The instrument will start to sample the emission when the probe is inserted properly, with a tip as "Sampling XX seconds" on the tips area. "XX seconds" means the

sampling period remained (by counting down. Totally 45 seconds, the first 15s is for preparation, and the final 30s is for actual sampling). The emission measurement in idling operating mode completes at the end of sampling by counting down.

4.7.2.4 Read out the measurement data and finish this measurement.

a) At the end of emission measurement in idling, the display will change to the interface of "Measurement complete", with the Max., Min. and average of HC, CO, CO_2 , O_2 , NO and n, as well as λ and lubricant temperature displayed on the upper part, and "retur" and "Print" on the lower part.

b) To print the measurement result, press S to move the cursor to "Print", then press K to print the data . Later, the cursor will return to "retur" automatically.

c) After the measurement for one automobile, take off the probe from the emission tube, remove the tachometric measuring jaw from the engine, and take out the measuring sensor for lubricant temperature.

d) Press K when the cursor is at "retur" to return to the main menu, and the cursor will go back to "Measurement" automatically. To continue the measurement for idling emission, press K and repeat the operations from 4.7.2.2 to 4.7.2.4.

Note: if the measuring scale for flow on the right lower corner of the display is of less than 2 measures, the symbol of "Flow" on the lower part of the measuring scale will flash, meaning that the sampling system is clogged. The measuring function of the instrument will be locked at this time, and press K to return to the main menu (same for dual-idling emission measurement). In such circumstance, the user shall remove the clogging immediately in the way described in 6.1 below.

To return the sub-menu of "Idling measurement" and stop measuring in the mid way during the idling emission measurement, press S and K simultaneously to return to the main menu.

4.7.3 Two idling measurement.

The sub-menu of "Dual-idling standard measurement" is composed of three parts. The upper part shows the name of the sub-menu, the middle part shows the immediate values measured for HC, CO, CO_2 , O_2 , NO, n , λ and T, and the lower part is for tips. There is a measuring scale for flow and the a symbol of "Flow" on the right lower corner.

4.7.3.1 Preparation.

By steps described in 4.7.2.1.

4.7.3.2 Check for HC residual and warm up of engine.

In the sub-menu of "two idling measurement", the instrument starts to check the HC residual and preheat the engine first in the same way described in 4.7.2.2.

4.7.3.3 Measure the emission in high idle speed.

a) At the end of warm up by counting down of 60 seconds, the instrument will start the

emission measurement in high idle speed, and a tip as “Decelerate to 2500 r/min” will appear on the upper part of the display. At this time, the driver shall decelerate the engine, and look attentively at the continuously changing revolving speed on the middle part of the display until it falls to about 2500 r/min. At this time, the tip on the upper part of the display will change to “Keep 2500 r/min”, and the tip on the lower part will be “Insert the probe ”. When the tip as “Insert the probe ” appears, the driver shall keep the revolving speed within 2500 r/min ± 50 r/min, and the operator shall insert the probe of the instrument into the emission tube of the automobile in the depth of 400mm.

b) So long as the probe is inserted, the tip on the upper part of the display will be still “Please keep 2500 r/min”, and the tip on the lower part will be “Sampling XX seconds” (by counting down. Totally 45 seconds, the first 15s is for preparation, and the final 30s is for actual sampling).

If the revolving speed in the final 30 seconds goes beyond the range of 2500 r/min ± 250 r/min, a tip as “R.P.M. out of range. Keep 2500 r/min” on the upper part of the display. The instrument will stop sampling at this time, and will not restart sampling until the revolving speed returns to 2500 r/min ± 250 r/min.

c) The emission measurement in high idle speed completes at the end of sampling by counting down, and the instrument will start the emission measurement in idling. At this time, the tip on the lower part of the display disappears, and the tip on the upper part will be “Decelerate to idle …”.

4.7.3.4 Measure the emission in idle speed.

a) When the tip as “Decelerate to idle…” appears on the upper part of the display, the driver shall decelerate the automobile. When the revolving speed falls to 1100 r/min or below, the tip on the upper part of the display will change to “Keep idling ”, and the tip on the lower part will be “Insert the probe ” (by counting down. Totally 45 seconds same as 4.7.2.3).

b) The emission measurement in idling operating mode completes at the end of sampling by counting down. At this time, the interface of “Measurement complete” appears on the display, with “Data1”, “Data2”, “Print” and “Retur” displayed on the lower part.

4.7.3.5 Read out the measurement data.

a) Read out the measurement data for emission in high idle speed.

Press S to move the cursor to “Data1”, then press K to change to the interface of “High idling data”, to display the Max., Min. and average of HC, CO, CO_2 , O_2 , NO and n, as well as λ and lubricant temperature in high idling operating mode. There are still four items for selection on the lower part of the display.

b) Read out the measurement data for emission in idling

Press S to move the cursor to “Data2”, then press K to change to the interface of “Low idling data”, to display the Max., Min. and average of HC, CO, CO_2 , O_2 , NO and n, as well

as λ and lubricant temperature in idling operating mode. There are still four items for selection on the lower part of the display.

c) Print the measurement data.

Press S to move the cursor to “Print”, then press K. The instrument will print out the measurement result for emission in both the high idling and idling operating modes. The cursor will return to “Retur” automatically at the same time.

4.7.3.6 Finish this measurement.

a) After the measurement for one automobile, take off the probe from the emission tube, remove the tachometric measuring jaw from the engine, and take out the measuring probe for lubricant temperature.

b) Press K when the cursor is at “Retur” to return to the main menu, and the cursor will go back to “Measurement” automatically. To continue the measurement for two idling emission, press K and repeat the operations from 4.7.3.1 to 4.7.3.5.

Note: to return from the sub-menu of “two idling measurement” and stop measuring in the mid way during the idling emission measurement, press S and K simultaneously to return to the main menu.

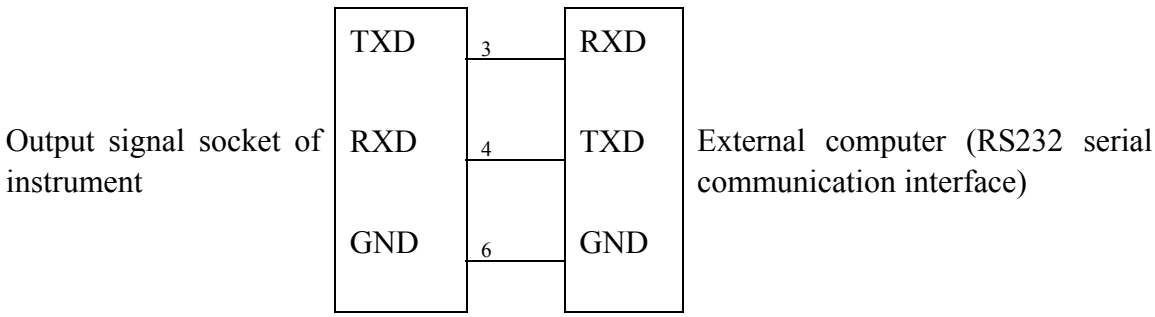
After the test and before switching off the power, set the instrument in “General measurement”, enter into such sub-menu (see 4.7), and wait for about 10 minutes in the measuring mode (the gas pump is in operating mode at this time). Meanwhile, put the probe in the clean air, so that the clean air will pass through the instrument and remove the emission remained in the pipe.

5. Output signals.

The output signal socket (fast-connect socket of 9 pins) on the rear panel of this instrument is RS232 serial communication interface connected with the external computer, to transmit the measurement data of the instrument.

5.1 Way of connection and serial communication parameter.

5.1.1. Way of connection.



5.1.2 RS232 serial communication parameter

Baud rate: 9600 Baud

Stop bits: 1

Start bits: 1

Data bits: 8

Parity: None

5.2 Data format and command.

5.2.1 Start the pump.

Sending of external computer: 01H

Instrument response: ACK (06H)

5.2.2 Stop the pump.

Sending of external computer: 02H

Instrument response: ACK (06H)

5.2.3 Get the real-time data.

Sending of external computer: 03H

Instrument response: ACK (06H), HC, CO, CO_2 , O_2 , NO, n, T, λ and calibration sum.

5.2.4 Set up the engine as four strokes

Sending of external computer: 04H

Instrument response: ACK (06H)

5.2.5 Set up the engine as two strokes

Sending of external computer: 05H

Instrument response: ACK (06H)

5.2.6 Set up the fuel as gasoline

Sending of external computer: 06H

Instrument response: ACK (06H)

5.2.7 Set up the fuel as liquefied petroleum gas

Sending of external computer: 07H

Instrument response: ACK (06H)

5.2.8 Set up the spark coil as “single”

Sending of external computer: 0AH

Instrument response: ACK (06H)

5.2.9 Set up the spark coil as “twin”

Sending of external computer: 0BH

Instrument response: ACK (06H)

5.2.10 Check of HC residual.

a) sending of external computer: 08H

b) Instrument response:

i. Checking the HC residual: 00H

ii. Finish the check of HC residual: ACK (06H) or NACK (15H)

Note: ACK means to pass the check of HC residual, and NACK means the failure of check of HC residual.

c) Way of communication:

i) The external computer sends 08H.

ii) When the instrument responds by 00H, the external computer repeats to send 08H until the instrument responds with ACK (06H) or NACK (15H) (check of HC residual finishes, which takes 20-60 seconds).

5.2.11 Idling method, dual-idling method and ASM communication method.

a) Sending of external computer: 08H (start the check of HC residual).

b) Response of instrument: 00H (checking of HC residual).

c) External computer repeats to send 08H until the instrument responds with ACK (06H) or NACK (15H) (check of HC residual finishes, which takes 1-60 seconds).

Note: ACK means to pass the check of HC residual, and NACK means the failure of check of HC residual.

d) Repeated sending of external computer: 03H (get the real-time data).

e) Response of instrument: ACK (06H), HC, CO, CO_2 , O_2 , NO, n, T, λ and calibration sum.

f) Sending of external computer: 02H (stop the pump and exit).

g) Response of instrument: ACK (06H)

Note: while incorporating with the external computer, to carry out the test with idling, dual-idling or ASM method, the instrument shall be responsible to make the check of HC residual and send out the real-time data then, and the external computer shall control the measurement and process the data.

5.2.12 If any command is sent to the instrument during the operation of zeroing, calibration, warm up and leak check, the instrument will responds with BUSY (05H). If the instrument receives the non-effective command, it will responds with NACK (15H).

5.2.13 Data formats.

a) ACK: 06H, single byte.

b) HC: HC data, integer with symbol (two bytes), high order first, unit as ppm. E. g., if the measurement result of HC is 1234ppm the HC data will be 04D2H. (if the gasoline is set up as the fuel, express it by n-hexane equivalent, and if liquefied petroleum gas is set up as the fuel, express it by propane equivalent).

c) CO: CO data, integer with symbol (two bytes), high order first, unit as 100 times of

percent. E. g., if the measurement result of CO is 1.23%, the CO data will be 007BH.

d) CO_2: CO_2 data, integer with symbol (two bytes), high order first, unit as 100 times of percent. E. g., if the measurement result of CO_2 is -0.25%, the CO_2 data will be 0FFE7H.

e) O_2: O_2 data, integer with symbol (two bytes), high order first, unit as 100 times of percent. E. g., if the measurement result of O_2 is 0.25%, the O_2 data will be 0019H.

f) NO: NO data, integer with symbol (two bytes), high order first, unit as ppm. E. g., if the measurement result of NO is 15ppm, the NO data will be 000FH.

g) n: data of revolving speed, integer with symbol (two bytes), high order first, unit as r/min (note: the revolving speed relates to the stroke of the engine).

h) T: data of lubricant temperature, integer with symbol (two bytes), high order first, unit as ℃.

i) λ：Excessive air coefficient data, interger with symbol(2bytes)，high order first, unit as 100 times of the actual. E.g., if measurement result of λ is 1.03，the λ data will be 0067H.

j) Calibration sum: sum of the foregoing data, integer without symbol (two bytes, high order first, carry abandoned).

Calibration sum: 06H + HC + CO + CO_2 + O_2 + NO + n + T + λ

6. Maintenance and repair.

6.1 Open the chassis of the instrument.

Open the chassis for maintenance or repair in following steps:

a) Press and take off the front cover plate from the printer as shown in the chapter of “Install the Color Tape” in the “Operation Manual of Micro Surface Type Printer” attached with this instrument, take out the entire printer from the casing of the chassis in the way described in the chapter of “Install the Paper Roll”, and carefully plug out the strip cable plug connected with the instrument (located at “Interface Socket” in the outline drawing of the “Operation Manual of Micro Surface Type Printer”.

b) Remove the four fastening bolts between the casing and the base plate and the two fastening bolts over the standard gas inlet on the back plate of the instrument. Turn the two side walls of the casing slightly outward, pull the casing backward at the same time to remove the casing and open the chassis of the instrument.

6.2 Replace the filtering elements of the filter.

In case that the sampling system of the instrument is clogged by the dust, oily mud or any other dirt in automotive emission, with the flow of the sampling system seriously reduced, the measuring scale for flow on the right lower corner of the display will be less then two measures, and the symbol of “Flow” below the measuring scale will flash. At this time, cut off the power of the instrument, check and clean the probe, sampling tube and short tube, replace the filtering cores of pre-filter, water-separating filter and the secondary

filter, and replace the filter paper of the filter-paper dust filter. Restart the instrument which is unclogged (if the NH trademark of the filter paper on the dust filter is hard to distinguish clearly due to the contamination, replace the paper even when the measuring scale on the right lower corner has more than 3 measures).

6.2.1 Replace the pre-filter.

a) Take out the sampling tube and short tube from the failed pre-filter.

b) Get the pre-filter from the instrument accessories, and connect the sampling tube and the short tube as per the arrowhead for gas flow marked on the case, by connecting the sampling tube with the small end of the pre-filter and the short tube with the large end as shown in Figure 1.

6.2.2 Replace the filter core of the water-separating filter.

As shown in Fig. 10, turn the water trap of the water-separating filter forcefully counterclockwise to take it off, loosen the fastening bolt on filter core to remove the failed filter core and replace the new one. Never scratch the porous surface by any hard object when assembling the new filter core.

6.2.3 Replace the filter paper of the filter-paper dust filter.

As shown in Fig. 11, turn the gland of the dust filter forcefully counterclockwise to take it off, remove the old filter paper and replace the new one. Then, tighten the gland to prevent from any air leakage. In case of leakage, replace the O-ring or apply some silicone sealant around the gasket ring.

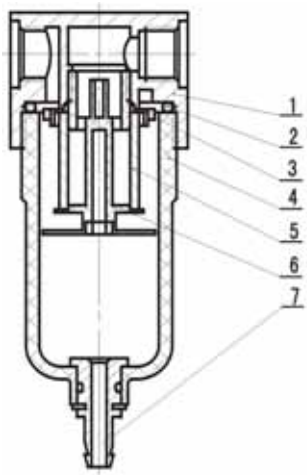
6.2.4 Replace the filter core of the secondary filter.

As shown in Fig. 12, pull the handle of the secondary filter outward to take out the old filter core, and replace the new one.

6.3 Reasons and remedies for failed check of HC residual.

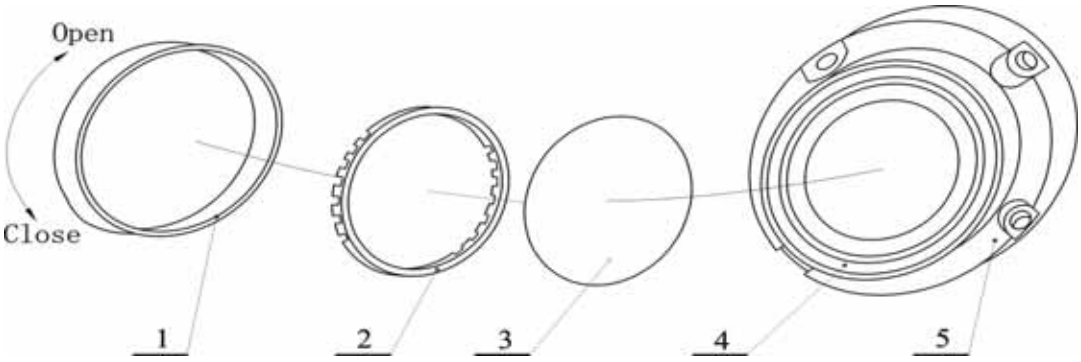
6.3.1 If the excessive HC residual is caused by the settlement and adsorption of HC in pipelines and components of the sampling system due to the excessive HC content in automotive emission tested or the excessively long measuring period, put the probe into the clean air, set the instrument to “General measurement”, and to operate for a period in the mode of “Measuring” (about 1～3 minutes). Restart the “Check of HC residual” after eliminating the HC residual in the pipeline by the clean air. Should the above method fails, remove the probe and sampling tube, and blow with the clean compressed air.

6.3.2 For failure caused in the way described in 6.3.1, it may be necessary to replace the filter cores of the pre-filter, water-separating filter and secondary filter, as well as the filter paper of the filter-paper dust filter.



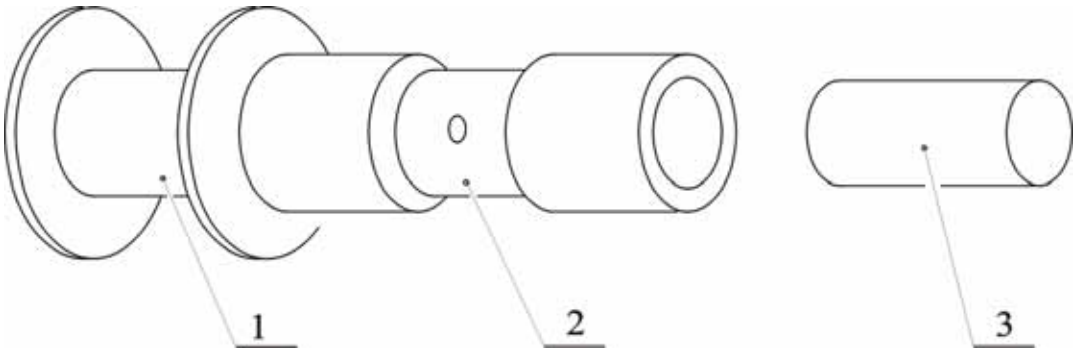
1. Body; 2. O-ring; 3. Cyclone blades; 4. Water-separating cup; 5. Filter core;
6. Water deflector; 7. Water outlet.

Figure 10. Replace the filter core of water-separating filter



1. Gland of filter; 2. Rubber gasket; 3. Filter paper; 4. O-ring; 5. Filter body

Figure 11. Replace the filter paper of filter-paper dust filter



1. Handle; 2. Sheathing; 3. Filter core

Figure 12. Replace the filter core of secondary filter

6.4 Reasons and remedies for failed leak check.

6.4.1 Check if the inlet of the probe is firmly stopped up in leak check to prevent it from air leakage – restart the test after stop-up.

6.4.2 Air leakage at the connection of the probe – connect and tighten it again.

6.4.3 Air leakage due to the breakage or punching of sampling tube – replace the new sampling tube.

6.4.4 Aged ends of the sampling tube or short tube, which cause the poor sealing – cut off the aged section or replace the new sampling tube.

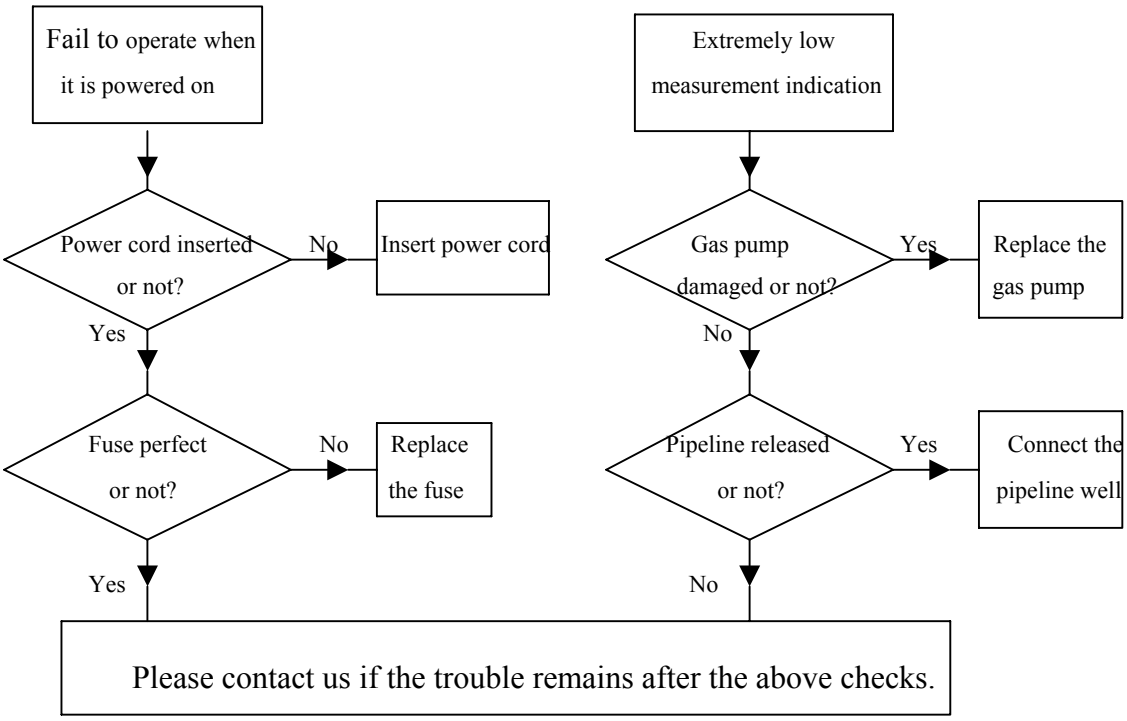
6.4.5 Air leakage at the gland of the filter-paper dust filter – connect and tighten the gland again, replace the O-ring or apply some silicone sealant on the gasket ring.

6.4.6 Air leakage at the connection of the water-separating cup and body – check if the gasket ring is failed or lost, and check the connection. Replace the gasket ring or assemble it again.

6.4.7 Air leakage at the sheathing of the secondary filter: the sheathing is not inserted to the desired position. Insert it again to the end.

6.4.8 Air leakage caused by the broken gas cell of the gas pump, replace it.

6.5 Simple troubleshooting.



6.6 Replace the printing paper and color tape of the printer.

Replace the printing paper and color tape according to the operation method in the “Install the paper roll” and “Install the color tape” in the “Operation Manual of Micro

Surface Type Printer" attached with this instrument. Roll up the paper roll firmly during assembly, otherwise, the printing paper may be gripped with poor feeding.

7. About the excessive air coefficient (λ) and air-fuel ratio (A/F).

7.1 Theoretic combustion of fuel.

The theoretic combustion of the fuel is the process to completely oxidize the carbon element C and hydrogen element H by the oxygen in air, and produce CO_2 and H_2O only. The molecular formula of hydrocarbon fuels is CnHm, in which, n is the number of carbon atoms, and m is the number of hydrogen atoms. Its chemical reaction equation is:

$$CnHm + (n + m/4)O_2 + 3.76\ (n + m/4)N_2 = n\ CO_2 + (m/2)H_2O + 3.76\ (n + m/4)N_2$$

As per the volume, the O_2 in the air makes up about 21%, and the N_2 makes up about 79%, meaning that each oxygen molecule in the air is equivalent to 79/21 = 3.76 nitrogen molecules. So, the N_2 coefficient in the above equation shall multiply 3.76.

7.2 Excessive air coefficient.

The air volume required for the theoretic combustion of the fuel is called the theoretic air volume. In fact, the air supplied during the operation of the engine is always greater or less than the theoretic air volume. To determine the actual air volume supplied during the operation of the engine, excessive gas coefficient λ is often used.

$$\lambda = L/L0$$

In which, λ means the excessive air coefficient;

L means the actual air volume supplied during the operation of the engine with the combustion of 1kg fuels; and

L0 means the theoretic air volume required during the operation of the engine with the combustion of 1kg fuels.

The mixed air with λ = 1 is called the theoretic mixed air or standard mixed air. The mixed air with λ > 1 is called the thin mixed air, and the greater the λ amount exceeding 1, the more air than the fuel, and the thinner the concentration of the mixed air. The mixed air with λ < 1 is called the thick mixed air, and the greater the λ amount less than 1, the less air than the fuel, and the thicker the concentration of the mixed air.

7.3 Air-fuel ratio.

The concentration of the mixed air can be evaluated by air-fuel ratio (AFR), namely, the ratio between the actual air volume supplied A with the actual fuel supplied F – A/F. The greater the air-fuel ratio (A/F), the thinner the concentration of the mixed air, and the less the air-fuel ratio (A/F), the thicker the concentration of the mixed air. The air-fuel ratio (A0/F) in theoretic combustion is called the theoretic air-fuel ratio.

7.3.1 The chemical reaction equation when cyclohexane (C_6H_{12}) is taken as the gasoline for theoretic combustion:

The theoretic air volume required A0 (L0) is: $A0 = (6 + 12/4)O_2 + 3.76\ (6 + 12/4)N_2$

Take the atomic weights of O and N into the above equation, and the result is:

$A0 = (6 + 12/4) \times 2 \times 16 + 3.76 \times (6 + 12/4) \times 2 \times 14 = 1235.52$

The fuel volume of cyclohexane (C_6H_{12}) is: $F = C_6H_{12}$

Take the atomic weights of C and N into the above equation, and the result is:

$F = 6 \times 12 + 12 \times 1 = 84$

The theoretic air-fuel ratio A0/F = 14.7

7.3.2 The chemical reaction equation when isooctane (C_8H_{18}) is taken as the gasoline for theoretic combustion:

$C_8H_{18} + (8 + 18/4)O_2 + 3.76\ (8 + 18/4)N_2 = 8\ CO_2 + (18/2)H_2O + 3.76\ (8 + 18/4)N_2$

The theoretic air volume required A0 (L0) is: $A0 = (8 + 18/4)O_2 + 3.76\ (8 + 18/4)N_2$

Take the atomic weights of O and N into the above equation, and the result is:

$A0 = (8 + 18/4) \times 2 \times 16 + 3.76 \times (8 + 18/4) \times 2 \times 14 = 1716$

The fuel volume of isooctane (C_8H_{18}) is: $F = C_8H_{18}$

Take the atomic weights of C and N into the above equation, and the result is:

$F = 8 \times 12 + 18 \times 1 = 114$

The theoretic air-fuel ratio A0/F = 15

7.3.3 The chemical reaction equation when propane (C_3H_8) is taken as the gasoline for theoretic combustion:

$C_3H_8 + (3 + 8/4)O_2 + 3.76\ (3 + 8/4)N_2 = 3\ CO_2 + (8/2)H_2O + 3.76\ (3 + 8/4)N_2$

The theoretic air volume required A0 (L0) is: $A0 = (3 + 8/4)O_2 + 3.76\ (3 + 8/4)N_2$

Take the atomic weights of O and N into the above equation, and the result is:

$A0 = (3 + 8/4) \times 2 \times 16 + 3.76 \times (3 + 8/4) \times 2 \times 14 = 686.4$

The fuel volume of propane (C_3H_8) is: $F = C_3H_8$

Take the atomic weights of C and N into the above equation, and the result is:

$F = 3 \times 12 + 8 \times 1 = 44$

The theoretic air-fuel ratio A0/F = 15.6

7.4 Relationship between the excessive air coefficient λ and air-fuel ratio A/F.

Cyclohexane (C_6H_{12}) is taken as the gasoline: $A/F = 14.7\ \lambda$

Isooctane (C_8H_{18}) is taken as the gasoline: $A/F = 15\ \lambda$

Propane (C_3H_8) is taken as the gasoline: $A/F = 15.6\ \lambda$