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जल परिशोधक यंत्र — पराबैंगनी रोगाणुनाशक सहित — विशिष्टि

Indian Standard

WATER PURIFIERS WITH ULTRA-VIOLET DISINFECTION — SPECIFICATION

ICS 11.080.99

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 4

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Hospital Equipment Sectional Committee had been approved by the Medical Equipment and Hospital Planning Division Council.

Water is not always fit for human consumption. Water may have foul odour, colour, turbidity, taste and most seriously, microbiological bacteria, which are hazardous to health. The foul taste can be because of contamination from dissolved solids. The colour can also be because of dissolved solids. Solids in suspension can cause both colour and turbidity. The presence of microbiological bacteria is most dangerous both because they are not visible to the naked eye and can cause ailments, which can prove fatal.

Dissolved solids can be removed only by elaborate treatment, which would not be practicable at every point of consumption. The public utilities can practise the treatment processes, before effecting the supply and distribution. The treatment-process can be one of neutralization, which can often cause precipitates, which then have to be removed as solids in suspension.

Filtration is the most common process for removing the solids in suspension. Even the smallest and simplest purifier would always have a filter. The filtration may be preceded by sedimentation, which can be accentuated by alum-dosing, etc.

For purifying water of its microbiological impurities, the traditional method has been of boiling the water. IS 9310 : 1979 specifies a water purifier with a heating element. This makes the process more time-consuming, more so, because the boiled water has to be cooled before consumption. The method is not energy-efficient, as the amount of water being purified is often in excess of the need of the consumer.

The other methods of disinfection, such as chlorination can affect the taste, odour and colour of water, while making it safe to drink.

Use of ultra-violet emission for disinfection is one of the modern techniques. The purifiers employing ultra-violet emission are operated, whenever a consumer would need to draw water. Thus, it is energy-efficient and at the same time is capable of rendering the bacteria harmless, ensuring safety against the health-hazards from water-borne diseases.

While preparing this standard, the committee has emphasized that water purifier will help in removing only the suspended matter and bacteria and will not filter any dissolved solids or chemicals. Water filters should, therefore, be used for filtering only that water which does not contain dissolved solids/chemicals beyond the permissible limits (*see* IS 10500 : 1991).

Indian Standard

WATER PURIFIERS WITH ULTRA-VIOLET DISINFECTION — SPECIFICATION

1 SCOPE

This standard covers water-purifiers employing ultra-violet (UV) radiation for disinfection of water. The purifier is expected to give water born pathogen free water, safe and suitable for human consumption. These purifiers are hence suitable for domestic use, for use in offices and places of public gatherings.

The water obtained from the purifier is not exactly the distilled water. It cannot hence be used, where only distilled water is specified.

2 REFERENCES

The following Indian Standards contain provisions which, through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
302 : 1979	General and safety requirements for household and similar electrical appliances (*fifth revision*)
3025	Methods of sampling and test (physical and chemical) for water and wastewater:
(Part 10) : 1984	Turbidity (*first revision*)
(Part 25) : 1986	Chlorine, demand (*first revision*)
9310 : 1979	Water purifier, potable
10500 : 1991	Drinking water (*first revision*)

3 CONSTRUCTION

3.1 Method of Mounting

Since the purifiers are expected to work for domestic use, their inlet ought to be so designed, that it can be connected to the tap. The units for domestic use shall facilitate wall-mounting or table top. Typical illustrations of the purifier are given in Fig. 1 and 2.

3.2 Main Components

Water purifier with UV disinfection would have the following components.

3.2.1 *Essential*:

a) Water inlet,
b) Carbon filter,
c) Optimal UV transmitting medium,
d) Purifier body with cover,
e) Gaskets and seals,
f) Indicator of proper functioning of UV lamp,
g) Pre-filter chamber,
h) UV lamp,
j) UV chamber,
k) Indicator lights for main supply, and
m) Supply cable with adaptor.

3.2.2 *Optional*:

a) Voltage stabilization circuit,
b) Electronic control circuit,
c) Solenoid operated valve, and
d) Flow switch.

NOTE — It is desirable to have proper voltage supply to get the appropriate UV intensity.

4 TERMINOLOGY

4.1 H_{Min}

The minimum static head required upstream of the purifier for the purifier to deliver the rate of flow, declared by the manufacturer.

4.2 H_{Max}

The maximum static head, permissible upstream of the purifier.

5 DESIGN AND PERFORMANCE REQUIREMENTS

5.1 Power Supply

The purifiers requiring power up to 1 kW, as of those for domestic use shall be capable of working with a single-phase, 220 ± 10 V, 50 Hz, a.c. supply.

The purifiers requiring power above 1 kW shall be capable of working with a three-phase, 415 ± 20 V, 50 Hz, a.c. supply.

5.2 Maximum Rate of Flow

The maximum rate of flow available from the purifier is one of the main items for the selection of a purifier by the user.

The rate of flow is related to the flow-velocities, provided in the design of the purifier, such that the water passing through the UV chamber gets adequate radiation, to render the bacteria in the water harmless.

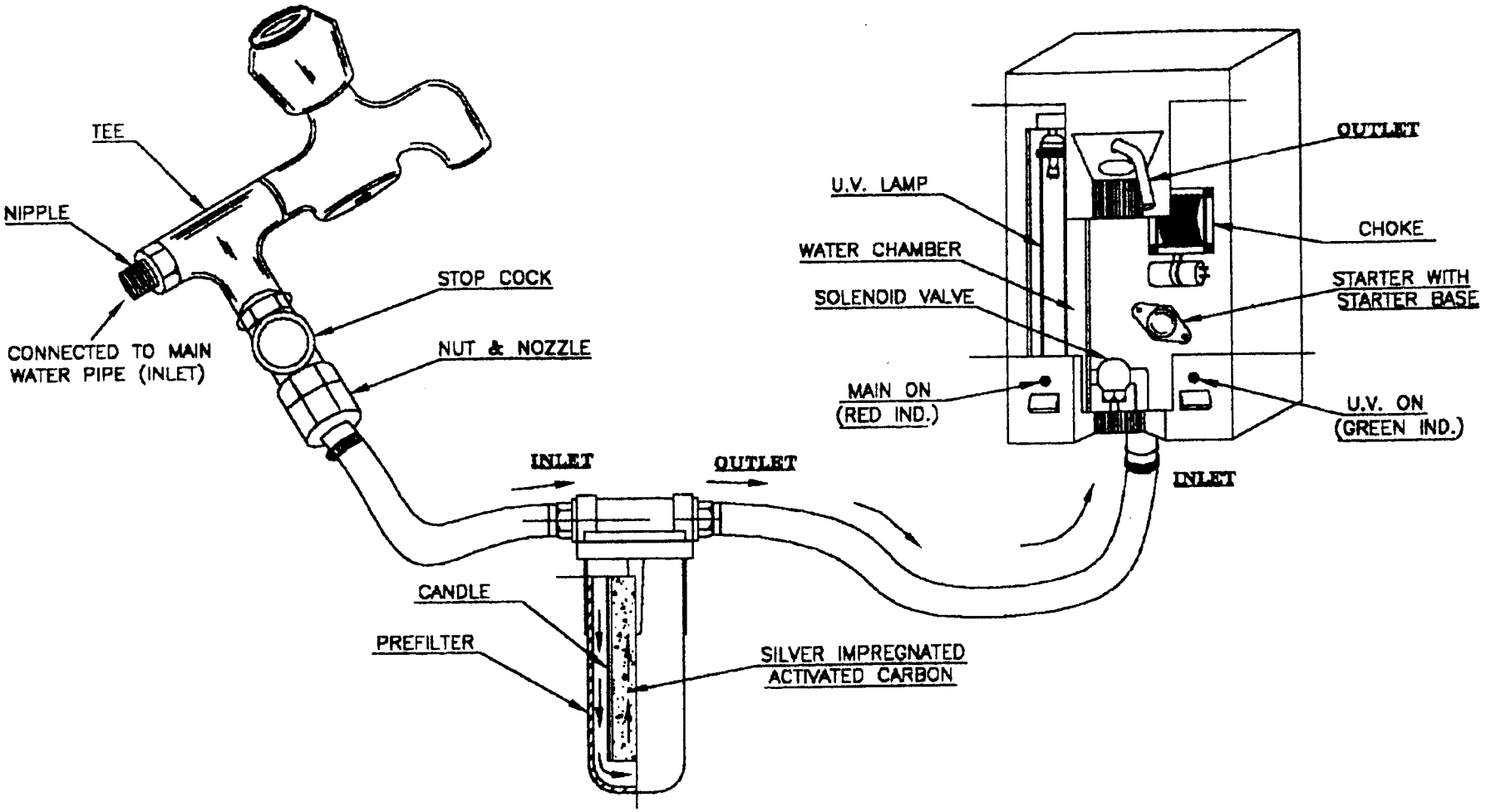

FIG. 1 INSTALLATION DIAGRAM FOR U.V. WATER PURIFIER — TYPE I

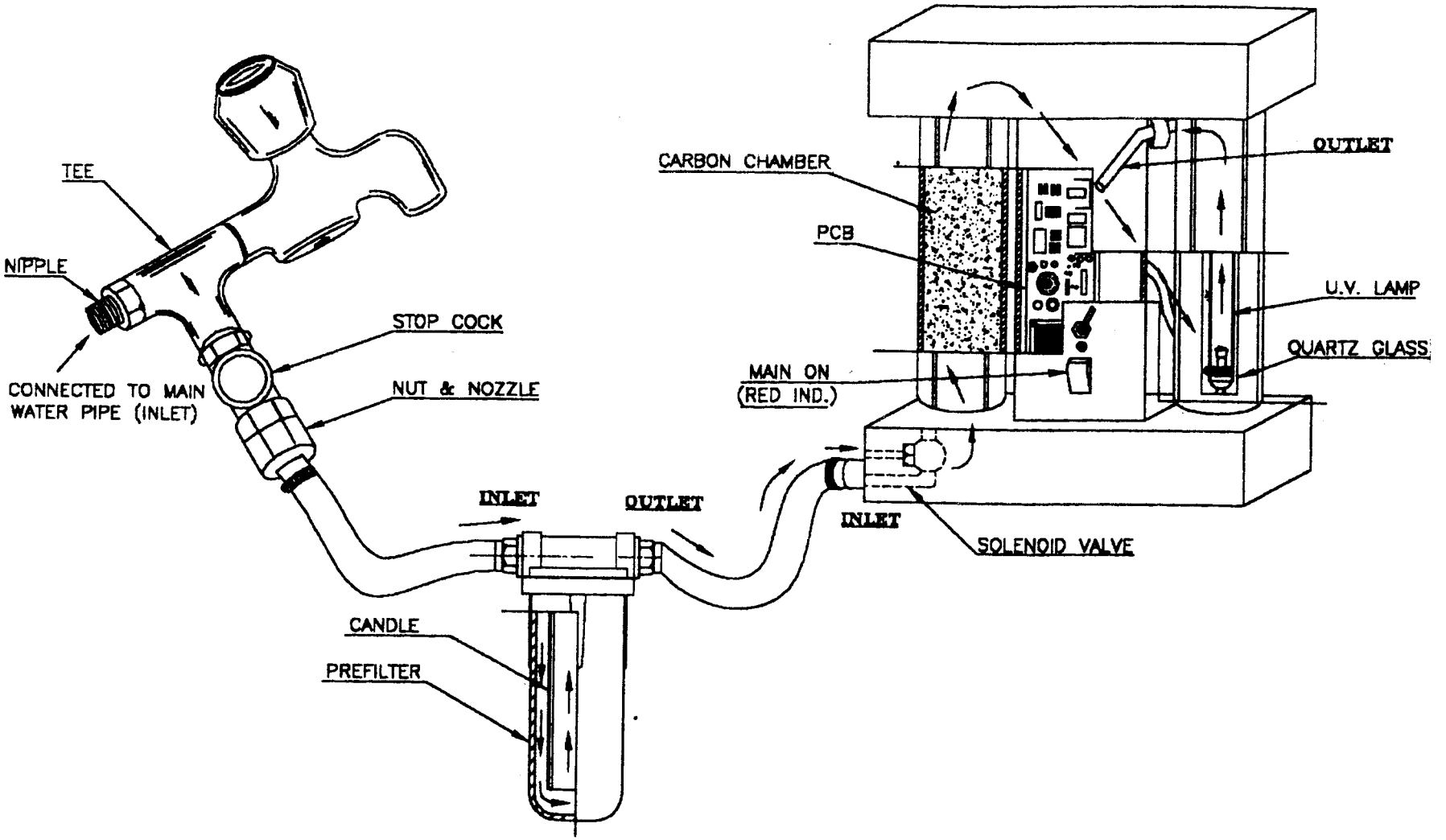

FIG. 2 INSTALLATION DIAGRAM FOR U.V. WATER PURIFIER — TYPE II

The purifier shall deliver the maximum flow-rate declared by the maufacturer on the unit as well as in the instructions manual when:

a) the filter candle is not clogged, as in its ex-works conditions; and
b) the minimum head H_{Min}, upstream of the purifier is available, limited within the maximum upstream head H_{Max}, recommended by the manufacturer in the instructions manual.

5.3 Electrical Safety

5.3.1 The entire electrical circuit shall be insulated from the water purifier, such that the leakage current shall not be more than 300 microamperes, when tested in accordance with the method given in IS 302.

5.3.2 The electrical circuit shall be also capable of withstanding for 1 min, a high voltage test at 1 000 V rms between body and the live parts, when tested in accordance with IS 302.

5.3.3 All parts of metallic construction shall be permanently and reliably connected to an earthing termination within the purifier.

5.4 Materials of Construction

5.4.1 Those surfaces of the components of the purifier, which are expected to get wetter by the flow of water through the purifier, shall be made of corrosion-resistant materials or shall have a corrosion-resistant treatment or coating of food grade quality. The coatings when applied shall not be soluble in water and shall not peel off at the maximum flow-velocity, expected at the surface.

5.4.2 The materials used for construction of the UV chamber shall be resistant to UV, non-degradable and non-leaching type up to specific time.

5.4.3 The internal surfaces of the UV chamber should be smooth polished and reflective of the UV light.

5.4.4 The elastomeric materials like rubber, used for components like seals, which are expected to get wetted by the flow of water through the purifier, shall be of food grade and UV resistant wherever applicable.

5.5 Safety Against UV Exposure

The UV chamber or the body of the purifier shall be such an enclosure, that the user does not get exposed to the UV light during the normal usage of the purifier.

5.6 Indicating Lights, In-Built Protections and Ease of Operation

5.6.1 An indicator light, preferably a red Light Emitting Diode (LED), should be provided to indicate the power supply being 'ON'.

5.6.2 An indicator light, preferably a green LED, should be provided to indicate when the initial water in the purifier would have received adequate radiation and would be ready to be drawn.

5.6.3 When solenoid valve is provided the electronic control circuit should contain a 'No Pass' system, comprising a sensor on the UV chamber, which will keep the solenoid valve closed, if there is any deposition on the UV transmitting medium around the UV lamp. The depositions may block the UV light from reaching the water. Hence, such 'No Pass' system will prevent any drawal of water from the purifier, if the water would not receive adequate UV-disinfection because of any deposition on the UV transmitting medium (protection also when UV lamp is not working or burnt out).

6 MANUFACTURE AND TESTING

6.1 Leakage-Tightness

All those portions of the purifier, through which the water passes, shall be checked by a hydrostatic test at a pressure, which will be 1.5 times the H_{Max}, that is the maximum upstream head recommended by the manufacturer.

6.2 Verification of Guarantees of Performance

6.2.1 *Maximum Rate of Flow*

The test for verifying the maximum rate of flow shall be conducted by collecting the discharge from the purifier into a calibrated volumetric measure alongside a count of time using a stop-watch.

During the test, upstream head shall be maintained within 5 percent above the recommended H_{Max}.

6.2.2 *Performance Tests*

The purifier shall be fed with tap water available from the community supply. Samples of water drawn from the purifier after purification shall be analysed for their purity. The tests given in **6.2.2.1** to **6.2.2.4** shall be conducted.

6.2.2.1 *Test for turbidity*

The purified water shall satisfy the following requirements in respect of turbidity when tested by method prescribed in IS 3025 (Part 10):

Input	*Output*
25-20 NTU	≤ 5 NTU

6.2.2.2 *Test for suspended particles*

It shall pass the test for freedom from suspended particles when the water taken in a clear 250-ml beaker made of colourless glass, shall not show any suspended particles when examined visually from a distance of 30-35 cm.

6.2.2.3 *Test for microbiology*

The UV purifier shall inactivate/kill the selected standard challenging organism *Sarcina lutea* (*Micrococcus luteus*) as per the details given in Annex A.

6.2.2.4 *Test for adsorption of activated carbon*

After passing 50 l of water containing 2 ppm *Max* chlorine purified water should not contain greater than or equal to 0.2 ppm of chlorine [*see* IS 3025 (Part 25)].

NOTE — To have optimum results carbon filter shall be replaced as per manufacturer's instruction.

7 MARKING

7.1 A nameplate shall be fixed on the body of the purifier, at a conspicuous location. The nameplate shall be marked with the following details:

a) Brand name;
b) Production serial number;
c) Minimum upstream head, H_{Min};
d) Model name or code;
e) Maximum flow-rate in l/min;
f) Maximum upstream head, H_{Max};
g) Rating of UV lamp in watts;
h) Life of UV lamp;
j) Supply voltage whether single or three-phase, frequency, volts and wattage; and
k) Warnning in case solenoid value is not provided as follows :

'DO NOT DRAW WATER UNLESS GREEN LAMP IS ON'.

7.2 An instructions manual for the proper method of operation and use of the purifier shall be supplied along with the purifier. It shall also include the life and specification of UV lamp.

7.3 BIS Certification Marking

The purifier may also be marked with the Standard Mark.

The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act,* 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers, may be obtained from the Bureau of Indian Standards.

8 PACKING

The packing of purifiers shall be as agreed to between the purchaser and the manufacturer.

ANNEX A

(*Clause* 6.2.2.3)

MICROBIOLOGICAL TEST FOR UV WATER PURIFIER

A-1 The water purifier must kill or inactivate all types of disease causing microorganisms from the water. The test shall be performance-based utilizing realistic worst case challenge organism and test conditions and the effluent water quality shall be equivalent to that of a public water supply meeting the microbiological requirements and the intent of the national primary drinking water regulations.

A-2 CHALLENGE ORGANISM

Selected standard challenge organism shall be *Sarcina lutea (Micrococcus luteus)* (MTCCI 2470).

NOTE — Microorganisms differ in their sensitivity to UV radiation. This variation may be due to the structure, thickness and composition of cell wall; to the presence of UV absorbing proteins or to the structure of the nucleic acids. Water-borne diseases may be caused by a wide variety of pathogenic microorganisms. Disinfection of drinking water with UV must ensure a maximum dose to cover this wide variation of sensitivities, for example, for 99.9 percent inactivation/kill of *E.coli* the UV dose required is 7 000 μ W-sec/cm^2 whereas a similar reduction of *Salmonella typhimurium* requires a dose of approx. 15 200 μ W-sec/cm^2. Similarly UV lamp output needed to inactivate certain bacteria is as follows:

Vibrio cholerae	6 500 μ W-sec/cm^2
Polio virus	21 000 μ W-sec/cm^2
Rota virus	24 000 μ W-sec/cm^2
Sarcina lutea (Micrococcus luteus)	26 400 μ W-sec/cm^2

As per NSF International (NSF) and Environmental Protection Act of USA (EPA) the recommended UV dosage for disinfecting contaminated water is 38 000 μ W-sec/cm^2 at the failsafe point and for potable water it is 16 000 μ W-sec/cm^2 at 50 percent of the UV lamp's normal output.

Since the dose required for *E. coli* is quite low that is 7 000 μ W-sec/cm^2, therefore selecting *E.coli* as the indicator organism and its 99.9 percent inactivation does not directly implies that other pathogenic organisms like *Salmonella typhimurium, Streptococcus haemolyticus Echo virus,* etc, that require a much higher dosage would also be eliminated. On the other hand, the dose required for 99.9 percent inactivation of *Sarcina lutea* is one of the highest, therefore the elimination of this organism by a UV water purifier implies and ensures that practically all the water-borne pathogenic microbes whose sensitivities fall under this dosage range would be definitely and positively inactivated/killed.

A-2.1 Colony Characteristics on Agar

A-2.1.1 It is dark yellow in colour, opaque, coarsely granular, medium size, circular, raised, moist, glistening, entire and convex.

A-2.2 Growth Medium

A-2.2.1 The growth medium shall be Nutrient Agar or Nutrient Broth.

A-2.3 Culture Media

A-2.3.1 The culture media shall be as follows:

Nutrient Broth		*Nutrient Agar*	
Peptone	5.0 g	Peptone	5.0 g
NaCl	5.0 g	NaCl	8.0 g
Beef extract	1.5 g	Beef extract	3.0 g
Yeast extract	1.5 g	Reagent grade water	1 000 ml
Reagent grade water	1 000 ml	Final *p*H (25°C)	7.3 ±0.2
Final *p*H(25° C)	7.4 ±0.2		

A-2.3.2 *Gram's Staining Reagents*

Grams iodine, crystal violet solution, saffranin solution, ethyl alcohol.

A-3 PREPARATION

A-3.1 Inoculum Preparation

Using an inoculating needle transfer the pure culture into a sterile and cooled nutrient broth culutre tube (10 ml) and incubate at 37±0.5° C for 24 h.

A-3.2 Dilution Water

Dechlorinated sterile tap water shall be used for preparation of dilution water.

A-3.3 Test Water

Spike 5 l of dilution water with 5 ml of *Sarcina lutea (Micrococcus luteus)* cell suspension (broth culture). This test water should produce a count of 2.0 to 2.5 × 10^3 CFU/ml otherwise count can easily be standardized by few preliminary tests. The test water shall be used as influent water and shall have following characteristics:

a) Turbidity ≤ 1 NTU,
b) *p*H value 7-8,
c) Temperature 25 ± 2° C.

A-4 PREPARATION OF TEST UNIT AND ACCESSORIES FOR SAMPLING

A-4.1 Ageing

Since maximum drop in initial UV intensity occurs during the first 24 h period, therefore the device shall be kept 'ON' for minimum 24 h (that is the UV lamp should have been glown for 24 h) prior to subjecting it to the challenge test.

A-4.2 Water flow/route pipes, pump and UV chamber (of the device) shall be shock disinfected with a strong oxidizing agent like chlorine and thereafter flushed clean with sterile water in order to completely eliminate the traces of any residual effect of the disinfectant.

A-5 TEST PROCEDURE FOR SAMPLING

A-5.1 Pass the test water through the UV chamber of the device (while it is 'ON') using the presterilized tubing and pump (preferably peristaltic). The rate of flow of test water through the device should be maintained as per the manufacturer's specification. Let initial 1.5 l to drain from the output spout and then collect 150 ml sample in duplicate in a presterilized 250 ml flask. Immediately proceed for membrane filtration.

A-6 MEMBRANE FILTRATION, PLATING AND INCUBATION

A-6.1 Output/Effluent Sample

Using MF technique filter 100 ml of each sample through 0.45 μ membrane filter. Keep membrane onto an NAM plate and incubate at 37 ± 0.5° C for 24 h.

A-6.2 Input/Influent Sample

Subject 1 ml input sample to serial dilution (10^{-2}, 10^{-3}). Using MF technique filter 1 ml of each dilution and plate it onto NAM. Input sample shall also be analyzed in duplicate. Incubate the plates at 37 ± 0.5°C for 24 h.

A-7 VERIFICATION AND COLONY COUNT

A-7.1 Observe the plates after the incubation period. *Sarcina lutea (Micrococcus luteus)* colonies on NAM are dark yellow in colour, opaque, coarsely granular, medium sized, circular, raised, moist, glistening, entire and convex. Count the colonies in influent and effluent sample plates using a colony counter. Simultaneously, pick up few colonies from both types of plates and observe under the microscope after Gram-Staining. Gram positive spherical cells, 1.0-2.0 /μm in diameter occurring singly, in pairs and characteristically dividing in more than one plane to form tetrads, irregular clusters or packets or cells; confirms *Sarcina lutea (Micrococcus luteus).*

A-8 RESULTS AND COMPUTATION

A-8.1 Disinfection efficiency shall be calculated using the following formulae:

$$\text{Percent disinfection} = \frac{\text{CFU/100 ml in input} - \text{CFU/100 ml in output}}{\text{CFU/100 ml in input}}$$

A-8.2 The device shall pass the following disinfection level:

Organism	*Influent challenge*	*Minimum required log*	*Percent reduction*
Sarcina lutea (Micrococcus luteus)	10^6 /100 ml	03/100 ml	99.9 percent

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Review of Indian Standards

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TO
IS 14724 : 1999 WATER PURIFIERS WITH ULTRA-VIOLET DISINFECTION — SPECIFICATION

(*Page* 1, *clause* **1**, *sentence* 2) — Insert the following at the end of second sentence:

'subject to the purifier shall be fed with tap water available from the community supply as per **6.2.2**'

(MHD 14)

Reprography Unit, BIS, New Delhi, India