



# Operating Instructions

For

## FP640 Flame Photometer



**HINOTEK GROUP LIMITED**

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## **1. PREFACE**

### **1.1. Overview**

Flame Photometer is an analysis instrument based on the basic principle of Emission Spectrometry. For example, if common salt is placed in flame, the flame will turn to yellow. The reason is that the outer electron of sodium atom in salt absorbs heat energy of the flame, and then transmits to excited energy level. When excited energy level is back to normal state, electron will release energy. One attribute of such energy is to emit spectral line at special wavelength of sodium atom – yellow spectral line (main wavelength is 589nm). The instrument which makes use of flame energy to emit characteristic spectrum of a certain atom, and inspects the spectrum energy to determine content of a certain element in a substance, is called flame photometer.

Featured of high sensitiveness, more choices, small sample and fast analysis speed, flame photometer is widely used in such applications as medical clinical application, soil, fertilizer, glass, ceramics, cement, refractory material, etc.

From the perspective of flame photometry, in theory, substance element content is in direct proportion to strength of emitted spectral line. However, under the influence of excited energy, and substance self absorption and self corrosion during combustion, such relation can be true only in case of low concentration. Measurement range for FP640 flame photometer is wide, and linear error will become larger with increase of solution concentration. Generally, better test result will be gained at concentration within 0-30 $\mu$ g/mL. In fact, if proper standard curve correspondent to concentration of tested sample and appropriate test methods are taken, both measurement range and linear error can meet needs of related industrial testing.

Flame photometer itself can't test absolute concentration value of the tested element. Therefore, we first need to prepare standard solution for test and calibration and to plot a standard curve. Then we can test the unknown solution. After readings displayed on the instruments are gained, we can find corresponding concentration value from the curve and then calculate the unknown concentration value for the tested substance.

FP640 flame photometer is subject to dramatic improvement based on original product, for which gas path is simplified to enable easier operation and adjustment, and digital display circuit is used to display clearer measurement results and more reliable readings. The instrument meets requirements for medical clinical test, and is also used in measurement of potassium element in agriculture and garden industry, and measurement of potassium oxide and sodium oxide in industrial applications. It can also be used to inspect Li salt administered by psychotic patient (Li filter is additionally needed).

### **1.2. Basic Parameters**

#### **1.2.1. Main Technical Specifications**

- a) Receiving element: silicon photocell;

- b) Spectrum: interference filter;
- c) Display: double channel digital display reading;
- d) Repeatability: Cv no greater than 3%;
- e) Linear error: potassium:  $\leq 0.005\text{mmol/L}$ ; sodium  $\leq 0.03\text{mmol/L}$ .

#### **1.2.2. Working Conditions**

- a) Ambient temperature: 10 -35 ;
- b) Relative humidity no greater than 85%;
- c) Instrument should be placed horizontally. Avoid direct sunshine; no strong electromagnetic field interference, no vibration affecting application;
- d) Site where the instrument is used should be equipped with fire extinguishing devices and good ventilation conditions;
- e) Power voltage:  $220\text{V}\pm 22\text{V}$ ; frequency:  $50\text{Hz}\pm 1\text{Hz}$ ; well-grounded.

#### **1.2.3. Dimension, Weight & Complete Set**

- a) Dimension:  $400\text{mm}\times 250\text{mm}\times 500\text{mm}$ ;
- b) Weight: 12.5kg;
- c) Complete set: including host machine, air compressor, gasoline carburetor, accessories, spare parts, etc.

## 2. INSTRUMENT STRUCTURE

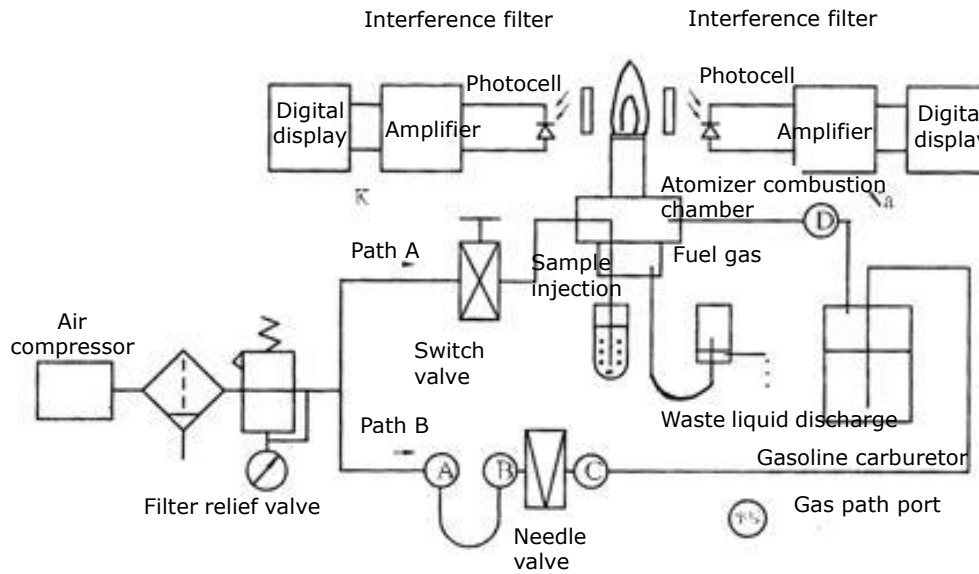


Figure 1

### 2.1. Gas Path System

Compressed air output from air compressor is adjusted to 0.15MPa through filter pressure relief valve and then divided into Path A and Path B. Path A (sample injection) is controlled by switch valve and will be used as air source of sample injection spray. Flow of Path B (fuel gas) is controlled by needle valve. Gas is filled in gasoline carburetor to mix gasoline and air and used as fuel gas and then flows into atomizer chamber. In the atomizer chamber, sample and fuel gas will be sent to combustion chamber after adequately mixed.

### 2.2. Measurement System

Sample will emit spectra line of element characteristics in the combustion chamber. The spectra line will become a light beam of single wavelength after influence of stray light is removed through interference filter. Then photocell will receive the photo energy and convert it to electricity signal. Readings of the sample can be displayed in the digital display after the signal is magnified through amplifier.

### **3. PREPARATIONS BEFORE USE**

#### **3.1. Fuel**

- a) If gasoline is used as fuel, first fill 2500mL-3000mL gasoline in gasoline carburetor and keep 1/3 space of the tank empty. Compressed air is filled at one end of the carburetor to make it bubble up under gasoline level and then go to the upper 1/3 space. Then pipe is used to lead to instrument fuel gas inlet. As mixture of gasoline and air is used, a certain ambient temperature is required while gasoline is in use to ensure gasoline gasify and combust. If the temperature is too low, it is hard to gasify and not easy to combust. No. 93 gasoline may be used when ambient temperature is relatively high. We recommend using No. 120 solvent oil where possible. Gasoline is also affected by utility time, production and storage time as well as conservation conditions. Ethanol gasoline can't be used. We recommend users to control it appropriately.
- b) When liquefied petroleum gas (LPG) is used, first remove connecting tube at Mouse A and B, and then install them to Port C and D to make Mount C and D connected. Mouse A is blocked with threaded pipe (with sealed silica gel gasket). Mouse B is covered with seal gasket or screwed on fuel gas joint with ring clip after winded by raw rubber. Connect the joint and outlet of relief valve on the LPG tank with 10mm fuel gas (otherwise purchased). Two ends should be tightly strapped and no leakage is allowed. Then open switch valve of LPG tank and adjust the flame. Instrument needle valve controls fuel gas flow in order to control the flame. Please refer to Figure 3 in *Section 4: Instrument Installation*.

#### **3.2. Solution**

- a) As different distilled water is used as solvent during solution preparation, different background value is caused. In order to avoid the difference, we recommend distilled water at the same vessel can be used during preparation and dilution of standard liquid and sample.
- b) Prepare necessary testing standard solution according to instrument testing scope in order to conduct relative measurement. Please refer to *Section 5: Instruction Operation* for specific concentration.

#### 4. INSTRUMENT INSTALLATION

##### a) Pipe connection

1. Tailor the pipe to proper length according to installation position
2. Fit nut on the pipe
3. Align the pipe to the port and fit it over, then fasten the screw tightly.



Figure 2

##### b) Gas path connection

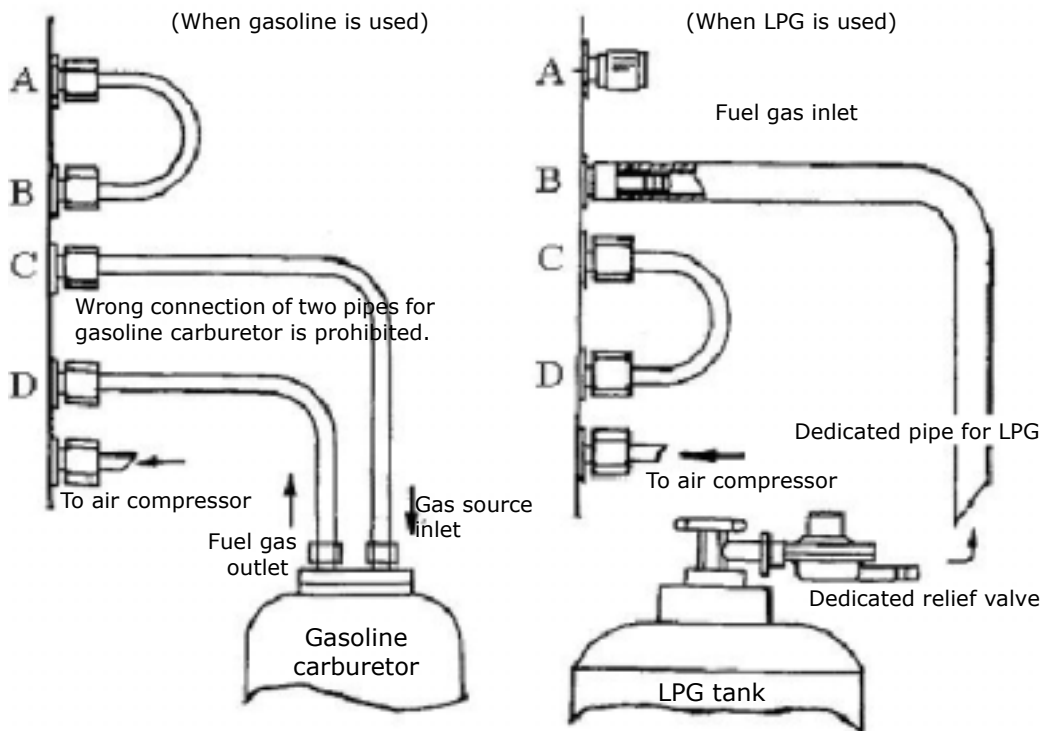


Figure 3

Note 1 (gasoline): Quick coupling with blue end has been installed on Port D and fuel gas outlet of carburetor. Just forcibly insert  $\phi 8$  rubber pipe while installation. While disassembly, push against the blue cap with fingers and pull the rubber pipe at the same time.

Note 2 (LPG):

1. Block Port A with accessories like bulkhead nut and silicon gel gasket.
2. Install outsourced rubber pipe taper joint to Port B and protect from leakage with raw rubber. Both ends of rubber pipe should be clamped

tightly.

3. First, remove the quick coupling from Port D and then remove pipe from Port A and B and then connect them according to Figure 3.

## **5. INSTRUMENT OPERATION**

### **5.1. Startup**

Place a glass cover at side of combustion chamber after installation according to requirements of *Section 4: Instrument Installation*. Add stainless wire net and clamping ring on the glass cover and then cover the chimney cap. Then the instrument can be operated once power is connected.

1. Switch power on and start air compressor. Then you will see readings on pressure gauge will increase to 0.15MPa or so. Open sample injection switch, insert a sucker in the solution. The solution will flow to atomizer chamber along with the sucker. Then the solution flow out to exhaust liquid cup shortly. It indicates the instrument atomization is normal.
2. Rotate fuel gas valve anti clockwise, and uncover chimney cap when it is not ignited. Then you can smell the gasoline and see mist waving.
3. First open sample injection switch and close fuel gas valve while ignition. Then, press ignition button and the same time gradually open fuel gas valve. Slightly pull the glass cover out and repeat ignition operation if it is hard to ignite.
4. Set sample injection switch to "Open" status and adjust fuel gas valve to make flame in blue taper shape with a little curve at bottom. Cover the chimney cap and observe if the flame is blue. Adjust fuel gas valve appropriately to make flame in blue. You can not uncover chimney cap, not close fuel gas valve but directly ignite in case of hot ignition.

### **5.2. Preheating**

The next step is preheating. As flame combustion and sample injection is a dynamic process, first temperature is at normal status and then temperature is going to rise. When fuel gas and sample injection volume are determined, the flame tends to thermal equilibrium and then the flame is relatively stable and excited energy is relatively constant. Therefore, the readings are quite stable.

Preheating will take about 30 minutes. It is better to inject sample continuously with distilled water, because it better simulates real sample injection conditions. If users only have a few samples and don't have too much time, they can begin measurement while calibration to save fuel and time.

### **5.3. Shutting Down**

Just cut off power to shut down the machine. Air compressor will immediately stop running and flame will go out as gasoline won't be gasified. When LPG is used, do not forget to close switch valve on the tank (tighten clockwise). Burn the machine with distilled water for 5 minutes at empty load before shutting down.

Do not rotate the sample injection switch or fuel gas of the instrument after shutting down. Just keep it in original state. If fuel is not changed, combustion conditions won't be subject to huge change for the next time. You can just start up and ignite the machine the next time. No need to make excessive adjustment to flame state. If it is hard to ignite the next time, please refer

to provisions in section 5.1: Startup and make slight adjustment after it is ignited.

#### 5.4. Medical Clinical Measurement

Flame photometer is mainly used to take quantitative measurement of  $K^+$  and  $Na^+$  in human serum in medical clinical application. Under normal condition,  $K^+$  is 0.04mmol/L and  $Na^+$  is 1.40mmol/L.

##### 5.4.1. Position of Switches at Back of The Instrument

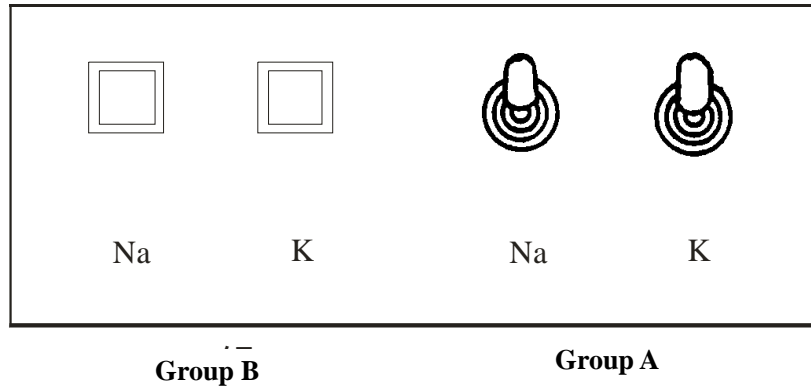


Figure 4

**Group A** is channel selection switch:

Up – to select the display.

Down – to shut down the display.

**Group B** is range selection switch:

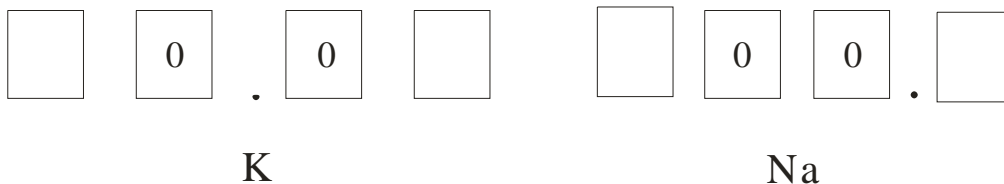
Ejected – general concentration measurement.

Pressed – higher concentration measurement.

Measurement in medical clinical application is general concentration measurement.

##### 5.4.2. Zero-full Scale Measurement

- a) Inject sample with blank solution and adjust "low scale" knob to make the instrument display following message:



- b) Inject sample with mixed solution of  $K^+$  0.04mmol/L +  $Na^+$  1.40mmol/L and adjust "high scale" knob until following screen is displayed on the instrument:

	4	.	0			1	4	0	.	
K					Na					

- c) Repeat this for several times. Sample can be tested if the readings are basically consistent.
- d) Dilute the serum for 100 times and inject sample. Readings displayed are  $K^+$  and  $Na^+$  contents of the patient's serum.
- e) Flame photometer is a relative measurement instrument. During measurement, the instrument can test samples after calibration. However, with more samples determined, standard solution needs to be recalibrated to ensure accuracy of test.

**5.4.3. Low-high Scale Measurement**

- a) As the light produced by blank solution makes K and Na content displayed to be a certain value. Readings of blank solution is not zero. From standard curve, we can see that concentration change does not go through the downward curve at zero. Measurement scope can be narrowed to a certain curve zone after low-high measurement method is used. Therefore, measurement error is reduced accordingly.
- b) As  $K^+$  and  $Na^+$  content of human serum varies within a certain range, e.g.,  $K^+$  scope is within 0.02mmol/L - 0.06mmol/L and  $Na^+$  scope is within 1.00mmol/L - 1.60mmol/L. Low scale measurement is used for  $K^+0.02\text{mmol/L}+Na^+1.00\text{mmol/L}$ , and high scale measurement is used for  $K^+0.06\text{mmol/L}+Na^+1.60\text{mmol/L}$ .

Operation steps: inject sample of  $K^+0.02\text{mmol/L}+Na^+1.00\text{mmol/L}$  mixed solution, and adjust to "low scale" knob. Following screen displays.

	2	.	0			1	0	0	.	
K					Na					

Then, inject sample with  $K^+0.06\text{mmol/L}+Na^+1.60\text{mmol/L}$  mixed solution and adjust "high scale" until following image is displayed on the instrument:

	6	.	0			1	6	0	.	
K					Na					

- c) In order to ensure measurement range for different high and low concentration, we need to change input signal of amplifier. Therefore, we are required to make

adjustment for several times so as to make display basically consistent with low and high scale concentration. Then we can begin sample measurement.

- d) Low and high measurement method is quite troublesome, but linear error is improved remarkably.
- e) Conduct sample measurement with methods specified in *section 5.4.2 d*).

### 5.5. Application in agriculture and silicate industry

In addition to traditional medical clinical measurement, this instrument is also applicable for test for agriculture and silicate industry.

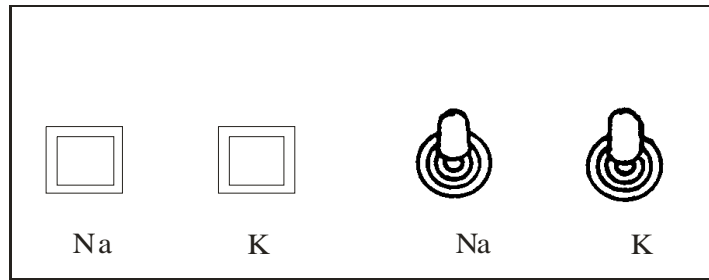
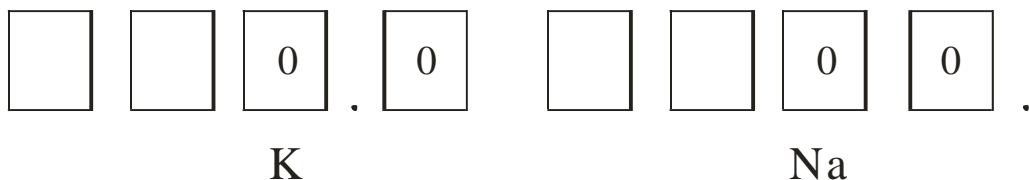


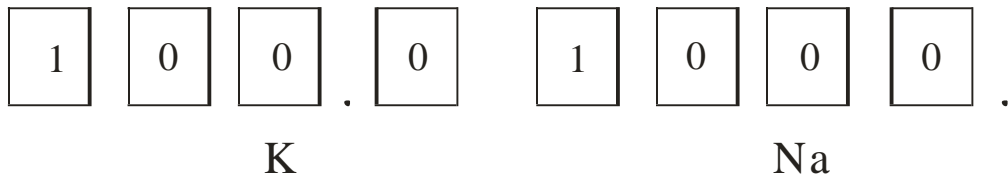
Figure 5

- a) Press down range select switch at back of the instrument under following circumstances:  $K_2O$  is greater than  $5\mu\text{g/mL}$  or  $K^+$  is greater than  $4\mu\text{g/mL}$ ;  $Na_2O$  is greater than  $50\mu\text{g/mL}$  or  $Na^+$  is greater than  $40\mu\text{g/mL}$ .
- b) Conduct measurement with zero-full scale method stated in section 5.4.2. If it is difficult to measure actual concentration of the tested substance with low-high scale method, you may refer to data given in following examples.
- c) In low scale method, distilled water or blank solution is used, where it is calibrated as 0. In high scale method,  $60\mu\text{g/mL}$  potassium +  $60\mu\text{g/mL}$  natrium standard mixed solution is used, where it is calibrated as 100. The, the last digit "0" on the display can be neglected.
- d) Input potassium and natrium standard mixed solution at interval of  $10\mu\text{g/mL}$  and record readings. Then the standard curve will be divided into five sections.

Low scale:

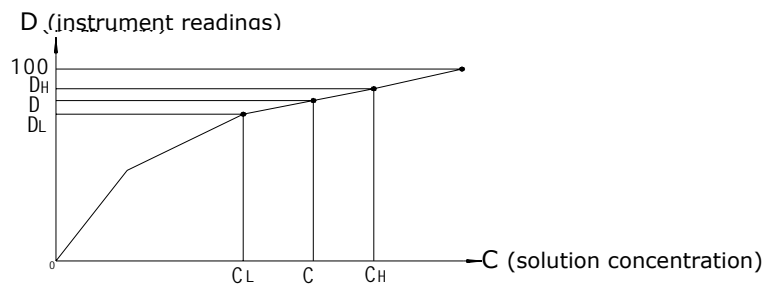


High scale:



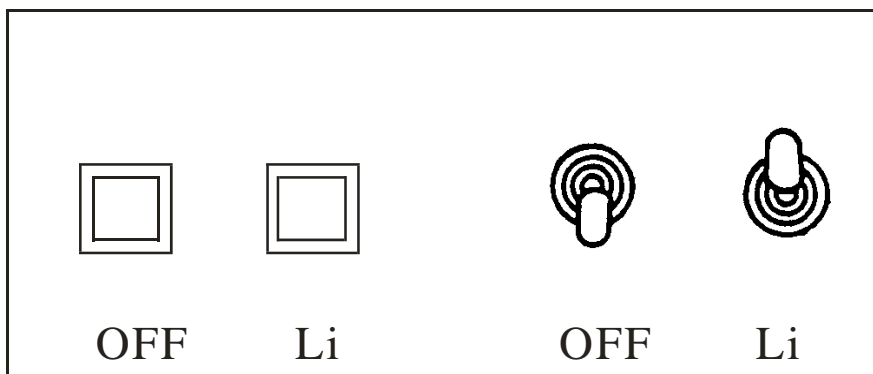
e) Input tested solution and record reading D, which is always on a certain section of standard curve. Among this section, reading at high end of concentration is recorded as  $D_H$ , and the concentration is recorded as  $C_H$ ; reading at low end of concentration is recorded as  $D_L$ , and the concentration is recorded as  $C_L$ . Actual concentration of tested solution can be calculated from below formula (1). Actual meanings of these symbols are indicated in the curve diagram.

$$C = \frac{D - D_L}{D_H - D_L} (C_H - C_L) + C_L \quad \text{----- (1)}$$



### 5.6. Measurement of Li (Li filter otherwise purchased)

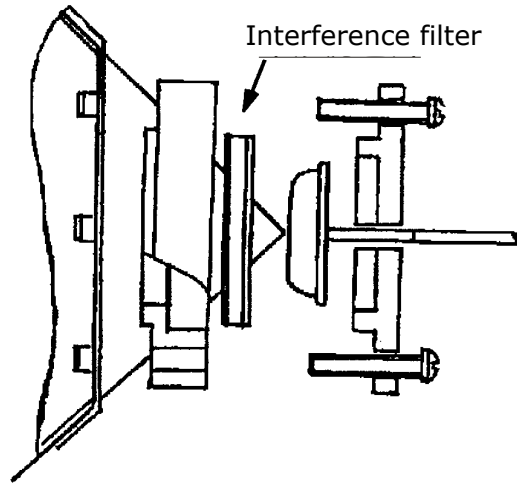
Flame photometer is widely used to make medication control of  $\text{Li}_2\text{CO}_3$  to psychotic patient. Detail method is introduced below:



**Figure 6**

a) Observe back of the instrument and the button switch is ejected. Toggle the switch up and down. Close sodium channel (no "OFF") and only display potassium channel (currently Li

channel).



**Figure 7**

- b) Open instrument cover, screw bolt on photocell tray at left and right of the chimney, and remove potassium filter. Install Li filter and reinstall and fix the instrument. Then the instrument becomes a dedicated device for Li measurement.
- c) Measurement method is the same as the zero-full scale method stated in *section 5.4.2*, i.e., first inject sample with distilled water and then calibrate to 0.

.

- d) Preparation and calibration of Li+solution

Weigh 0.1919g  $\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$  (A.R), and dissolve it with distilled water in 1L fixed measuring flask, i.e., 3mmol/L stock solution. Dilute it 10 times while in use as application solution, i.e., 0.3mmol/L and calibrate as follows:

.

- e) Measurement of background value

Inject sample of  $\text{K}^+0.04\text{mmol/L} + \text{Na}^+1.40\text{mmol/L}$  mixed solution. As K and Na signal is quite strong. Li filter background transmissibility is impossible to be zero. A "constant value" is displayed on the instrument. Assuming:

.

This value (shown above) is the background value of Li measurement.

f) Measurement of patient treatment effective value

Inject sample after patient's serum is diluted for 10 times. If following screen is displayed:

.

Then, actual Li<sup>+</sup> content of patient serum is as follows:

$$\text{Li}^+ = \frac{\text{Measured reading} - \text{blank}}{\text{Set reading}} \times \text{Standard concentration} \times \text{dilution times}$$

$$= \frac{2.0 - 0.5}{3.0} \times 0.3 \times 10 = 1.5 \text{mmol/L}$$

g) According to the records of treatment literature:

Effective treatment value for Li is 0.5mmol/L ~ 1.5mmol/L. The patient is easy to suffer from drug intoxication if the value is >1.5mmol/L.

## 6. MAINTENANCE

### 6.1. Routine Maintenance

After testing work is completed, inject sample to blank solution continuously for 5 minutes to completely clean the atomizer chamber and avoid contamination of serum to pipeline.

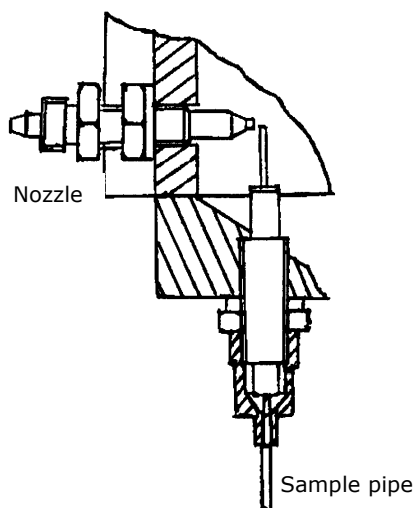
### 6.2. Water Discharge

Water in the air is compressed and condensed inside the filter relief valve or condensed in air receiver of the air compressor while air compressor of the instrument is working. Accumulated water inside in the long run will affect normal function of the instrument.

After the instrument is used for some time (several month), the user may raise the instrument, and then push against filter relief valve and blow off valve below the instrument. Then accumulated water will be discharged under force of compressed air. Then, just loosen the valve. In addition, discharge water accumulated in air receiver of air compressor when power is off.

### 6.3. Cleaning of Atomizer Chamber

The atomizing effect of atomizer chamber is the key to normal operation of the instrument. Long-time usage of atomizer chamber will block or contaminate nozzle. User may remove it for cleaning itself.



**Figure 8**

Nozzle is aligned with outlet of sample needle port, with a distance  $<0.5\text{mm}$ .

- Unscrew three fixed bolts at bottom of atomizer chamber and remove the atomizer chamber;
- Unscrew nuts of sample pipe and nozzle, and remove sample pipe and nozzle. Clean them with cleaning agent. Then reinstall them to original state;

- c) Close fuel gas valve, open air compressor, make sample injection switch at "Open" position, and insert capillary tube in the solution to observe atomizing effect; if sample is not sucked or atomizing effect is poor, adjust relative position of sample pipe and nozzle to make it generate atomizing effect. Then tighten nuts to fix it.
- d) Reinstall atomizer chamber to the instrument. You will observe mist at combustion head while sample is sucked.

#### 6.4. Replacement of Gasoline

Necessity to replace gasoline depends on combustion flame. If flame is small after it is ignited (sample suction switch at "OFF" position), and there's no change to the flame after gas volume is increased, it indicates that combustible constituents of the gasoline have been exhausted and the gasoline needs to be replaced. User may dump all gasoline, but it is required to keep 1/3 upper space of carburetor empty. Once the container is full, gasoline will directly go to atomizer chamber when air compressor is started, which is easy to lead to fire accident. Attention should be paid to fire protection while replacing gasoline.

#### 6.5. Troubleshooting

Symptoms	Causes	Repair methods
No flame	<ul style="list-style-type: none"> <li>1. No enough fuel gas</li> <li>2. Room temperature is low and gasoline is difficult to be gasified.</li> <li>3. No electricity discharge for electronic igniter</li> </ul>	<ul style="list-style-type: none"> <li>1. Replace or supplement fuel.</li> <li>2. Take insulation measures or replace highly volatile fuel.</li> <li>3. Check distance between discharge point and sprayer.</li> </ul>
Readings not stable Poor repeatability	<ul style="list-style-type: none"> <li>1. No enough fuel gas, poor gasoline quality.</li> <li>2. Atomizer chamber is blocked, and sample pipe (plastic) is distorted, both not smooth.</li> <li>3. Foreign substance at fuel spout, flashing stray light</li> <li>4. Flame too big</li> </ul>	<ul style="list-style-type: none"> <li>1. Replace fuel.</li> <li>2. Repair atomizer chamber, and replace sample pipe.</li> <li>3. Remove foreign substance.</li> <li>4. Turn down fuel gas valve appropriately.</li> </ul>
Poor sensitivity	<ul style="list-style-type: none"> <li>1. Filter is moldy</li> <li>2. Photocell is aged.</li> <li>3. Glass cylinder contamination affects transmittance.</li> <li>4. Atomizing efficiency is low.</li> </ul>	<ul style="list-style-type: none"> <li>1. Replace.</li> <li>2. Replace.</li> <li>3. Clean.</li> <li>4. Repair atomizer chamber.</li> </ul>