On-Line UV-COD Monitor

Organic Pollution Monitor

UV-5500

CONTENTS

[I] Unpacking & Inspection

To avoid damage in transit, HME products are shipped to the customer in special shipping containers. Upon receipt of the product, perform the following unpacking and inspection procedures:

Note: If damage to the shipping container is evident upon receipt, request the carrier to be present when the product is unpacked.

a. Carefully open the shipping container following any instructions that may be marked on the box. Remove all cushioning material surrounding the product and carefully lift the product from the container.

Retain the container and all packing material for possible us in reshipment or storage.

b. Visually inspect the product and applicable accessories for any physical damage such as scratches, loose or broken parts or any other sign of damage that may have occurred during shipment.

Note: If damage is found, request an inspection by the carrier's agent within 48 hours of delivery and file a claim with the carrier. A claim for equipment damage in transit is the sole responsibility of the customer.

Specification

Nomenclature : COD monitor
Model : UV-5500
Measurement Method : 2 wave length 2 Beams.
(UV 254nm/VIS 546mm)
Measurement Range : COD 0~200 ppm (standard)
COD 0~1000 ppm
Specify one of the above
Measurement Cell : Falling water stream cell,
cell column 10mm (or 6 mm) dia.
Cleaning Method : Automatic cell cleaning
by motor driven wiper & chemical solution.
Ambient Temperature/Humidity : -5~40 ^{o}c, 85%RH or less
Sample Conditions
- Temperature : 0~40 ^{o}c
- Pressure : 0.5~5 kgf/cm

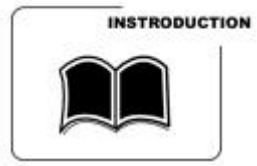
- Flow rate : 2~5 l/min

Repeatability : Within +/- 2% FS
Linearity : Within +/-2% FS
Zero Drift : Within +/-2% FS
Span Drift : Within +/-2% FS
Response Time : Within 1 min
(for 90% response, after entering sample inlet, flow rate 2 l/min)
Output Signal: 4~20mA DC (max.load 600 ohm)
Power Requirements : 220V AC ±10% 50/60Hz (110V OPTION)
Piping Connection Port :

- Sample inlet : VP 16A
- Drain port : VP 20A
- Weight : Approx. 50kg

Integrated Auto Cell chemical cleaning system
Model : CL-100

[II] Introduction



This organic pollution monitor of type UV-5500 is generally referred to as a UV(Ultraviolet) monitor. The UV monitor provides continuous measurement of organic concentration in sample solutions based on ultraviolet absorption.

This monitor features simple measuring principles and easy maintenance, which other automatic monitors do not have. Those features permit this instrument as an automatic monitor for measurement of organic concentration to meet enough the regulations of total water pollution which have recently come into effect, attracting attention from various industries. This monitor has been desired to make the most of those principle features and provide stable performance and ease of operation.

Relationship between COD and UV Absorption.

It is well known that organic concentrations in solutions may be estimated by applying ultraviolet rays of a wavelength of 254 nm to a sample solution and measuring its absorption. Much work has been done in this field. The relationship between organic concentration and ultraviolet absorption revealed by these studies can be summarized below.

(1) Any substance dissolved in water has its own peculiar absorption spectrum in the ultraviolet region.

(2) Ultraviolet absorption by such inorganic ions as chloric ions, sulphuric ions, bromic ions, or hydroxyl ions are not negligible at around a wavelength of 220 nm but are mostly negligible at wavelengths of 250 nm or longer. Thus, the absorption at wavelengths of 250 nm or longer its attributed to the existence of organic substances.

(3) Different substances have different absorption spectra in the ultraviolet region. Therefore the absorption of a substance measured at a fixed wavelength of 254 nm is proportional to its concentration, but then relationship depends on the kind of chemical.

Generally, Cyclic compounds which have double bonds have greater absorption. Chain compounds which have no double bonds exhibit smaller absorption.

Ultraviolet absorption can therefore be expected to provide a parameter for determining organic concentrations in sample solutions. However, the relationship between organic concentration and absorption map not be uniform for a large of sample solutions that use industrial waste water or river water, which contains unknown complicated organic substances. A change in the composition of an organic substance in a sample solution may disturb the relationship between organic compound concentration and absorption.

Moreover, waste water or river water always contains suspensions often colored, which cause ultraviolet rays to scatter and absorb them thus affecting the absorption spectrum.
To cope this problem, such a method is generally employed as to determine a difference between the absorption of two wavelengths : ultraviolet rays and visible rays for sample solutions containing large quantities of organic suspensions. However clear relationships may be revealed in some cases by measuring only ultraviolet rays.

Since this monitor has such problems related to its measuring principles. it is recommended to check the relationship between COD concentration and ultraviolet absorption by the specified method so as to confirm the existence of an acceptable relationship prior to using the UV monitor to meet the regulations of water pollution.

Generally, the relationship between ultraviolet absorption and COD concentration is believed to be linear for solutions such as biologically treated water, which contains organic substances of a relatively stable composition.

Main features

This ultraviolet absorbance meter (UV meter) offers the following main features that the other automatic water pollution meters do not have.

① Completely continuous measurement is possible with little delay in time.

② A relatively simple structure makes maintenance very easy.

③ Handling is very simple because no reagents at all used for measurement.

④ Initial and running costs are low.

In addition, this monitor has the following advantages over other UV meters.

① It ensures very stable and accurate measurements because a unique method is employed to compensate for fluctuations in light intensity of the UV lamp. It has special compensation circuit board.

② The calibration filter is provided on standard models zero point and span calibration is quite easy.

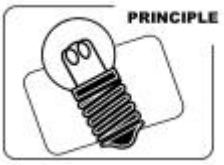
③ The automatic cell cleaner is incorporated provide excellent cleaning efficiency.

④ Values obtained immediately before automatic cleaning are held as an output during the cleaning operation.

⑤ About 500ml of sample solution is adequate to manual measurements.

⑥ Compact design permits easy handling.

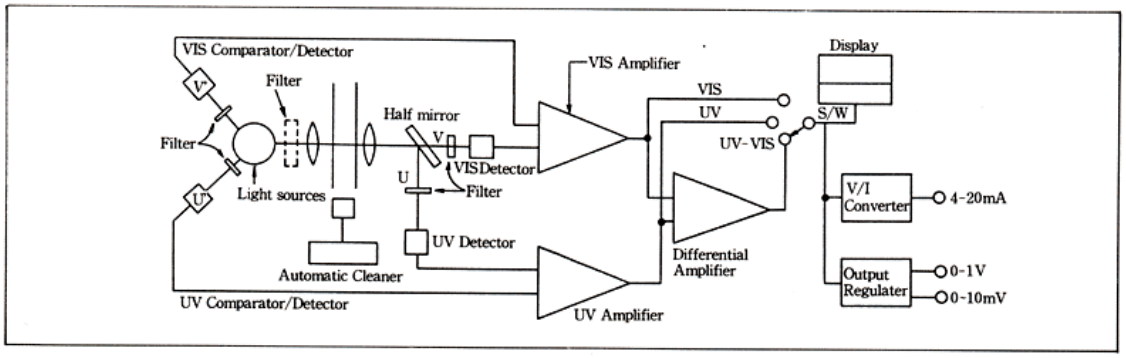
[III] Principle



Basic Principle

[Fig1] shows operating principles for the UV-5500 type organic pollution monitor. In [Fig1] radiation from a light source (high-pressure discharge lamp) is allowed to radiate in three direction.

In one direction light goes through a measuring cell and then is divided by a half mirror into two beams; U (ultraviolet rays) and V (visible rays). The light radiating in the other two forms to U'beam (reference ultraviolet rays) and V' beam (reference visible rays), which provide signals for correction of fluctuations in the intensity of the light source.



[Fig 1] Measuring principle

Beams U and U' are detected by the optical filter, which allows only ultraviolet light of a wavelength of 254 nm to pass, and the filter output is applied to the UV amplifier as an electric signal.
Beams V and V' are detected by the optical filter, which allows only visible light of a wavelength of a 546 nm to pass, and the filter output is applied to the VIS amplifier as an electric signal.
At the UV amplifier and the VIS amplifier those main electric signals are compensated for fluctuations light intensity of the light source, amplified on a logarithmic scale, and sent to the differential amplifier.

The differential amplifier then determines a difference between the ultraviolet absorption signal and the visible absorption signal, reduces them into signals free from the influence of inorganic suspensions, and sends them to the indicator. At the same time those signals pass through the V/I converter and the output regulator to provide output signals.

For sample solutions containing large quantities of organic suspensions, as mentioned above, a transfer switch (SW) is mounted on the panel to permit the signals to bypass the differential amplifier, so that only the ultraviolet absorption signal may be directly read and output.

This monitor incorporates an automatic cleaner to automatically clean the wet part of the sample cell is designed so that optical system components such as the lens, filter, and half mirror do not collect moisture due to rapid changes in temperature or humidity.

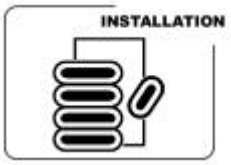
Lamp characteristics and reference beam circuit

The lamp relatively easily provides two beams of light having wavelengths of 254 nm and 546 nm that the UV meter needs. However, the relative intensity of light from the lamp varies with the ambient temperature or electric current in the lamp. The magnitude of change also differs from the wavelength of 254 nm to 546nm. Nor it is uniform for all lamps.

Fluctuations in the relative intensities of ultraviolet and visible rays may cause a drift.

To avoid the drift, a reference beam circuit, as mentioned by principle, is incorporated for each of the beams of wavelengths of 254nm and 546 nm to compensate for the fluctuations.

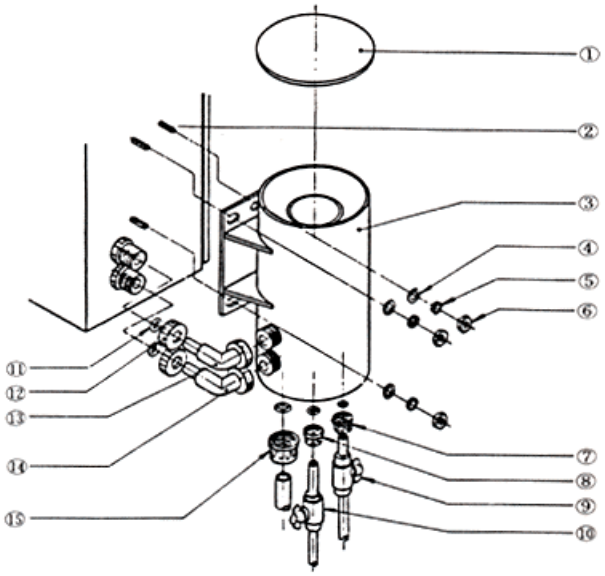
[IV] Installation



When installing Organic Pollution Monitor UV-5500 securely fasten the body of the instrument and poles (supplied as option) together with bolts and then fix the body in position with anchor bolts.

PLUMBING

Carry out plumbing work necessary to allow the sample solution to flow into the water testing tank. Use PVC (polyvinyl chloride) pipes of VP13 and install them with reference the drawing given below.



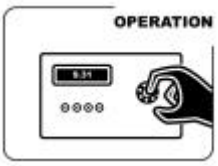
① Cover for water testing tank
② Fastening volt for water testing tank
③ Water testing tank
④ Washer
⑤ Sample washer
⑥ Nut
⑦ Fastening TP joint for VP16
⑧ TP joint for VP16
⑨ Adjusting Valve
⑩ Drain Valve
⑪ O ring for sealing
⑫ Fastening nut
⑬ Connecting elbow (sample out)
⑭ Connecting elbow (sample in)
⑮ Fastening TP joint for VP20

Power Source Connections

On the bottom of the body of this monitor are provided three conduit holes (drip proof type box connectors of size 15). Pass the power and signal cables through the conduits and connect them securely to the solderless terminals on the terminal board in the body.

The power requirements are 220V AC, 50 Hz.(or 110V AC, 50Hz) The power cable should be wired to avoid the interference by noise from motor-driven equipment and other noise sources.

[V] Operation

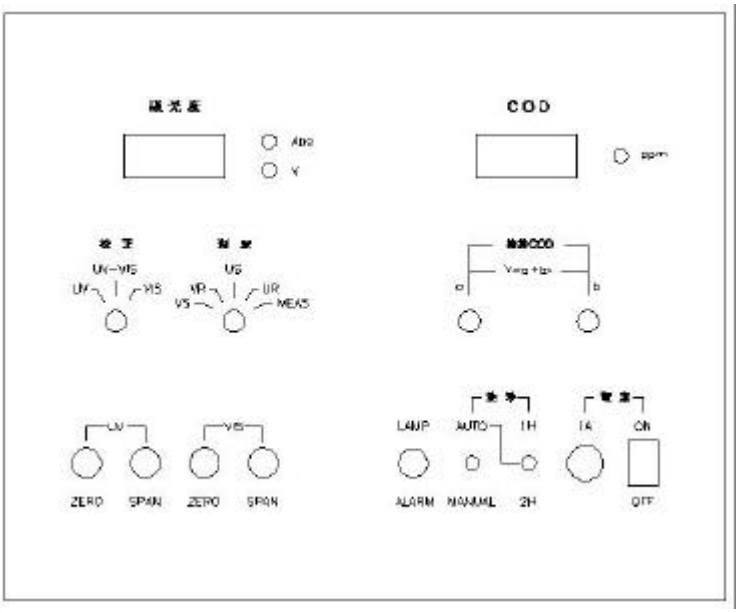


When the instrument has been installed, operate it following the procedures below.

① Start the sampling pump to send a sample solution into the water testing tank. Regulate the valve on the tank to obtain a proper flow rate (1 to 2 1/min) of the sample solution.

② open the front door and turn ON the power switch on the front panel. Then the red pilot lamp goes on and the equipment starts measuring.

③ Note that it takes about one hour for indicator readings to stabilize, when the equipment has been laid up for extended periods. This is because the lamp(high pressure discharge lamp) taken much time to stabilize.



ZERO/SPAN Adjustment Procedure

When the indications have stabilized, carry out the zero and span adjustment according to the following procedures.

Zero Adjustment

① Turn OFF the sampling pump and fully open the drain valve on the water testing tank. After complete draining close the valve. Clean the measuring cell using chemical & physical method cleaner.

Note : Clean the testing tank when making zero adjustments at the time of maintenance.

② Pour distilled water into hole of rear water testing tank for cleaning. And then, Pour distilled water into hole of rear water testing tank for adjustment.
③ When the indications have stabilized, set Adjustment(校正) switch to UV, then adjust the variable resistor for UV zero-adjustment until the meter reads 0.
④ Set Adjustment(校正) switch to VIS, then adjust the variable resistor for VIS zero-adjustment reads zero.

Span Adjustment

Monitor UV-5500 incorporates a span-calibrating filter (attenuation filter) so as to provide constant absorption at 0.8 Abs.

The adjustment procedures are given below.
① Press the "knob" for calibration filter to insert the filter.
② When the indications have stabilized, set Adjustment(校正) switch to UV, adjust the UV span adjusting variable resistor until the meter indicates the 0.8 Abs.
③ Set Adjustment(校正) switch to VIS, adjust the VIS span adjusting variable resistor until the meter indicates the 0.8 Abs.
④ The span adjustment has been completed. Then pull the calibration filter by pulling the "knob" forward.
Carry out at least twice the zero and span adjustments until no deviation occurs.

Measurement

After Zero/Span Calibration, return to UV-VIS mode.
Note : Please confirm whether calibration filter is pulled out.
① Open Adjusting Valve(9) and turn on the pump of instruments. then adjust amount of sample water using Adjusting Valve(9).
② Then switch selector of panel to MEAS.
③ Read the measuring value.

CLEANING

① Cleaning switch has 3 direction, (Manual-OFF-AUTO) Press Cleaning switch for cleaning. Cleaning shall be proceed only 1 time. Set this switch to Auto, if you need continuous and periodical cleaning. Period of cleaning is determined by 1H or 2H. 1H means 1 hour.

② Mechanical and chemical cleaner will be operated simultaneously.

[VI] Compensation

This instrument has integrated compensation circuit. Once the compensation value is entered into instrument, then It makes operator can read actual COD value without additional calculation.

Method

To reduce difference between real COD value of water analysis value in laboratory and measured COD value of instrument, user can compensate instrument according to the following procedure.

① In order to make accurate measurement, proceed ZERO/SPAN adjustment including cleaning procedure. And then, set volume a and volume b of front panel to 5.0 each.
② Note UV (Abs) value during measurement. And then, get the sample water near the instruments for water analysis in laboratory.
③ Repeat step ② several times at time interval.
④ User can calculate an equation which reduce difference between real COD value and measured COD value of instrument. Equation is same as below.

y = a + bx

Get the fixed number a and coefficient b between measured UV (Abs) values and water analysis values in laboratory.

Results can be calculated by below equation.

$$y = (Y\ average) + \frac{n\ (XY\ total) - (X\ total \times Y\ total)}{n\ (X^2\ total) - X\ total^2} \times (x - X\ average)$$

⑤ Calibrate Zero and Span using distilled water.
⑥ In order to compensate, press the "knob" for calibration filter to insert the filter.
⑦ Abs value of Standard calibration filter is 0.8
Set indicator display result value which is calculated by coefficient b times 0.8, using volume b of front panel. And then, set indicator display result value which is calculated by (coefficient b * 0.8) + fixed number a
⑧ Then pull the calibration filter by pulling the "knob" forward. Return to measuring mode.

Example

n	X	X^2	Y	Y^2	XY
1	0.27	0.0729	30	900	8.1
2	0.28	0.0784	30	900	8.4
3	0.25	0.0625	28	784	7
4	0.3	0.09	33	1.089	9.9
5	0.26	0.0676	23	529	5.98
6	0.32	0.1024	30	900	9.6
7	0.24	0.0576	28	784	6.72
8	0.23	0.0529	20	400	4.6
9	0.25	0.0625	21	441	5.25
10	0.25	0.0625	22	484	5.5
Total	2.65	0.7093	265	7.211	71.05
Average	0.265		26.5		
$(Total)^2$	7.0225		70,225		

X : Measured UV (Abs) value in instrument.
Y : Water analysis value in laboratory.
n : Sample number

$$y=(Y\ average)+\frac{n\ (XY\ total)-(X\ total\times\ Y\ total)}{n\ (X^2\ total)\ -\ X\ total^2}\times(x\ -\ X\ average)$$

$$=26.5\ +\frac{10\ \times 71.05-(2.65\ \times\ 265)}{10\ \times 0.7093\ -\ 7.0225}\times\ (x\ -\ 0.265)$$

$$=117.02x\ -\ 4.51$$

① Adjusting volume b
When calibration filter is inserted, x value(UV Abs) shall be 0.8
Note : Abs value of standard calibration filter is 0.8

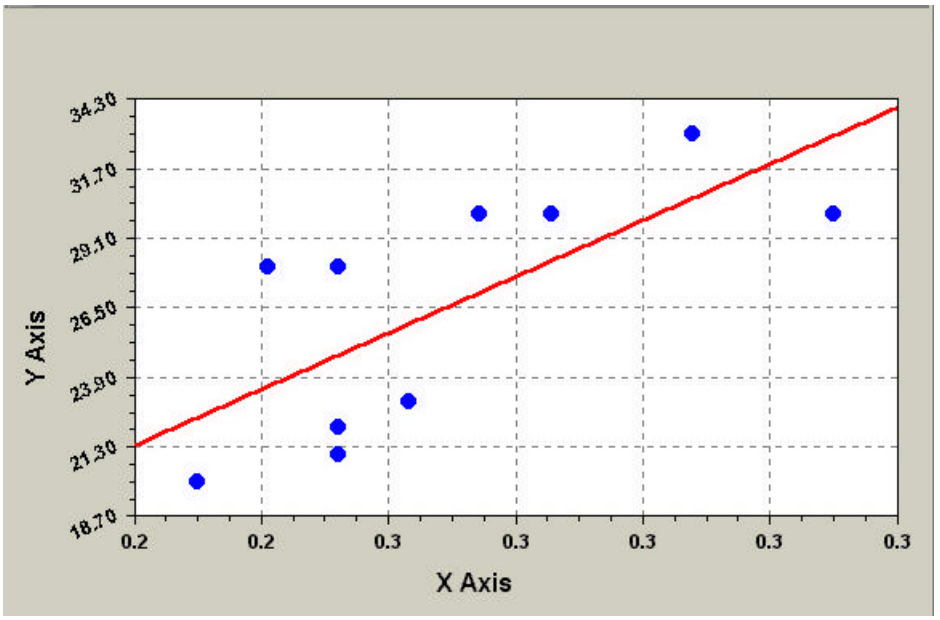
Y = (117.02 x 0.8) + a
Therefore, Y = 93.61 + a
Please set display value to 93.61 adjusting volume b.

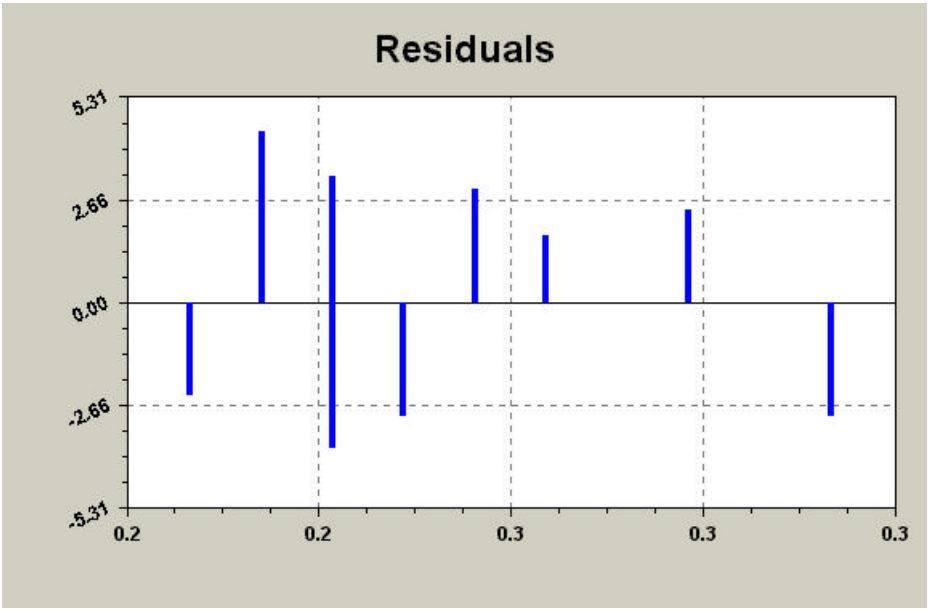
② Adjusting volume a
Next, you can get result value when fixed number a is adopted.

y = 93.61 - 4.51
therefore, y = 89.1

Please set the value of display value to 89.1 adjusting volume a. and then, return to measuring mode.

Now operator can read actual COD value without further calculation. Compensated instrument has measuring curve which is same as below.





[VII] MAINTENANCE & INSPECTION

Cleaning of Water Testing Tank

Open the cover the tank and remove dirt on its inner surface once a week, though depending on the properties of water tested. Inspection period should be shortened for cleaning of heavy dirt.

Cleaning of the Sample Solution Line

Periodically clean the pipeline between the water testing tank and the measuring cell, which is not automatically cleaned unlike the measuring cell which is automatically cleaned every hour.
Loosen the joints of the water testing tank and the instrument body and remove the pipes. Then carefully clean the pipe connections in the instrument body with brush.

Cleaning of the Measuring Cell

Remove dirt on the inner surfaces of the measuring cell, working a rubber brush up and down. However, some kinds of dirt cannot be removed by physical cleaning. Such dirt can be removed relatively easily by the use of a chemical (approx. 4% diluted hydrochloric acid).
Such dirt deposits may cause an increase in zero point on the UV side which affects measurements. To avoid this problem, clean the measuring cell by the following procedure.

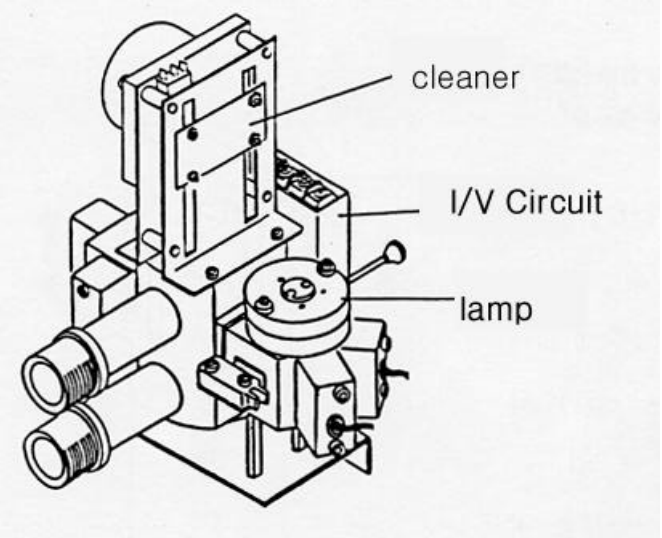
① Close the water valve on the water testing tank and then open the drain valve. after the tank is drained, close the drain valve.

② Place about 0.5 Liter of a chemical (approx. 4% diluted hydrochloric acid) into the tank and allow it to stand for about five min or so.

③ Then depress the cleaning button to manually move a rubber brush up and down. This operation should be repeated a few times.

④ Drain the chemical in the tank, pour distilled water in the tank and then, proceed Zero/Span adjustment procedure.

Note : If instrument have automatic chemical cleaner, above procedure shall be performed automatically during mechanical cleaning.



Replenishment of the Cleaning Chemical

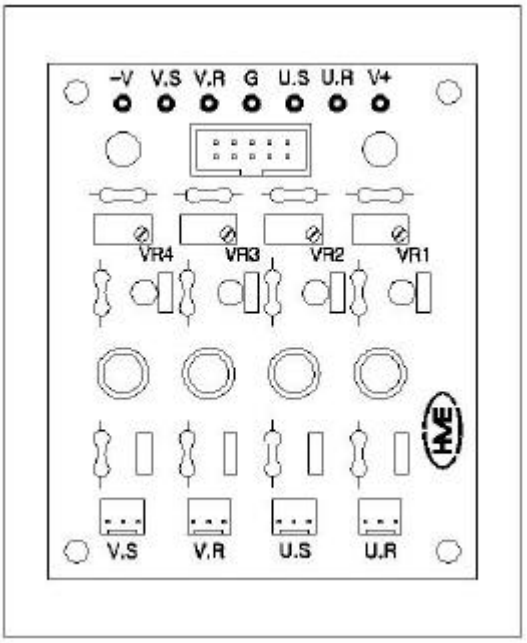
Replenish a cleaning chemical. The chemical should preferably be an about 4% diluted hydrochloric acid solution. The replenishment interval should be vary by the amount of replenishment, cycle of replenishment and capacity of the tank.

Replacement of the Light Source Lamp

Continuous measurement by the UV meter deteriorate the light source lamp. When it is deteriorated beyond use, the light source alarm lamp
goes on. If the alarm lamp lights, adjust the variable resistor on the I/V board until a proper light source output is obtained.

If the adjustment of the variable resistor does not results in eliminating the problem, replace the light source lamp with a new one and allow one or two hours of aging.

Strength of lamp light can be adjusted on variable resistor of I/V circuit board.



Adjustment of volumes in I/V Board

The Optical system in this monitor is provided with an I/V circuit board as shown above.

① Pour distilled water into water test tank.
② Wait lamp have stabilized. Voltage outputs of VS, VR, US, UR are not stabilized, If lamp is not stabilized.
③ Check whether standard calibration filter pulled out.
④ Change switch position to VS. Operator may learn VS voltage output value on left indicator of front panel. Adjust the variable resistor volumes VS(VR4) until voltage output value on indicator became 6V.
In serial order, make sure whole voltage outputs VS(VR4), VR(VR3), US(VR2), UR(VR1) to 6V.

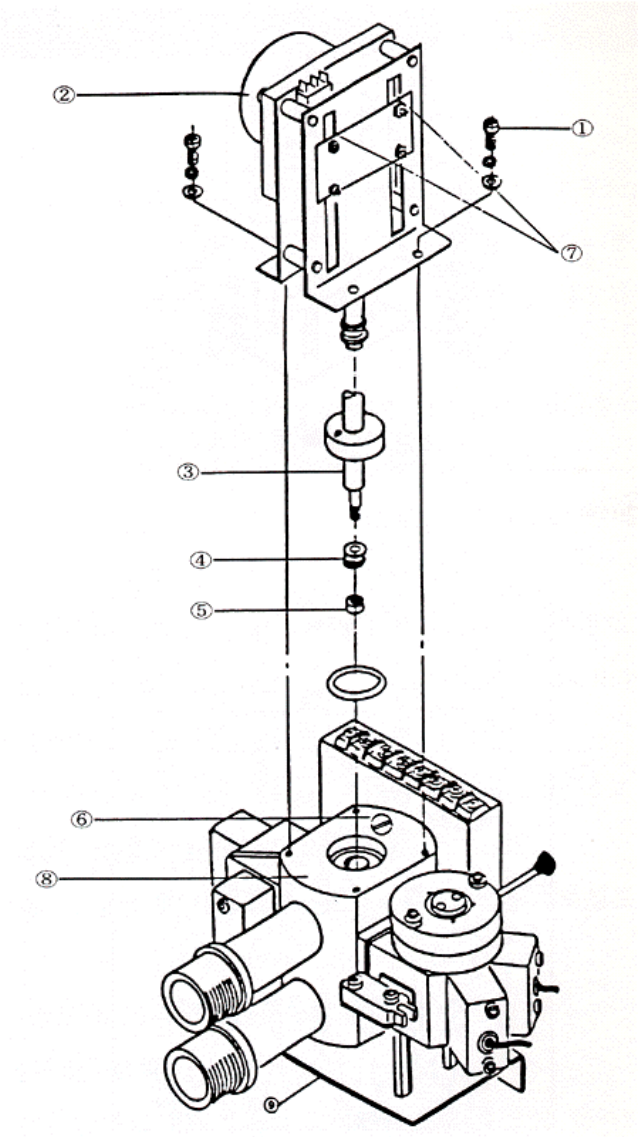
Note: if monitor have 0-1000ppm measuring range, set voltage outputs(VS, VR, US, UR) became 10V.

Replenishment of the Desiccant (Silica gel)

Exchange always desiccant (silica gel) when the cleaning rubber or the measuring cell has been replaced with a new one.
When the cleaning rubber has been replaced, open the desiccant inlet and replace the desiccant with new silica gel. Then close the inlet and make sure that the screw should be at a lower level than the surface of the optical system body.

Regreasing of the Piston Rod

Silicone grease is applied to the piston rod to permit the cleaning section to work smoothly. However, the piston rod may run dry after extended periods continuous measurement. A dry piston rod silicone disturbs the cleaning operation. To avoid this problem, apply silicone grease to part ③,⑦ in Fig.



① Screw
② Cleaning Motor
③ Piston Rod
④ Cleaning Rubber
⑤ Rubber Fastening Nut
⑥ Desiccant Inlet
⑦ Grease Inlet
⑧ Optical System Body

[VIII] CHECK LIST

Perform maintenance and inspection according to the procedures given below. The table given below should be used as a guide for maintenance and control, although the maintenance and inspection procedures should be varied, depending on the properties of water tested.

Maintenance Program					Description	Frequency					Procedure	Time required
Item				Program designation		At initial startup	Weekly	1 ~ 3 Months	semiannually	Annually		
Components	Meter sampler section	1	Water sample drainage	Drainage check	Check that drainage permits constant water flow without causing leakage	○	○			□	Visually inspect and replace tube periodically or whenever broken	10 min
		2	Sample regulating tank	Regulating tank level check	Check that regulating is always filled up to overflow level	○	○				Visually inspect	20 min
				Regulating tank cleanup	Check that regulating tank interior is not contaminated	○	○				Visually inspect and clean with brush if necessary	
	Measuring section	1	Sample cell wet scrubber	Scrubbing effect check	Check for proper scrubbing operation	○	○				Visually inspect	10 min
				Scrubbing operation check	Check that automatic scrubbing operation is performed at specified intervals	○	○					
				Scrubber element and tubing replacement	Check for sufficient scrubbing effect	○		□			Visually inspect and replace as necessary (periodic replacement is recommended)	30 min
		2	Light source lamp	Lamp replacement	Check lamp for deterioration			□			Visually inspect and replace when zero or span calibration is impossible (periodic replacement is recommended)	1 hr
		3	Zero and span check	Zero check	Calibrate with distilled water	○	○				Visually inspec	10 min
				Span check	Calibrate with calibration filter	○	○					
	Indicator recorder section	1	Recorder (option)	Record chec	Check for smooth chart transport	○	○				Visually inspect	10 min
				Chart replacement	Check amount of remainder		○	□			Visually inspect and refill as necessary	
				Ink check	Check amount of remainder		○	□				

On-Line COD Monitor

UV-5500

WARRANTY

HME warrants meters and parts manufactured and supplied hereunder to be free from defects in materials and workmanship for a period of 12 months from date of shipment. If within such period any meters or parts shall be proved to Seller's satisfaction to be defective, such meters or parts shall be repaired or replaced at Seller's option.

Seller's obligation hereunder shall be limited to such repair and replacement and shall be conditioned upon Seller's receiving written notice of any alleged defect within 10 days after its discovery and, at Seller's option, return of such meters or parts F. O. B. to Seller's factory.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS OR IMPLIED WARRANTIES WHATSOEVER INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES (EXCEPT OF TITLE) OF MERCHANT ABILITY AND FITNESS FOR A PARTICULAR PURPOSE. HME shall not be liable for any defects attributable to acts or omissions of others after shipment, nor any consequential, incidental or contingent damage whatsoever.

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Equipment sold by HME is not intended for use in connection with any nuclear facility or activity unless covered by a specific quotation where the conditions of such usage will be detailed.
If equipment is used in a nuclear facility or activity without a supporting quotation, HME disclaims all liability for any damage, injury or contamination, and the buyer shall indemnify and hold HME, its officers, agents, employees, successors, assigns and customers, whether director indirect, harmless form and against any and all losses, damages or expenses of whatever form or nature (including attorneys fees and other costs of defending any action) which they, or any of them, may sustain or incur, whether as a result of breach of contract, warranty, tort (including negligence), or other theories of law, by reason of such use.