International Association of Plumbing and Mechanical Officials – India

Evaluation of Point of Use Drinking Water Purification systems – Specification IAPMO- I WPS-01:2019

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1. **INTRODUCTION**

Point-of-use (POU) Drinking Water treatment units have become very essential in every household of Indian consumer in order to protect from health risks due physical, microbiological and chemical contaminants that are gaining entry in to drinking water sources majorly because of unhygienic practices. Treatment technologies namely Ultra Violet radiation, membrane technologies, resin/active agent leaching media are widely being used for drinking water disinfection and treatment to alleviate and polishing the quality of the drinking water.

Treatment devices that remove microbial and chemical contaminants are playing a significant role in reducing disease burden, especially in developing countries. Bureau of Indian standards has developed different individual standards for evaluating performance of drinking water treatment products based on technologies namely Ceramic candles, Ultra Violet radiation and Reverse Osmosis. All these standards adequately deal with evaluation of point of use water purification systems for their performance. The current standard deals with detailed testing of Material safety, Structural integrity, Water efficiency rating ( in case of Reverse Osmosis systems), microbial, physico-chemical reduction performance tests thus making the document fully comprehensive in nature.

IAPMO India has taken an initiative to develop the above mentioned comprehensive standard (for evaluating Drinking water purification products using different technologies) supersedes the approach of all other standards that are currently existing. The products/ standalone filters complying to this standard will help Indian consumers to choose an appropriate treatment system.

This standard emphasizes an opportunity for organized sector of industry that produce complete units and/or components to improve their quality standards and at the same time facilitates to adherence and maintenance of good manufacturing practices and Quality assurance in production and product performance.

PART – A: TECHNICAL REQUIREMENTS

1. **SCOPE OF THIS DOCUMENT:**

This document is aimed to cover minimum quality compliance tests and also the contaminant reduction tests irrespective of the technology used in the water purification system. The products passing all the Quality compliance and performance tests in terms of physico-chemical and microbial reduction tests will qualify for certification as per this standard. Failure to passing any of the minimum quality compliance tests will lead to disqualification of the product for performance tests as well as certification process.

**Section – A. Minimum quality compliance tests**

i) Material safety test for any water purification systems/components

ii) Structural integrity tests for any water purification systems/components

**Section - B**. Contaminants & Salt Reduction tests for water Purification systems

i) Turbidity reduction

ii) Chlorine reduction

iii) Microbial reduction

iv) Pesticide reduction

v) Salt rejection

vi) Inorganic reduction

vii) Metal reduction

viii) Iron reduction

**Section - C**. Water Efficiency rating test for RO based water purification systems

Note: Section C containing Water Efficiency rating test can’t be done separately under this standard. The sections A and B are prerequisite criteria and they have to be passed before conducting Water Efficiency test.

The section A i) and ii) can be used for testing filter bowl and cap (housings).

The section A i) can be used for testing Plastics, elastomers, smaller components all that are likely to come in direct contact with drinking water.

**iii) TERMS AND DEFINITIONS**

The terms and definitions described in this document pertain only to this standard.

iii.1 Purified water production

The ability of the RO system to deliver treated water either in terms of direct flow, into the storage tank (just covered with a lid) or a pressurized tank under the specified test water and other conditions as per this standard. The total volume of the treated water is considered as the volume equivalent to that produced during a time period of 1 hour or the volume that is filled in the storage tank from the point when purified water started coming out of the outlet spout in case of a direct flow model, falling into the storage tank and pressurized tank till the point where production of treated water stops due to auto shut off. In this document a synonym of Permeate water is also used for Purified water.

iii.2 Purified water production rate

The ratio of the total output (treated water) water to the total input water.

iii.3 Purified water flow rate

Total volume of treated water dispended either in direct flow model or the volume filled in the storage tank from point of start of filtration in to the storage tank till the point of filtration stops due to auto shut off. The flow rate essentially expressed as total volume of treated water dispensed per hour irrespective of the model of RO system. All these data are applicable under specified conditions of test water and other test conditions.

iii.4 Minimum allowable value of water efficiency:

Under prescribed testing conditions set out by this standard, the minimum purified water production rate allowed/required from the RO membrane.

iii.5 Material safety is the compliance of product water leachates under international extraction methods which is collected over 72 hr and pooled water is analysed for all the Drinking water parameters. The leachates are expected to be well within IS10500:2012 Drinking water Maximum Acceptable limits.

iii.6 Structural integrity : The complete assembled units when pressurized from the input port (shall include any connector, coupler, a part of the installation kit provided by the manufacturer) till the outlet port at 6 or 7 Kg/Sq.Cm, as applicable, for 30 minutes there shall not be any leakage of water from all components and joints.

iii.7 Water Recovery Efficiency: The actual amount of treated water (permeate) produced in a duration of specified time of running and corresponding reject water and auto flush water, in case of direct flow models, are taken into consideration for arriving at Water efficiency rating of the product under testing.

**SUMMARY OF TESTING REQUIREMENT AND ACCEPTANCE CRITERIA FOR VARIOUS WATER PURIFICATION SYSTEMS/STANDALONE FILTERS EVALUATION Table – 1**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| S.No | Name of  the test | Type of Water Purification Technology | | | | | No. of units for testing | Acceptance criteria for Product water Quality |
| UV | UF | RO | RESIN/MEDIA | OTHERS |
| 1 | Material  Safety | √ | √ | √ | √ | √ | 2 Fresh units | 72 hr extracted pooled water to comply IS10500:2012 Drinking water Requirement Acceptable Limit Maximum |
| 2 | Structural  Integrity | √ | √ | √ | √  Gravity flow storage type WPS exempted, UV chamber is exempted## | √ | One of the two units used for Material safety tests | When the test unit is pressurized from the input port (shall include any connector, coupler, a part of the installation kit provided by the manufacturer) till the outlet of the water purification system, for non-RO products, at a rate of 6 Kg/Sq.Cm for 30 minutes and for RO products at 7.0Kg/sq.cm for 30 minutes, there shall not be any leakage of water from all components and joints. Also there shall not be any emerging air bubbles from water joints. |
| 3 | Water  Recovery Efficiency | -- | -- | Optional  ### | -- | -- | 1 Fresh RO membrane in any of the units tested. Pre and Post filters of RO to be removed. | The product shall pass 5\*,4\* or 3\* as per its capability |
| 4 | Microbial reduction | √ | √ | √ | √ | √ | The second unit used for Material safety | Minimum of 5 log reduction for Klebsiella terrigena MTCC2271, 3 log reduction of MS2 phageATCC15597B1 when tested for 5 days. |
| 5 | Turbidity reduction | √ | √ | √ | √ | √ | The unit used structural integrity | From an input Turbidity of 15 NTU to <5 NTU |
| 6 | Chlorine  reduction | √ | √ | √ | √ | √ | Same unit as above | From an input Chlorine of 2 mg/L to < 0.2 mg/L |
| 7 | Pesticide reduction | -- | -- | √ | -- | -- | Same unit as above | From 10 µg/L of total pesticide to 0.5 µg/L as total pesticide or 0.1µg/L as an individual pesticide |
| 8 | Salt  rejection | -- | -- | √ | -- | -- | Same unit as above | At least 90% reduction from an input water TDS of 1500 mg/L |
| 9 | Inorganic reduction | -- | -- | √ | -- | -- | Same unit as above | From 3 mg/L of Input water Fluoride as F to <1 mg/L. From 150 mg/L of input Nitrate as NO3 to < 45 mg/L |
| 10 | Metal reduction | -- | -- | √ | -- | -- | Same unit as above | From 3-5 times of concentration in the input water to less than the acceptable limits as per IS10500:2012 Drinking water specification |
| 11 | Iron reduction | -- | -- | √ | -- | -- | Same unit as above | From 1.0 mg/L input Iron as Fe to < 0.1 mg/L |

**##** UV chamber is exempted from pressurizing. However, in case the UV chamber is installed as Pre cooler, under the sink or in other installations where UV chamber is subjected to pressure ( if the chamber is connected between two solenoid valves or ON/OFF valves) shall be tested under structural integrity using 6kg/Sq.cm pressure for 30 minutes.

**###** Manufacturer has an option of excluding these tests if the product is not capable of meeting any of the star rating designated as 5,4 and3. In such case the product will be tested as per sections A and B.

SECTION - A. Minimum quality compliance tests

A i) Material safety test for any water purification systems/components

**A.i.1 SCOPE**:

The point – of – use systems referred in this standard are intended to be used for purifying Drinking water sources at house hold which are operated 2 – 4 times a day by the consumer. In general, the systems are left in electrically off condition and the water is stagnated in the void spaces of the filters, purification chambers, tubing, connectors and all various other fittings that are part of the product assembly. This standard establishes minimum health effects requirements for the chemical contaminants and impurities that are indirectly imparted to drinking water from products, components, and material used in drinking water systems.

**A.i.2 ACCEPTANCE CRITERION:**

Materials in contact with drinking water shall not impart levels of target compounds that exceed the maximum Acceptable Limit as per IS10500:2012 Drinking Water Specification (Table 19, page 23)

**A.i.3 PRINCIPLE INVOLVED IN MATERIAL SAFETY DETERMINATION**

The product or component under testing is thoroughly flushed with tap water as per manufacturer’s recommendation and then exposed to an aggressive water medium for three consecutive periods of 24 hr duration. From all the three exposures, water samples are collected and pooled together. A representative volume of extracted water is used for analysis in order to determine various physico- chemical, inorganic, organic, metallic and pesticide constituents by appropriate methods.

**A.i.4 EXPOSURE WATER**

Systems and components shall be exposed to RO/DI water that has been adjusted to contain TDS of 50 ± 5 mg/L, 0.5 ± 0.05 mg/L Free available chlorine and pH of 6.75 ±0.25. Exposure water used to evaluate systems or components shall be maintained at a temperature of 23±2 0C

**A.i.5 PREPARATION OF EXPOSURE WATER**

Add 17 mg of MgSO4.7H2O in 1 Liter of RO DI water (with < 5 micro Siemen/Cm) thoroughly. Add 30 mg of NaHCO3 in to the mixture and dissolve. Then add 20 mg of CaCl2.2H2O to these contents and dissolve thoroughly. Add sufficient Sodium Hypochlorite solution in order to achieve 0.5 mg/L free available Chlorine. Check TDS and accordingly adjust to 50 mg/L by adding small quantities of NaCl ( @ 1 mg of NaCl in 1 Liter will yield 1 ppm of TDS). Check pH and accordingly adjust to 6.75 by adding HCl ( 5%solution).

**A.i.6** **EXPOSURE PROCEDURE:**

**A.i.6.1 Plumbed in Units without reservoir**

Two systems shall be installed as shown in Figure -1. Systems shall be flushed with tap water adequately to drive away all the manufacturing debris, colour and odour if any. Unit shall be run for at least 20 Liter of filtration. Then the systems shall be conditioned with exposure water by allowing at least 10 Liter volume to flow through. The exposure shall be carried out at 14.4 PSI ( 1 Kg/Sq.Cm) pressure. The flow rate shall be adjusted to maximum as per manufacturer’s recommendation.

Figure:1 Installation of the Test units for Material Extraction test

Control valve for by-pass Test unit – 1 Test Unit – 2

Pressure Gauge

50-100 Lit Exposure water tank Pump Connection pipes

The systems shall be filled with exposure water adequately and be maintained for a period of 24 hr at a temperature of 23 ± 2 0C. In this condition the unit shall be electrically off. After the completion of 24 hr period, first fraction of 2Liters of water sample shall be collected from each product into a 6Lit glass vessel with a ground glass stopper. The systems shall again be flushed with exposure water at least for 10 Lit filtrations and left for another 24 hr stagnation. After 24 hr period, the first fraction of 2 Lit water sample from each system shall be collected into the same 6Lit vessel. The systems shall again be flushed with exposure water for at least 10 Lit filtration and left for 3rd consecutive stagnation of 24 hr. After this period, the first fraction of 2Lit water sample from each unit shall be collected into the same 6 Lit vessel. The pooled water sample of 6 Lit to be used for analysis. .

Note: During each stagnation period the product shall be in OFF condition electrically. Units shall be under pressurized condition.

Note: Adjust tap water used for flushing with a concentration of TDS 400-500ppm, Hardness of 250-300 ppm, pH of 7.2 to 7.8 and temperature of 23 ± 2 0C.

**A.i.6.2 Plumbed in Units with reservoir**

In case of products like RO and products with any other technology having a storage tank, following method shall be used for collection of water samples. Two products to be connected to Exposure water source with 14.4 PSI input water pressure. The units to be flushed with tap water as per manufacturer’s recommendation. After flushing, the units shall be conditioned by exposure water filtration and filling in to the storage tank once. The product to be switch off electrically. The storage tank water shall be discarded through the outlet tap, except for 2 Liter ( to be retained in the storage tank). The system to be maintained at a temperature of 23 ± 2 0C for 24 hr. After the stagnation period, the products to be run and treated water to be allowed to fill in the storage for another 1 Liter (the total volume in tank will be 3 Liters). Systems shall be switched off electrically and 2 L water sample to be collected from each unit through outlet tap into a 6 Lit glass vessel with ground glass stopper.

The units shall again be flushed with exposure water, storage tank to be refilled. The tank water to be discarded except for 2 Liter from the storage tank. The system to be maintained at a temperature of 23 ± 2 0C for the second 24 hr stagnation. After this period, the product to be run and treated water to be allowed to fill in the tank for another 1 Liter (the total volume in tank will be 3 Liters). Systems shall be switched off and 2 L water sample to be collected from each unit through the outlet tap into the same glass vessel of 6 Lit capacity with ground glass stopper.

By following the above methodology, after 3rd set of 24 hr stagnation period, 2L water sample shall be collected into the same vessel through outlet tap of the product.

The pooled sample of 6L from the vessel to be used for analyzing various test parameters as shown in Table:28 – page 34.

Note: During each stagnation period the product shall be in OFF condition electrically. Units shall be under pressurized condition.

**A.i.6.3 Plumbed in components and critical consumables**

Components that are used in assembling the Water Purification systems ( examples such as cartridges of Sediment filter, Carbon filter, RO filter, UF filter, Nano filter, antiscalants, water quality polishing cartridges, mineral addition cartridges etc. shall be subjected to exposure and extraction in order to determine the safety of the components in contact with drinking water. Multiples of components to be used in parallel to contain at least 8 components X 250 ml volume = 2Lit (considering a void volume of 250 ml). In this case, initially the components to be connected to Exposure water source with 1.0 Kg/Sq.Cm input water pressure. The units shall be flushed with tap water as per manufacturer’s recommendation. Then the units shall be conditioned by passing Exposure water at a flow rate equivalent to maximum recommended service flow rate of the component. At least 10 liters of exposure water shall be passed through each component and left for stagnation for 24 hr. At the end of 24 hr period, first fraction of water samples shall be collected in to 6Lit glass vessel with a ground glass stopper, making sure delivery of 250 ml from each cartridge /filter so that the total volume is 2 Lit. Again the components shall be flushed for another 10L with exposure water and left for stagnation for another 24 hrs. At the end of 24 hrs period, first fraction of 250 ml water samples from each component shall be collected in to the same 6 Lit vessel so that the total volume withdrawn is 2Lit. The same procedure shall be repeated for third consecutive 24 hr and water samples shall be collected in to same glass vessel.

The pooled sample of 6L from the vessel to be used for analyzing various test parameters as shown in Table:28 – page 34.

Note: During each stagnation period the product shall be in OFF condition electrically. Units shall be under pressurized condition.

Note: During each stagnation period the product shall be in OFF condition electrically. Units shall be under pressurized condition.

The exposure water from the feed water tank ( connected to the units/ components for conducting exposure and extraction procedures as described above) shall be collected through that end of the tube which is connected to the test unit. For the purpose the tube can be disconnected from the unit and samples of 2Lit water to be collected after every 24 hr interval. This water also to be pooled in 6Lit glass jar with ground glass stopper. **This sample will be treated as Blank.**

**A.i.6.4 Pour through Models with bottom reservoir.**

In this case two completely assembled units are used. The test units shall be flushed with tap water as per manufacturer’s instruction after installing. The units shall then be conditioned with Exposure water for at least 2 filtrations. After 2nd filling of the bottom reservoir discard filtered water from bottom reservoir through outlet tap except for 2 Lit and left for stagnation of 24 hr. After 24 hr period, exposure water to be filtered from top reservoir and allow to fill bottom reservoir for 1Lit. Top reservoir to be removed. 2Lit water sample shall be collected from the bottom reservoir through outlet tap into 6Lit glass jar with ground glass stopper.

The product shall be assembled, conditioned with 2 filtrations with exposure water. Filtered water from the bottom reservoir shall be discarded except for 2 lit and left for stagnation of 24 hr. After 24 hr period, exposure water to be filtered from top reservoir and allow to fill bottom reservoir for 1Lit. Top reservoir to be removed. 2Lit water sample shall be collected from the bottom reservoir through outlet tap into 6Lit glass jar.

Above procedure shall be repeated for 3rd consecutive 24 hr stagnation and 2 Lit water sample shall be collected from the bottom reservoir through outlet tap into 6Lit glass jar.

The poled sample of 6Lit from the vessel to be used for analyzing various test parameters as shown in Table:28 – page 34.

The exposure water from the feed water tank ( in which exposure water was prepared) shall be collected freshly every day and added to 6Lit glass jar with ground glass stopper. 6 Lit Pooled sample of 3 consecutive 24 hr period shall be collected. **This sample will be treated as Blank.**

**A.i.6.5 Smaller components:**

Components made of plastics, foams, elastomers and components like metallic check valves, blending valves, saddle valves or any such item that come in direct contact with water shall also be evaluated separately for Quality assurance purposes for Material safety tests using this standard.

For this purpose, the material under testing shall be taken as high as 10 times the surface area when compared to the area that come in contact with water in the assembled product. The samples shall be taken in a glass beaker and flushed in running tap water ( as shown in Fig – 2) at least for 5 minutes.

Figure - 2 Flushing and rinsing method for components in Material Extraction test

Running Tap waterC:\Users\User\Desktop\download.jpg

1 Lit Glass vessel

Components like

O rings, washers etc.

These components are to be rinsed with exposure water thrice by adding 1L exposure water and stir with a glass rod for 15 – 20 times. The rinse water to be discarded. After completion of three rinses, 1Liter exposure water shall be added to the contents and left for stagnation of 24 hr. After 24 hr period, 1 liter sample shall be decanted into a 6 lit glass jar with ground glass stopper. The samples shall again be rinsed thrice with exposure water, left for stagnation of 24 hr. After 24 hr period, 1 Lit sample to be decanted into the same sampling jar. The same procedure shall be repeated for 3rd consecutive 24 hr stagnation and collection of 1 Lit sample be completed.

The pooled sample of 3L from all 3 extractions is diluted to 6 liters by adding exposure water. The prepared sample to be used for analyzing various test parameters as shown in the Table:19-Page 29

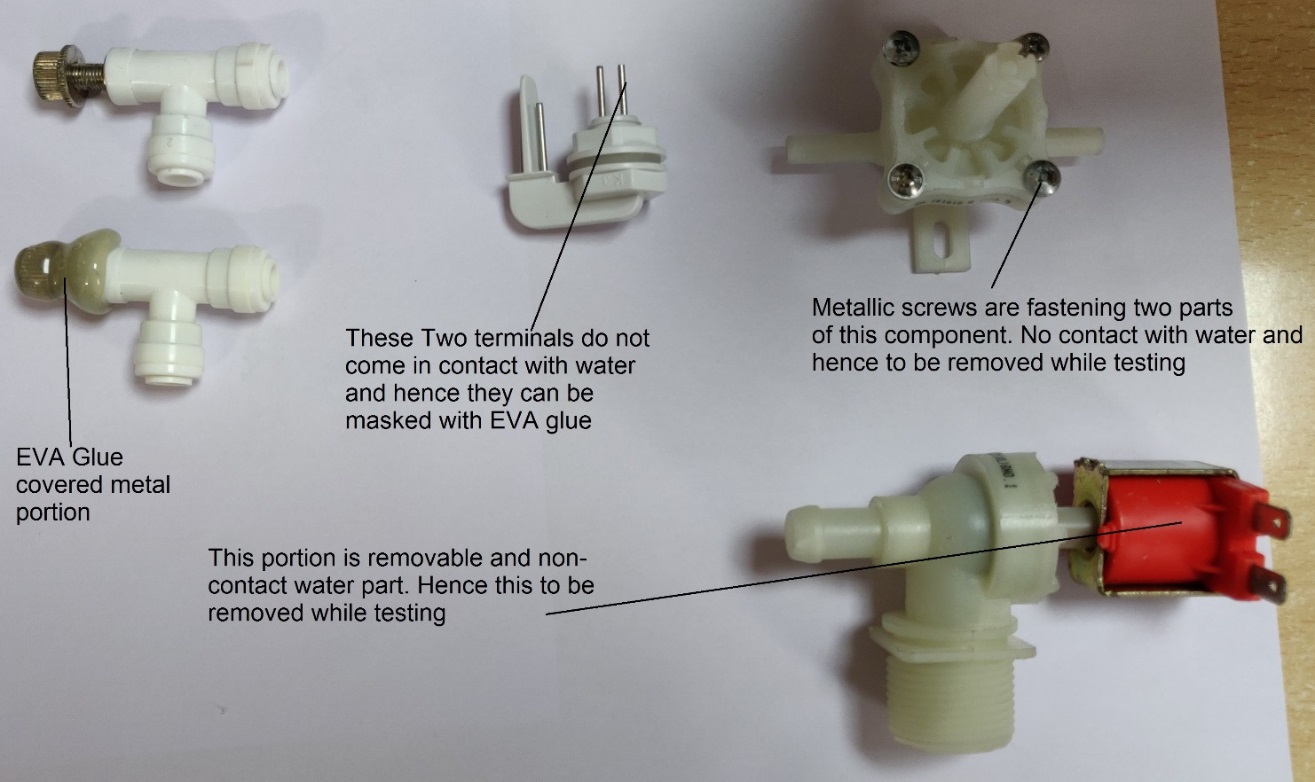
Blank: 2 Lit fresh exposure water shall be taken into glass jar of 6 Lit on daily basis for 3 consecutive 24 hr intervals.

Note: Carryout analysis of 6Lit pooled water sample for all the parameters as per Table:19-page 29.

Report concentration of each constituent after deducting the corresponding value of **blank** ( only exposure water ) from the value that is obtained for samples.

Each Laboratory has to generate data of safety of masking material. For the purpose, 100 Sq.Cm area ( EVA, Teflon or any other polymeric inert material) is flushed with tap water and extracted with exposure water for three consecutive 24 hr stagnation period. This will ensure no chemical constituent is leaching in to the water from these materials. Whenever new grade of masking material is used by the laboratory, the data as per Annexure – 1 shall be generated. The data pertaining to these material shall be included in the final test report provided these material are used for masking some portion of the test samples.

Figure – 3 How to mask non-water contact portion of the components



**A.i.7.0 NORMALIZATION AS APPLICABLE**

If the concentration of any of the constituent (after subtracting blank sample’s concentration) of the sample is found to be higher than the maximum acceptable limit of IS10500:2012, the pooled sample value shall be normalized by the following equation.

Concentration of the constituent in mg/L

----------------------------------------------------------------------x Actual Surface area of the material come

Surface area of the material used for testing in Sq.cm in direct contact with water in Sq.Cm

Note: Certain components have a combination of material like plastic and metal as shown in Fig – 2. For such components the integrated portion of the material which doesn’t come in contact with water shall be masked with EVA (ethylene vinyl acetate – Birla 3 M food grade) glue to prevent water contact.

Some cases, the water non contacting portion can be removable. This portion shall be detached. In some cases, non removable non - contact water portion may also be available. Suitable methods can be used for masking these portions.

While calculating surface area of the components, the outer and inner surfaces to be considered, provided both the surfaces are made of same material. If the outer surface has a lining, coating etc. which is non-contact water portion, this shall be wrapped with Teflon tape.

SECTION - A. Minimum quality compliance tests

A ii) STRUCTURAL INTEGRITY TESTING FOR ANY WATER PURIFICATION SYSTEMS/COMPONENTS

**A.ii.1-SCOPE**:

The point – of – use systems referred in this standard are intended to be used for purifying Drinking water sources at house hold which are operated 2 – 4 times a day by the consumer. In general, the systems are plumbed in to kitchen water supplies either operated electrically in majority of the cases. Very few models of purifiers/filters are which are non-electrical in nature also connected to drinking water supplies under pressure. This standard establishes minimum safety of the products against pipe line pressure of water supply. However, this standard exempts structural integrity test for Gravity flow pour through systems, non-electrical products installed with running water supply but which are shut off, when not in use, by closing the main tap. Also the UV chambers of a purification systems if the manufacturer declares that the systems are not meant for such installation where UV chamber is subjected to pressure.

**A.ii.2.0 PRINCIPLE:**

When the test unit is pressurized from the input port ( shall include any connector, coupler that is part of the installation kit provided by the manufacturer) till the outlet of the water purification system at a rate of 6 Kg/Sq.Cm for 30 minutes, there shall not be any leakage of water from all components and joints. Also there shall not be any emerging air bubbles from water joints. In case of RO systems the applied pressure shall be 7 Kg/Sq.cm.

**A.ii.2.1 APPARATUS FOR STRUCTURAL INTEGRITY Figure- 4**

Install one unit after flushing as shown in the figure below.

Open/Close Valve

Purifier 2

Purified water

Outlet port



Storage tank

Hand operated pump Open/Close Test Product

Valve

**A.ii.2.2 PRESSURIZATION OF TEST UNIT FOR STRUCTURAL INTEGRITY TEST Table – 2**

Fill the tank of Hand operated pump with Test Water with existing Tap water as shown in the Table below.

|  |  |  |
| --- | --- | --- |
| TEST WATER CHARACTERISTIC | INPUT WATER CONCENTRATION | REMARKS |
| pH | 6.5 to 8.5 | Dilute tap water with RO/DI water if needed. |
| TDS mg/L | 400-500 mg/L |
| Turbidity NTU | <1NTU |
| Temperature 0C | 24 -29 0C |

**A.ii.2.3 PROCEDURE**

Turn on the test unit in service mode

Allow water to flow by pumping water from the hand pump and make sure that the entire system is filled with water and filtered water was produced at least for 5 minutes.

Close the Open/close valve which is connected to the outlet port.

Pressurize the unit slowly by operating hand pump to reach the working pressure at 6.0Kg/Sq.Cm

Close the Open/close valve which is connected to the inlet port.

Keep the entire system under pressure for 30 minutes.

**A.ii.2.4 ACCEPTANCE CRITERION:**

There shall not be any leakage water at any joints and also no air bubbles coming out at any joints.

SECTION - B CONTAMINANTS AND SALT REDUCTION TESTS FOR WATER PURIFICATION SYSTEMS

1) Turbidity reduction

2) Chlorine reduction

3) Pesticide reduction

4) Inorganic reduction

5) Metal reduction

6) Iron reduction

7) Salt rejection

8) Microbial reduction

**B.1.0** **PHYSICO - CHEMICAL REDUCTION PERFORMANCE EVALUATION TESTS**

**B.2.0 Scope:** This standard allows performance tests of the complete systems/ standalone filters that are aimed at conducting for 5 days consecutively on a continuous basis with two stagnation points. The resultant test data provides information regarding reduction performance of various contaminants consistently. Also the stagnation break point analysis data reveals the likely behavior of filters to creep the adsorbed/ retained contaminants under the influence of pressure during stagnated periods. This kind of approach in testing water purifiers brings uniqueness to this protocol. This will give ample scope to rule out the possibility of dislodging/ desorbing contaminants that have been adhering to the filter surfaces or within the matrix. Performance for 5 days duration will provide data that is statistically significant. The tests are to be done in a sequential manner on at least one production unit.

**B.3.0 PHYSICO - CHEMICAL CONTAMINANT & SALT REDUCTION REQUIREMENTS:**

**Table 3**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| # | Name of the test | Applicable Technology | | | | | Influent water Concentration | Maximum Acceptable Product water concentration |
| UV | UF | RO | RESIN/  MEDIA | OTHERS |  |
| 1 | Turbidity reduction | √ | √ | √ | √ | √ | 10 ± 1 NTU | Maximum 1 NTU |
| 2 | Chlorine reduction | √ | √ | √ | √ | √ | 2.0 mg/L ± 10% | Maximum 1 mg/L |
| 3 | TDS reduction | -- | -- | √ | -- | -- | 1500 mg/l± 10% | Maximum 150 with at least 90% reduction |
| 4 | Metal reduction | -- | -- | √ | -- | -- | Arsenic as As 50 µg/L | Maximum 10 µg/L |
| Lead as Pb 50 µg/L | Maximum 10 µg/L |
| Mercury as Hg 5 µg/L | Maximum 1.0µg/L |
|  | Chromium as Cr 150 µg/L | Maximum 50 µg/L |
| Cadmium as Cd 15 µg/L | Maximum 3.0µg/L |
| Selenium as Se 50 µg/L | Maximum 10 µg/L |
| Nickel as Ni 50µg/L | Maximum 20 µg/L |
| Molybdenum as Mo 30µg/L | Maximum7.0 µg/L |
| Iron as Fe 1.0 mg/L | 0.1 mg/L |
| 5 | Nitrate as NO3 | -- | -- | √ | -- | -- | 150 mg/L | 45 mg/L |
| 6 | Fluoride as F | -- | -- | √ | -- | -- | 5.0 mg/L | 1.0 mg/L |
| 7 | Pesticide reduction | -- | -- | √ | -- | -- | Atrazine: 2µg/L | 0.1µg/L as an individual pesticide and 0.5µg/L as total pesticide |
| Lindane: 2µg/L |
| Chlorpyriphos: 2µg/L |
| Endosulphan(1 & 2 combined) 2µg/L |
| Malathion: 2µg/L |

Note: In the process of continuous R&D under Indian Scenario many Water treatment products with different technologies are emerging out. The protocols in this standard can be applied to any other technology which is not listed in above table but resulting in to same or similar performance as shown above.

**B.3.1 SEQUENCE OF THE TESTS THAT ARE TO BE CARRIED OUT: Table – 4**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Item** | **UV** | **UF** | **RESIN/MEDIA/**  **OTHERS** | **GRAVITY** | **RO** |
| No. of units required for testing | 2 | 2 | 2 | 2 | 3 |
| Material Safety test | Two units to be used for Material safety test | | | | |
| Structural integrity test | The first unit used for Material safety test to be used for Structural integrity testing | | | | |
| Contaminant and Salt reduction test | After completion of structural integrity the same unit to be used for Turbidity and Chlorine reduction testing | | | | The unit used for structural integrity to be used for contaminant and salt reduction testing |
| Microbial reduction test | The second unit used for Material safety to be used for Microbial reduction testing | | | | |
| Water Efficiency test | -- | -- | -- | -- | The unit used for Microbial reduction test to be used for Water Efficiency testing. Replace RO membrane with the same type as earlier. Remove all the pre and post filters. If a scale prevention mechanism and/ or filter exists in the product, retain the same. If any blending valves are involved in the product, all of them to be shut off. |

Notes:

1.Structural integrity test is exempted for Storage type gravity flow filters.

2.Pressurization shall be done from the first inlet port of the product (which may include nozzles, quick fit connectors, metal diverter valves which are part of installation kit). Following the Solenoid valve, the filters or stage(s) of filtration that are not subjected to clogging are eliminated from the structural integrity pressurization. Eg: UV chamber ( reactor), Storage tank and the tap of the Gravity flow storage type Water purifiers. Complete unit of Faucet mounted water purifiers Standalone filters with plastic taps/faucets and faucets similar to the pictures as shown in page No: 34

3. Turbidity reduction test to be done only once on the day 1. Turbidity and Chlorine tests can be done in combination.

4.Chlorine test to be done separately from Day 2 onwards.

4. TDS, metals, inorganics test can be done in combination. If Metals are found to be getting precipitated, spike metals in RO /DI water and conduct tests separately

5. Pesticide test to be done separately

6.Iron reduction test to be done separately

**B.4.0 TEST WATER COMPOSITION:**

**B.4.1Test Water for Turbidity + Chlorine reduction, Pesticide reduction, Iron reduction and Structural integrity tests Table: 5**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test Water Characteristic |  | |  |  |  |
| Input Water Concentration | Quantity of Salt to be added | Contaminant  Name | Input Water Concentration | Quantity of Salt/solution to be added |
| pH | 6.5 to 8.5 | If RO/DI water with <25 mg/L TDS is used as back ground water follow this method. In 100L volume of water add 10.0gr of CaCl2.2H2O, 8.4 gr of MgSO4.7H2O, and 16.5 gr of NaHCO3 toyield about 200 mg/L of TDS and 100 mg/L each Hardness and Alkalinity. Rest of TDS can be adjusted by adding NaCl @ 1 mg in Liter = 1 mg/L (ppm)  Addition of 1 mg of Sodium salt of Humic acid in 1 Liter will yield 1 mg/L ( ppm ) of TOC. | Turbidity | 15 NTU±10% | A4 coarse Test dust and standardize required quantity. |
| TDS mg/L | 400 - 500 mg/L | Chlorine as Cl | 2mg/L±10% | Use Sodium Hypochlorite solution 4%. Add 50 µL/ Liter in order to obtain 2mg/L concentration. Standardization is required. |
| TOC mg/L | 1-2 mg/L | Atrazine | 2µg/L±10% | Prepare 1000 ppm of each pesticide separately by taking 25 mg ( liquid or salt) in 25 ml of Methanol. From this solution add 2 µL in 1 Liter ( 2ppb). Depending on the Test water tank volume add sufficient quantity of pesticide solution. |
| Turbidity NTU | <1NTU | Chlorpyriphos | 2µg/L±10% |
| Temperature 0C | 24 -29 0C | Endosulphan | 2µg/L±10% |
|  |  | Lindane | 2µg/L±10% |
|  |  | Malathion | 2µg/L±10% |
|  |  | Iron as Fe | 1.0mg/L±10% | Add 2.9 mg of FeCl3 /Liter to yield 1 mg/L of Iron. Use a small quantity of Sulphuric acid for dissolving this salt in water. |

**Existing Tap water can be diluted with RO/DI water to adjust TDS of the water. RO/DI water added with CaCl2.2H2O, MgSO4.7H2O, NaHCO3 may also be used.**

**Note: TOC need not be added for preparing test water of Structural integrity tests. Do not add any contaminant.**

**B.4.2 Test Water for Salt (TDS ) Rejection, Inorganic and Metal reduction tests Table – 6**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test Water Characteristic | Input Water Concentration | Quantity of Salt to be added | Contaminant Name | Input Water Concentration | Quantity of Salt to be added |
| pH | 7.2 to 8.2 | If RO/DI water with <25 mg/L TDS is used as back ground water follow this method. In 100L volume of water add 50.0gr of CaCl2.2H2O, 42.0 gr of MgSO4.7H2O, and 50.0 gr of NaHCO3 toyield about 800 mg/L of TDS and 500 mg/L each Hardness and 300 mg/L Alkalinity. Rest of TDS can be adjusted by adding NaCl @ 1 mg in Liter = 1 mg/L (ppm) | Arsenic as As | 50 µg/L± 10% | Add 10.4 mg of Sodium Arsenate ( Na2HAsO4.7H2O) and 4.33 mg of Sodium Arsenite ( NaAsO2) in 100 Lit test water to yield 25 **µg/L each of Arsenic III and Arsemic V contaminants.** |
| TDS | 1500 mg/L ± 10% | Lead as Pb | 50 µg/L± 10% | Add 8 mg of Lead Nitrate (Pb(NO3)2) in 100 Lit of Test water to yield 50 **µg/L of Lead.** |
| Total Hardness as CaCO3 | 500 mg/L ± 10% | Mercury as Hg | 5 µg/L ± 10% | Prepare 100 ppm of Mercury solution by adding 13.6 mg of Mercury Chloride ( HgCl2) in 100 ml distilled water. Dissolve using 1 ml of Nitric acid. Take 5 ml of this solution and add to 100 Lit of test water to yield 5 µg/L of Mercury. |
| Total Alkalinity as CaCO3 | 300 mg/L ± 10% | Chromium as Cr | 150 µg/L± 10% | Add 77 mg of Chromium Chloride (CrCl3.6H2O) in 100 Lit of test water to yield 150 µg/L of Chromium. |
| Turbidity NTU | <1 | Cadmium as Cd | 15 µg/L± 10% | Add 2.5 mg of Cadmium Chloride (CdCl2) in 100 Lit of Test water to yield 15 µg/L of Cadmium |
| Temperature 0C | 24 – 29 0C | Selenium as Se | 50 µg/L± 10% | Add 6 mg of Sodium Selenate (Na2SeO4) and 6 mg of Sodium Selenite(Na2SeO3) in 100 Lit of Test water to yield 50 µg/L of Selenium. |
|  |  | Nickel as Ni | 50µg/L± 10% | Add 25 mg of Nickel Nitrate(Ni(NO3)2.6H2O in 100 Lit of test water to yield 50µg/L of Nickel |
|  |  | Molybdenum as Mo | 210µg/L± 10% | Add 271 mg of Ammonium Molybdate (NH4)6Mo7O24.4H2O )in 100 Lit of test water to yield 210µg/ of Molybdenum. |
|  |  | Fluoride as F | 5mg/L± 10% | Add 1.1 gr of Sodium Fluoride(NaF) in 100Lit of test water to yield 5mg/L of Fluoride. |
|  |  | Nitrate as NO3 | 150 mg/L± 10% | Add 20.6 gr of Sodium Nitrate (naNO3)in 100Lit of test water to yield 150 mg/L of Nitrate - NO3. |

**Notes:**

1.If heavy metals are precipitating while adding relevant salts, this particular test can be performed with RO/DI water by spiking metal contaminants.

2.TDS, Fluoride and Nitrate reduction tests can be run together.

**B.4.3 METHOD FOR PREPARATION OF TEST WATERS**

Take 100 Liters of R/DI water having TDS < 25 mg/L. Add adequate quantities each of CaCl2.2H2O,MgSO4.7H2O and NaHCO3 salts ( Refer Table -13 on page 19). Generally, it is recommended that after addition of each salt, mix the contents thoroughly to dissolve completely.

After preparing above test water checks TDS and adjust to 1500 mg/L by adding adequate quantity of NaCl. 1 mg of NaCl in 1 Liter water will increase TDS by 1 ppm ( 1 mg/L ).

Add Contaminants like Turbidity, Chlorine, Metals, Pesticides, Fluoride, Nitrate, Iron as applicable at an adequate quantities ( Refer Tables 12 and 13 on pages 18 and 19) and mix thoroughly.

While doing the above it is recommended that Turbidity and Chlorine can be added together. Metals, Fluoride and Nitrate can be added together. Pesticides and Iron shall be added separately.

Finally check pH of test water and adjust as required by adding 5% of HCl or NaOH solutions

Note:

1. While preparing Test water for Salt rejection or any other Test water, before adjusting the pH, check TDS of the water and adjust to required concentration by adding NaCl @ 1 mg/L ( = 1 ppm) and then adjust pH.
2. In case of adjusting TOC, add Sodium Salt of Humic Acid @ 1 mg/Lit ( = 1 ppm) after adjusting TDS. Then adjust pH.

**B.4.4 PRODUCT INSTALLATION AND RUNNING PROCEDURES:**

B.4.4.1 1Install one unit and flush with tap water as recommended by the manufacturer at 1 Kg/Sq.Cm input water pressure. Condition with Test water without contaminants at least for 10 minutes.

B.4.4.2 In case of Gravity flow storage purifier, assemble the unit as recommended by the manufacture. Flushing is required as recommended. Condition the product by filtering at least one container full of test water without contaminant.

Condition flushed units as specified in the following table.

**B.4.5 PRODUCT CONDITIONING Table – 7**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S.No | Name of the test | No. of units required for testing | How to conduct test | Conditioning  Process before each test |
| 1 | Turbidity reduction | **One of the units used for material safety testing** | Combined test | Condition the product by passing Test Water without Turbidity and Chlorine at least for 10 minutes. |
| 2 | Chlorine reduction |
| 3 | Pesticides reduction | **Same as above** | Independent test | Condition the product by passing Test Water without Pesticides at least for 10 minutes. |
| 4 | TDS reduction, Inorganics and metals except for Iron | **Same as above** | Combined test ## | Condition the product by passing Test Water having 1500 mg/L TDS but without inorganics and metals at least for 10 minutes. |
| 5 | Iron reduction | **Same as above** | Independent test | Condition the product by passing Test Water without Iron at least for 10 minutes |

Notes: 1 ## If metals are precipitating while adding into TDS reduction test water, conduct this test with RO/DI water.

Notes: 2 Structural integrity test is exempted for Storage type gravity filtration products.

**B.4.6 SAMPLING PROCEDURE**

After conditioning the products as described in Table – 14, allow Test water with spiked contaminant(s) to filter at least for 10 Liters in direct flow models. Then collect samples.

In case of products with storage tank, allow filtered water to fill the tank fully. Discard the treated water. Allow second tank to fill. Then collect samples. The treated water samples to be collected directly from the storage tank outlet tap.

**B.4.7** **TESTING PROCEDURES FOR DIFFERENT PRODUCTS**

**B.4.7.1 A typical example of Testing scheme for RO Product Table: 8**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Running Day** | **Day of Operation** | | **Type of Activity** | **Sampling** | **Analysis to be done** |
| **1** | **Monday** | | Pesticide, Salt & Metal and Iron reduction tests spread over 8 hrs. Ensure conditioning the unit after each test with corresponding Test water without spiked contaminants for 10 minutes. After collecting the water samples, leave the units under pressurized condition. Electrically switched off. | Yes  The second tank filling in case of storage tank models. After 10Lit permeate production in case of Direct flow models | Pesticides, Metals, TDS, Nitrate & Fluoride, Iron |
| **2** | **Tuesday** | | Run the system with 400-500mg/L NaCl TDS water, pH 7.2 to 7.8 and collect the first fraction. | Yes  The 1st tank in case of storage models. The first 2 liters in case of Direct Flow models | Pesticides, Metals, Nitrate , Fluoride and Iron |
| Pesticide, Salt & Metal and Iron reduction tests spread over 8 hrs. Ensure conditioning the unit after each test with corresponding Test water without spiked contaminants for 10 minutes. After collecting the water samples, leave the units under pressurized condition. Electrically switched off | Yes  The second tank filling in case of storage tank models. After 10Lit permeate production in case of Direct flow models | Pesticides, Metals, TDS, Nitrate & Fluoride, Iron |
| **3** | **Wednesday** | | Pesticide, Salt & Metal and Iron reduction tests spread over 8 hrs. Ensure conditioning the unit after each test with corresponding Test water without spiked contaminants for 10 minutes. After collecting the water samples, leave the units under pressurized condition. Electrically switched off | Yes  The second tank filling in case of storage tank models. After 10Lit permeate production in case of Direct flow models | Pesticides, Metals, TDS, Nitrate & Fluoride, Iron |
| **4** | | **Thursday** | Pesticide, Salt & Metal and Iron reduction tests spread over 8 hrs. Ensure conditioning the unit after each test with corresponding Test water without spiked contaminants for 10 minutes. After collecting the water samples, leave the units under pressurized condition. Electrically switched off | Yes  The second tank filling in case of storage tank models. After 10Lit permeate production in case of Direct flow models | Pesticides, Metals, TDS, Nitrate & Fluoride, Iron |
| **5** | | **Friday** | Run the system with 400-500 mg/L NaCl TDS water, pH 7.2 to 7.8 and collect the first fraction. The 1st tank in case of storage models  The first 2 liters in case of Direct Flow models | Yes  The 1st tank in case of storage models  The first 2 liters in case of Direct Flow models | Pesticides, Metals, Nitrate , Fluoride and Iron |
| Pesticide, Salt & Metal and Iron reduction tests spread over 8 hrs. Ensure conditioning the unit after each test with corresponding Test water without spiked contaminants for 10 minutes. After collecting the water samples, leave the units under pressurized condition. Electrically switched off | Yes  The second tank filling in case of storage tank models. After 10Lit permeate production in case of Direct flow models | Pesticides, Metals, TDS, Nitrate & Fluoride, Iron |

Ensure conditioning the unit after each test with corresponding Test water without spiked contaminants for 10 minutes

**B.4.7.2 A typical example of Testing scheme for UV, UF and Resin/Media Filter Products Table – 9**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Running Day** | **Day of Operation** | **Type of Activity** | **Sampling** | **Analysis to be done** |
| **1** | **Monday** | Turbidity +  Chlorine test | Yes  The second tank filling in case of storage tank models. After 10Lit of filtered water production in case of Direct flow models | Turbidity and Chlorine |
| **2** | **Tuesday** | Chlorine test | Same as above | Chlorine |
| **3** | **Wednesday** | Chlorine test | Same as above | Chlorine |
| **4** | **Thursday** | Chlorine test | Same as above | Chlorine |
| **5** | **Friday** | Chlorine test | Same as above | Chlorine |
| **6** | **Saturday** | Chlorine test | Same as above | Chlorine |

**B.4.8 SAMPLING VOLUMES THAT ARE TO BE COLLECTED FOR ANALYSIS Table – 10**

|  |  |  |  |
| --- | --- | --- | --- |
| S.No | Type of Test | Sampling Volume | |
|  | Input Water | Treated water |
| 1 | Turbidity reduction | 500 ml | 500 ml |
| 2 | Chlorine reduction | 500 ml | 500 ml |
| 3 | Pesticide reduction | 1.5 Liters | 1.5 Liters |
| 4 | TDS, Inorganic and Metals reduction | 1.0 Liter | 1.0 Liter |
| 5 | Iron | 500 ml | 500 ml |
| 6 | Microbiology | 250 ml | 250 ml |

**B.4.9 ANALYSIS OF VARIOUS SAMPLES Table – 11**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S.No | Type of Analysis | Test Method | Calculation | Maximum Allowable storage of the samples |
| 1 | Turbidity | APHA 23rd edn 2130 | As per dilutions used, incorporate dilution factor and calculate actual concentration | 24 hr in HDPE /LDPE/PET bottles |
| 2 | Chlorine Free Available | APHA 23rd edn 4500 Cl F | As per calculation method prescribed by the standard method | No storage allowed |
| 3 | Total Dissolved Solids | Calibrated TDS meter. Different TDS meter for Input water and Treated waters | %TDS reduction  (input water TDS mg/L- Treated water TDS mg/L)  -------------------------------------- x 100  Input water TDS mg/L | 1 week in HDPE / LDPE/PET bottles |
| 4 | Pesticides | APHA/USEPA methods using GC-MS | As per dilutions used, incorporate dilution factor and calculate actual concentration | 2 weeks in HDPE /LDPE/PET bottles preserved at 4 - 8 0C |
| 5 | Metals | APHA 23rd edn 3113 B AAS/Graphite Furnace  APHA 23rd edn 3312 B for Mercury  AAS with vapour/hydride generator  ICP / ICPMS method can also be used | As per dilutions used, incorporate dilution factor and calculate actual concentration | 2 weeks in HDPE/LDPE/PET bottles acidified @ 0.3% HNO3. Stored at 4-8 0C |
| 6 | Iron | APHA 23rd edn 3500 Fe B | As per dilutions used, incorporate dilution factor and calculate actual concentration | 1 day in HDPE/LDPE/PET bottles acidified @ 0.3% HNO3. Stored at 4 – 8 0C |

**B.5.0 MICROBIAL REDUCTION TESTS**

**B.5.1 SCOPE:**

The prescribed protocol is meant for testing microbial reduction performance of Drinking water treatment units/ standalone filter capable of disinfecting/reducing microbial species in contaminated water covering bacterial and virological contaminants. This protocol can be used for evaluating microbial reduction capability of water treatment units using any technology namely Ultra Violet radiation, Mechanical filtration including ceramics, Microfiltration, Ultrafiltration and Reverse osmosis, Resin, chemical based media etc. Also the basic advantage of this protocol is that it can be applied to standalone disinfection filter cartridges and/or fully assembled units or any other technology leading to microbial reduction.

**B.5.2 INFLUENT WATER MICROBIAL CONCENTRATION Table – 12**

|  |  |
| --- | --- |
| Klebsiella terrigena ( Raoultella terrigena) MTCC2271 | ≥5 x 105 cfu/ml |
| MS2 phage ATCC 15597B1 | ≥5 x 104 pfu/ml |

Spiking is done together and at the time of sampling. Culture propagation and preparation can be seen in Annexure – 1

**B.5.3 ACCEPTANCE CRITERIA FOR % REDUCTION ( Log REDUCTION) Table – 13**

|  |  |
| --- | --- |
| At all sampling points: Bacterial reduction | Minimum of 99.999% (5 Log reduction)  Average of 99.999% overall |
| At all sampling points: Virus Reduction | Minimum of 99.99% (3 Log reduction )  Average of 99.99% overall |

**B.5.3 TEST WATER COMPOSITION OF MICROBIAL REDUCTION TESTING Table – 14**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Test Water Characteristic** | **Recommended concentration** | | **Test water Usage** | **Remarks** |
| GTW#1 | Challenge Water | GTW#1 up to 3rd day of testing followed by Challenge water till end of the test.  GTW#1 up to 50% Volume followed by Challenge water from 75% volume till end of the testing | For sampling on running days, allow at least 20 Lit of Spiked Test water to flow through the unit/component and collect samples.  In case of Stagnation break point sampling, collect immediate fraction |
| pH | 6.5 to 8.5 | 8.6 to 9.2 |
| TDS mg/L | 400-500 mg/L | 1500±150 mg/L |
| TOC mg/L | 1-2 mg/L | 5-6 mg/L |
| Turbidity NTU | <1NTU | 5-6 NTU |
| Temperature 0C | 24-29 0C | 10 – 12 0C |

Higher concentration of TOC, Turbidity and low temperatures will be used only while introducing challenge water at the time of sampling only.

**B.5.4 MATERIAL RECOMMENDED FOR ADJUSTING THE CONCENTRATION OF TEST WATER COMPOSITION**

1. CaCl2.2H2O, MgSO4.7H2O, NaHCO3, NaCl, HCl (5%) Solution, NaOH (5%) Solution, Sodium salt of Humic acid
2. The GTW#1 water is supposed to be adjusted for TDS, Total Hardness and Total Alkalinity. The concentrations to be ranging between 400-500 mg/L for TDS and 80-100 mg/L for Hardness and Alkalinity.

.

1. Challenge Water to have 1500±150 mg/L of TDS and 300 - 400 mg/L of Total Hardness and 150 – 200 mg/L of Total Alkalinity as CaCO3
2. Humic acid can be added to attain 1 mg/L of TOC by adding 1 mg of Humic acid salt to dissolve in 1 Liter.
3. A4 coarse test dust to be added to achieve required quantities of dust ( Laboratory has to standardize the required quantity).

**B.5.5 PREPARATION OF TEST WATER FOR MICROBIAL REDUCTION TEST Table - 15**

Take 100 Liter of RO /DI water in a feed water tank and add following salts in a sequence mentioned below. After each addition, mix the contents well. Finally add NaCl, if required, in order to adjust TDS @ 1mg / Liter to yield 1 ppm of TDS.

|  |  |
| --- | --- |
| GTW#1  General Test Water | Add 8.0 gr CaCl2.2H2O salt in 100 Lit RO/DI water mix well.  Add 7.0 gr MgSO4.7H2O salt in the above water and mic well  Add 13.2 gr of NaHCO3 salt in the above water and mix well. This will yield 80 mg/L each of Hardness and alkalinity and TDS of 160 mg/L. Check TDS and adjust by adding NaCl salt @ 1mg/Liter = 1 ppm  Adjust pH if required using 5% HCl or NaOH solution as applicable. |
| CHALLENGE WATER | Follow the above procedure for preparing Challenge water by adding-Add 30.0 gr CaCl2.2H2O,Add 25.0 gr MgSO4.7H2O and 25.0 gr NaHCO3 to yiled about 300 mg/L of Hardness and 150 mg/L of Alkalinity. Check TDS and adjust by adding NaCl salt @ 1mg/Liter = 1 ppm  Adjust pH if required using 5% HCl or NaOH solution as applicable. |

Note: All the chemical reagents used are analytical reagent.

**B.5.6 PROCEDURE OF MICROBIAL REDUCTION TESTING**

One of the units that was used for Material safety to be used for this purpose. A fresh unit can also be tested.

**B.5.7 Installation & Conditioning of the test unit/standalone filter:**

**B.5.7.1** Install one unit and flush with available tap water as per manufacturer’s recommendation after adjusting the maximum service Flow rate as recommended by the manufacturer. For Flow through models use input water pressure as 1Kg/Sq.Cm

**B.5.7.2** Pass Test Water without spiking the microorganisms at least for 20 Liters filtration to condition the unit.

**B.5.7.3** Run the product with designated Test waters for 7 ½ hr maximum on daily basis with a .

Cycle time of running: 30 min ON / 30 Min OFF within 7 ½ hr

**B.5.7.3.1 Pour through Gravity type systems**: Perform 3 pourings with water head of the Top reservoir maintained. Rest the unit for 1 hr. Resume 3 pourings followed by rest. Repeat these cycles in a day to complete 80 -100 Lit filtration (maximum) per Day).

**B.5.7.3.2 Flow through Models:** 30 min ON / 30 Min OFF within a day to complete 80 – 100 Lit filtration (maximum) per Day)

**B.5.7.4 SCHEME OF TESTING FOR MICROBIAL REDUCTION BY VARIOUS TECHNOLOGIES**

**B.5.7.4.1** Drinking water purification systems / Disinfection stand-alone cartridges with UV, UF,RO technologies ( Size Exclusion Methods) with or without storage tanks. **Table- 16**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Day of  testing | Day | Testing Laboratory may follow below mentioned | Running Test Water | Sampling | Spiking |
| 1 | Monday | Start at 9.30AM and end at 5.0PM | GTW#1 | 20 Lit filtration | Spiked Test water |
| 2 | Tuesday | Start at 9.30AM and end at 5.0PM | GTW#1 | Beginning of the day after 20 Lit filtration | Spiked Test water |
|  | Wednesday | Start at 11.0AM and end at 5.0PM | After Stagnation for 18 hrs | Immediately after starting without discarding the product water | Non spiked test water |
| 3 | Thursday | Start at 9.30AM and end at 5.0PM | GTW#1 | Middle of the day | Spiked Test water |
|  | Friday | Start at 11.0AM and end at 5.0PM | After 18hr stagnation | Immediately after starting without discarding the product water | Non spiked test water |
| 4 | Saturday | start at 9.30AM end at 12.30PM | Challenge Test water | Middle of the day | Spiked Test water |
| 5 | Monday | start at 12.30 PM, collect sample and continue running | After 48 hr stagnation | Immediately after starting without discarding the product water | Non spiked test water |
|  |  | Sample at 5.0 PM and terminate testing | Challenge water | End of the day | Spiked Test water |

Laboratories may follow different days of running maintaining sampling frequency and stagnation. Before leaving the unit/standalone filter for stagnation. During overnight the units are to be kept electrically off but in pressurized condition. Test water ( GTW#1 or Challenge water) shall be emptied from Feed water tank during stagnation periods. At the time of re-starting after stagnation the feed water tank to be filled with relevant Test water. For calculating % Reduction of microorganisms at stagnation point sample, the average of previous Input water counts to be considered.

Special Note:Spiking of microorganisms is done only at the time of sampling. Addition of 5-6 NTU, 5-6mg/L TOC and maintaining temperature of 10-12 0C in case of Challenge Test are done only at the time of sampling.

**B.5.7.4.2** Drinking water systems / Disinfection stand-alone cartridges in case of RESIN/ACTIVE AGENT MEDIA CARTRIDGE technologies **Table – 17**

|  |  |  |  |
| --- | --- | --- | --- |
| Test Volume | Running Test Water | Sampling | Spiking |
| 20Lit filtration | GTW#1 | After filtering 20 Lit with spiked test water | Spiked Test water |
| 10% Volume | GTW#1 | After filtering 20 Lit with spiked test water | Spiked Test water |
|  | After Stagnation for 18 hrs | Immediately after starting without discarding the product water | Non spiked test water |
| 25% Volume | GTW#1 | After filtering 20 Lit with spiked test water | Spiked Test water |
| 50% Volume | GTW#1 | After filtering 20 Lit with spiked test water | Spiked Test water |
|  | After Stagnation for 18 hrs | Immediately after starting without discarding the product water | Non spiked test water |
| 75%  Volume | Challenge Test water | After filtering 20 Lit with spiked test water | Spiked Test water |
| 100% Volume | Challenge Test water | After filtering 20 Lit with spiked test water | Spiked Test water |
|  | After Stagnation for 18 hr | Immediately after starting without discarding the product water | Non spiked test water |
| 120%  Volume | Challenge Test water | After filtering 20 Lit with spiked test water | Spiked Test water |

Before leaving the unit/standalone filter for stagnation, the Test water ( GTW#1 or Challenge water) shall be emptied from Feed water tank. Also whenever the unit is in OFF condition the same input water pressure to be maintained. Pressurization is not applicable for Pour through / storage type gravity flow filters. For calculating % Reduction of microorganisms at stagnation point sample, the average of previous Input water counts to be considered.

Special Note: Spiking of microorganisms is done only at the time of sampling. Addition of 5-6 NTU, 5-6mg/L TOC and maintaining temperature of 10-12 0C in case of Challenge Test are done only at the time of sampling.

**B. 5.7.5 Special Provisions for Disinfection units / treatment systems**:

If a Sediment filter (shall not be Cyst reduction filter or a membranous type of filter) is used as separate filter which can be replaced independently, the testing laboratory can backwash/replace filter a per manufacturer’s recommendation. The following conditions may be applicable

i) Whenever sediment filter is choked where the flow is reduced by more than 60% of the original flow. The laboratory can do back wash by tap water. Also the filter has to be replacement as recommended by the manufacturer.

In case of an integrated sediment filter along with the disinfection cartridge ( or disinfection stage of filtration), following sampling pattern may be used in case of premature choking.

If the Laboratory finds that the test flow rate is reducing when the Challenge water is introduced ( from 50% volume on wards), the flow rate has to be monitored at frequent intervals. When it is noticed that the flow rate is dropped by 75%, one sampling to be conducted (with spiked water) followed by another sampling after at least 18 hr stagnation. This is the termination of the test.

Special Note: When the laboratory takes the last sampling as described above, the filter/product shall have completed 5th day sampling with challenge water / or 90% of the filtration depending on the type of product. If these requirements are not met, retesting on fresh products is mandatory.

**B. 5.7.6 Sampling Volume**: Sampling volume shall be at least 250 ml in a sterilized bottle added with a neutralizer ( prepare neutralizer as described below)

**B.5.7.6.1 Preparation of Neutralizer:** 10% Sodium thioglycollate solution +14.6% Ringers Sodium Thiosulphate

Dissolve 10 gr of Sodium thioglycollate slat in 70 ml RO/DI water.

Dissolve 14.6 gr of Sodium Thiosulphate salt in the above solution.

Make up the volume to 100 ml using RO/DI water

Add @ 1 ml of above neutralizer solution in 100 ml sample (to neutralize metal ions and chlorine).

**B.5.7.6.2 MICROBIOLOGICAL GROWTH MEDIA TO BE USED FOR ANALYSIS**

i) Sterile Mac Conkey’s Agar Medium

ii) Sterile Tryptic Soy Agar Medium

iii)Sterile Tryptic Soy Broth Medium

iv) Sterile Saline- 0.9% NaCl solution

SECTION – C WATER EFFICIENCY RATING TESTS FOR RO BASED WATER PURIFIERS

**C.1.0 Preamble:**

**Reverse osmosis** (**RO**) is a water purification technology that uses a semipermeable membrane to remove ions, molecules and larger particles from drinking water. It is essentially a filtering process in which raw water (with more concentration of Total Dissolved Solids and other chemical and microbiological constituents) is forced to pass through the membrane that blocks most dissolved or suspended contaminants to above 90%, leaves in to the reject stream there by dispensing treated water from the membrane outlet with lower concentration of TDS and other constituents. Many of the POU systems of RO available in the market operate with a water efficiency (the ratio between the treated water and the reject water) ranging between 15 – 30% depending on the membrane and specification of the product recommended by the manufacturer. Considering an average per cent efficiency of 20% treated water, the water that is coming out from the unit as reject water is let to the drain by many of the end users. The Indian consumer tends to find his own method of conserving this waste water. The need of the hour is to market more water efficient purification systems in order to save water and minimize pollution of water bodies and ground waters. A major emphasis is needed on RO systems to enhance Water Efficiency percentage alongside its benefits of reducing various contaminants like Heavy metals, hazardous inorganics, pesticides, microorganisms, suspended particulates etc.

**C.2.0 SCOPE**:

The point – of – use systems referred in this standard are intended to be used for purifying Drinking water sources at house hold which are operated 2 – 4 times a day by the consumer. This standard establishes minimum water saving efficiency, technical requirements and testing method. This standard does not establish performance, taste and microbial growth support requirements for drinking water system products, components or materials. This standard applies to city supply of drinking water, private sources of drinking water as input water. RO membrane being the key purification unit, the water saving efficiency is aimed at minimizing the reject water volume. Accordingly, the water efficiency ratings are allocated.

**C.3.0 PRINCIPLE OF RO SYSTEM WATER EFFICIENCY RATE AND CLASSIFICATION**

The actual amount of treated water (permeate) produced in a duration of 1 hour running and corresponding reject water and auto flush water, in case of direct flow models, are taken into consideration for arriving at Water efficiency rating of the product under testing.

In case of products with storage tank, the volume of permeate water produced to fill the storage tank and shutting off filtration occurs is considered for efficiency rating. During the period the corresponding reject water and auto flush water are taken into consideration.

Overall, the water efficiency is monitored for 6000 Lit permeate production with 150 Lit to 200Lit of filtration ( permeate) on a daily basis. During this process of filtration water efficiency performance is monitored at different intervals of 500 Lit permeate production.

**C.3.1** **CLASSIFICATION OF SYSTEM FOR PURIFIED WATER (PRODUCTION) EFFICIENCY**

**C.3.1.1**The water efficiency of the system is classified into 3 ratings namely 5 C:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.png,

4 C:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.png and 3 C:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.png .

**C.3.2 ACCEPTANCE CRITERIA**

The purified water production efficiency rating of water purification systems shall comply with the regulation of below table.

**C.3.2.1** Water Efficiency Rating scheme **Table – 18**

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | **Classification of system water (production) efficiency** | | |
| 5 C:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.png | 4 C:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.png | 3 C:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.png |
| Purified water production rate | Criterion for 5 star rating:  ≥50% recovery throughout the tested volume. Testing will be done as per manufacturer’s claim about Volume | Criteria for 4 star rating:  >40% up to 50% recovery during 1/3rd of the life claim. Followed by up to 30% during 2/3rd of the claimed life.  Testing will be done as per manufacturer’s claim about Volume. | Criteria for 3 star rating  >30% up to 40% recovery during 1/3rd of the life claim. Followed by up to 25% during 2/3rd of the claimed life.  Testing will be done as per manufacturer’s claim about Volume |

Note: If a manufacturer has a RO membrane capable of producing 5 C:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.png efficiency, or 4 C:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.png efficiency or 3 C:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.pngC:\Users\User\Desktop\download.png efficiency, with a capacity for 3000Lit , the membrane will be tested for 3000Lit only. At the time of certification testing, the customer has to clearly mention the claimed volume.

**C.3.3 PROCEDURE OF DETERMINING WATER EFFICIENCY**

Any one of the units that was tested for other performance tests can be used for this purpose.

Replace a new RO membrane. All other Pre, Post filters and other supporting filters, cartridges are to be removed. If the product has any antiscaling filter/ gadget, it needs to be retained. Essentially this particular test unit will contain only the Solenoid valve, Booster pump, RO membrane, Reject water valve and an Antiscalant filter /devise (if provided in the unit).

**C.3.4 Installation & Conditioning of the test unit/standalone filter:**

**C.3.4.1** Install one unit ( as shown in Figure – 5 ) and flush with available tap water as per manufacturer’s recommendation after adjusting the maximum service Flow rate as recommended by the manufacturer. For Flow through models use input water pressure as 1Kg/Sq.Cm. Pass test water ( Table - 26 ) for at least 10 Liters for conditioning. Then start collecting water samples as described in Table 27.

**C.3.4.1.1 Installation scheme for testing Water Efficiency Figure :5**

Test Unit with Solenoid valve, Booster pump, Antiscalant cartridge and RO

membrane element

Treated water

1

Reject water

Feed Water Tank

**Pressure gauge**

PUMP

**C.3.4.2 Test Water Characteristics for Water Efficiency testing Table - 19**

|  |  |
| --- | --- |
| Test Water Characteristic | Concentration |
| pH | 7.2 – 7.8 |
| TDS mg/L | 1500±50 mg/L |
| Total Hardness as CaCO3 mg/L | 500-600 mg/L, |
| Total Alkalinity as CaCO3 mg/L | 350±50 mg/L |
| Turbidity NTU | <1 NTUNTU |
| Temperature 0C | 24 – 290C |

**C.3.4.3** **Test Water Preparation**: For 100 Liter capacity

Use demineralized or RO/DI water with TDS <25mg/L. Add 46 gr of MgSO4.7H2O, 55 gr of CaCl2.2H2O and 58 gr of NaHCO3. Measure individual parameters and ensure required concentrations are achieved. This preparation will yield a TDS of approximately 850 mg/L. Hardness of 500 mg/L, Alkalinity of 350 mg/L. Add NaCl (@ 1 mg/L = 1 mg/L (ppm) of TDS) of approximately 65 gr into 100 Lit of test water to obtain a TDS of 1500 mg/L .

Use 5% NaOH or 5% HCl solution to adjust the pH to manage the scope of 7.2 to 7.8

Note: All the chemical reagents used are analytical reagent.

**C.3.5 PROCEDURE OF WATER EFFICIENCY TESTING**

**C.3.5.1** Determining the total capacity of treated water and total water consumption for RO process pertaining to the unit under testing.

Allow 15 minutes of rest between two filling of storage tank models or 15 minutes of running in direct flow models. Total volume of permeate water that can be filtered in a day is 100 -150 Liters. If the sampling point falls in the evening hours, running has to be stopped and continued further in the next day morning to facilitate proper sampling of Permeate and Reject water volumes.

**C.3.5.1.1 Total capacity of product water (treated water) and reject water**

After conditioning the test units, close the outlet tap depending on the type of model.

The products shall be electrically switched on with Test water flowing in to the test units. When the output water (treated water) starts coming out from the outlet tap (direct flow model – open to atmosphere) for 15 minutes. When the filtered water is falling in to the storage tank it shall be till the storage tank fills and product shuts off automatically.

Note: connect a transparent silicon hose to the pressurized tank models so that the initiation of the treated water flowing into the tank can be seen and stop watch can be started to note the duration of tank filling time.

In case of direct flow models, the total volume of treated water collected in 15 min duration and corresponding reject water (including initial autoflush water at the time of switching ON the product ) to be measured.

Note: If the system is provided with autoflush mechanism at an interval of 1 hr running, or any such interval, the volume of autoflush water shall be separately measured. ***This volume also has to be considered for calculation of % Recovery.***

In case of the storage tank models, and pressurized tanks the running has to be continued till the tanks are filled completely and product shuts off automatically. The whole volume of permeated water collected in the tank and the corresponding reject water volume (including initial autoflush water at the time of switching ON the product) shall be measured.

**C.3.5.1.2** Calculation of Water Efficiency:

Calculate % Efficiency of RO treated water by using the following formula

Permeate water Volume in Liters

% RO water Efficiency = -------------------------------------------------------- x 100

Reject water + Autoflush water Volume in Liters

**C.3.5.1.1 Determining the Water Efficiency for Total capacity ( Liters) permeate production**

**Using the same procedure as described in C.3.5 collect water samples as per below given table.**

**C.3.5.1.2 Schedule for water sample collection for Water Efficiency testing Table - 20**

**(storage tank models)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S.No** | **% Volume of Permeate water Filtration** | **Water Efficiency Sampling & Calculation** | | | | **Salt rejection sampling & Calculation** | | |
| **Permeate Water Volume Liters** | **Reject water Volume**  **Liters** | **Autoflush water Volume**  **Liters** | **% Recovery** | **Raw water TDS mg/L** | **Permeate water TDS mg/L** | **% Reduction** |
| **1** | **Initial 15 min running or first tank filling** |  |  |  |  |  |  |  |
| **2** | **25% Volume** |  |  |  |  |  |  |  |
| **3** | **33% Volume**  **1/3rd of total volume** |  |  |  |  |  |  |  |
| **4** | **50% Volume** |  |  |  |  |  |  |  |
| **5** | **75% Volume** |  |  |  |  |  |  |  |
| **6** | **100% volume** |  |  |  |  |  |  |  |

**ORGANOLEPTIC , GENERAL PARAMETERS CONCERNING SUBSTANCES UNDESIRABLE IN EXCESSIVE AMOUNTS AND PARAMETERS CONCERNING TOXIC SUBSTANCES**

**Table – 21**

**IS10500:2012 Drinking Water Specification**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **SL. NO** | **CHARACTERISTICS** | | **REQUIREMENT**  **Acceptable Limit** | **TEST METHOD** |  |
|  | **ORGANOLEPTIC PARAMETERS** | | | |  |
|  | **Colour, Hazens max** | | **5** | **APHA 23rd edn 2120B** |  |
|  | **Odour max** | | **Agreeable** | **IS3025 Part 5 1983 RA1996** |  |
|  | **GENERAL PARAMETERS CONCERNING SUBSTANCES UNDESIRABLE IN EXCESSIVE AMOUNTS** | | | |
|  | Total Dissolved solids mg/L ( TDS ) max | | 500 | APHA 23rd edn 2540 C |  |
|  | Aluminum  (as Al) mg/L, Max | | 0.03 | APHA 23rd edn 3113 B |  |
|  | Ammonia ( as Total Ammonia –N) mg/L max | | 0.5 | APHA 23rd edn 4500 NH3 F |  |
|  | Anionic detergents mg/L max | | 0.2 | IS 13428 Annex K |  |
|  | Boron as B mg/L max | | 0.5 | APHA 23rd edn 4500 B B |  |
|  | Chloramines as Cl2 mg/L max | | 4.0 | APHA 23rd edn 4500 Cl F |  |
|  | Copper as Cu mg/L max | | 0.05 | APHA 23rd edn 3113 B |  |
|  | Iron  as Fe) mg/L max | | 0.3 | APHA 23rd edn 450o Fe B |  |
|  | Magnesium ( as Mg) mg/L max | | 30 | APHA 23rd edn 3500 Mg B |  |
|  | Manganese as Mn mg/L max | | 0.1 | APHA 23rd edn 3113 B |  |
|  | Mineral Oil mg/L max | | 0.5 | APHA 23rd edn 5520B |  |
|  | Nitrate  (as NO3) mg/L max | | 45 | APHA 23rd edn 4500 NO3 B |  |
|  | Phenolic compounds (as C6H5OH) mg/L max | | 0.001 | APHA 23rd edn 5530C |  |
|  | Selenium (as Se) mg/L max | | 0.01 | APHA 23rd edn 3113 B |  |
|  | Sulphide as H2S mg/L max | | 0.05 | IS 13428 : 2500 Annex |  |
|  | Zinc as Zn mg/L max | | 5 | APHA 23rd edn 3113 B |  |
|  | **PARAMETERS CONCERNING TOXIC SUBSTANCES** | | | |
|  | Cadmium (as Cd) mg/L max | | 0.003 | APHA 23rd edn 3113 B |  |
|  | Cyanide as CN mg/L max | | 0.05 | APHA 23rd edn 4500 CN C |  |
|  | Lead  (as Pb) mg/L max | | 0.01 | APHA 23rd edn 3113 B |  |
|  | Mercury (as Hg) mg/L max | | 0.001 | APHA 23rd edn 3112 B |  |
|  | Molybdenum as Mo mg/L max | | 0.07 | APHA 23rd edn 3113 B |  |
|  | Nickel as Ni mg/L max | | 0.02 | APHA 23rd edn 3113 B |  |
| 26 | Arsenic Total as As mg/L max | | 0.01 | APHA 23rd edn 3113 B |  |
| 27. | Chromium Total as Cr mg/L max | | 0.05 | APHA 23rd edn 3113 B |  |
|  | | **PARAMETERS CONCERNING TOXIC SUBSTANCES** | | |
| 28 | | Poly chlorinated biphenyles mg/L max | 0.0005 | APHA 23rd edn  6431C/6410B |
| 29 | | Poly nuclear Aromatic Hydrocarbons as PAHs mg/L max | 0.0001 | APHA 23rd edn  6440C/6410B |

Table 28 Contd/-

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **SL. NO** | **CHARACTERISTICS** | | **REQUIREMENT**  **Acceptable Limit** | **TEST METHOD** | |  |
|  | | **PARAMETERS CONCERNING TOXIC SUBSTANCES** | | | | |
|  | | **Trihalomethanes :** |  |  | |
| 30 | | Bromoform mg/L max | 0.1 | APHA / USEPA  GCMS & HPLC Methods |  |
| 31 | | Dibromochloromethane mg/L max | 0.1 |
| 32 | | Bromodichlorometahne mg/L | 0.06 |
| 33 | | Chloroform mg/L max | 0.2 |
|  | | **Pesticides:** |  |  |  |
| 1 | | Alachlor µg/L | 20 |  |  |
| 2 | | Atrazine | 2 |  |  |
| 3 | | Aldrine / Dieldrin | 0.03 | APHA / USEPA  GCMS & HPLC Methods |  |
| 4 | | **α HCH** | 0.01 |  |  |
| 5 | | **β HCH** | 0.04 |  |  |
| 6 | | **γHCH (Lindane)** | 2 |  |  |
| 7 | | **δ HCH** | 0.04 |  |  |
| 8 | | Butachlor | 125 |  |  |
| 9 | | Chlorpyriphos | 30 |  |  |
| 10 | | 2,4 Dichlorophenoxyacetic acid | 30 |  |  |
| 11 | | DDT o,p and p,p isomers of DDT, DDE and DDD | 1 |  |  |
| 12 | | Endosulphan ( **α, β** and Sulphate ) | 0.4 |  |  |
| 13 | | Ethion | 3 |  |  |
| 14 | | Isopruturon | 9 |  |  |
| 15 | | Malathion | 190 |  |  |
| 16 | | Methyl Parathion | 0.3 |  |  |
| 17 | | Monochrotophos | 1 |  |  |
| 18 | | Phorate | 2 |  |  |

Note: Any published and equivalent methods can be used for estimating above constituents.

Figure – 6

PICTURES OF COMPONENTS/PRODUCTS EXEMPTED FROM STRUCTURAL INTEGRITY TESTS

**Storage Faucet mounted Standalone UV chamber**

**Type filter Water Filter Filter**



PART – B : OTHER REQUIREMENTS

**Part – B 1.0 FREQUENCY OF TESTING:**

Once in 3 years provided the wetted parts are maintained the same in terms of surface area, material supplier and the moulder.

The test sample will be obtained by testing laboratory from the local market but not from the factory produced batch at the time of re-testing.

**Part – B 2.0 FACILITY INSPECTION BY CERTIFYING BODY:**

Once a year

**Part – B 3.0 REFERENCES**

1. **NSF Protocol P231: Microbiological Water Purifiers (2003).**
2. **NSF/ANSI S53 – 2007. Drinking Water Treatment Units – Health Effects (2007).**
3. **Journal of the IPHE, 2004, No 4, pp 65.**
4. **Campbell *et al*., 1992. Viability of *Cryptosporidium* parvum oocysts: Correlation of *in vitro* excystation with inclusion or exclusion of fluorogenic vital dyes. App. Environ. Microbiol. 58: 3488-93.**
5. Asburg, E.D., 1983, Methods of Testing Sanitizers and Bacteriostatic Substances; in Disinfection, Sterilization and preservation (Seymour S. Block, ed.), pp. 964-980).
6. **Standard Methods for the Examination of Water and Wastewater, 18th Edition, American Public Health Association.**
7. **Chambers, *et al*., J. Amer. Water Works Assoc., 54: 208-216, 1962.**
8. **Cotruvo J, Jones G. Policy on Iodine Disinfection. Washington, DC: U.S. Environmental Protection Agency, 1982.**
9. **ASSE/IAPMO standard # 1086 Residential Reverse Osmosis – Water Efficiency**
10. **NDRC ( National Development and reform committee and National Office of saving water ) of China – Draft standard of RO system efficiency rate and classification**
11. **Some of the user manuals of RO systems available in Indian market in domestic sector**
12. **IS16240:2015 Reverse Osmosis (RO) based Point –of-sue (PoU) Water Treatment system – Specification**

***ANNEXURE-1***

### PROTOCOL FOR PREPARATION AND ANALYSIS OF TEST MICROORGANISMS

### i) BACTERIUM: R.terrigena MTCC 2271) PREPARATION AND ASSAY

**ii) SURROGATE VIRUS: MS2 phage ATCC 15597B1 PREPARATION AND ASSAY**

**Materials:**

***Equipment and Accessories-***

* Vortex mixer
* Millipore vacuum pump
* 0.45 µ sterile Millipore membrane filters (Millipore HAWP 04700)
* Sterile syringes and forceps
* Pipettes
* Incubator
* Laminar air flow
* pH meter

***Chemicals and Reagents-***

Test organism R.terrigena MTCC 2271 suspension-

The level of bacteria per spike should be approximately ~5 x 107/100ml, as a 7 log10 spike is required for determining up to 6 log10 reductions.

**Neutralizer-**

10% Sodium thioglycollate+ 14.6% Ringers Sodium Thiosulphate – Add 1 ml in 100 ml sample (to neutralise metal ions and chlorine). Alternately D/E medium could be used as a neutralizer.

**Sterile MacConkey's Agar Medium**

**Sterile Tryptic Soy Agar Medium**

**Sterile Tryptic Soy Broth Medium**

**Sterile Saline : 0.85% NaCl**

**Procedure:**

***Bacterial Culture Maintenance & Preparation For Testing Purposes-***

*The Growth State of the test bacteria is critical as this affects sensitivity and resistance to disinfectants. Consequently, only bacteria in the stationary phase should be used. The test organism should be washed and suspended in sterile saline before addition to the challenge water.*

1. For this purpose, the test organism or is to be maintained on Trypticase Soy Agar (TSA) slants and checked using MacConkey's agar for purity.
2. The culture is to be held frozen in glycerol (or equivalent method) containing media at –200C for a period of not more than 6 months and is to be revived & preserved again.
3. The culture is to be passed once in TSB for 15-18 hours and incubated at 37°C.
4. The resultant suspension is to be recovered by centrifugation at 3000 x g for 10 minutes. Or an isolated colony is to be suspended in sterile saline and adjusted to get **the desired OD.** Alternately, culture could be recovered from overnight plate directly in saline (taking care not to scrape out agar) and the OD adjusted to 0.8-1.0.
5. The supernatant is to be discarded and the cells washed with sterile saline and re-suspended in sterile saline.
6. Adjust the culture density of this suspension, using spectrophotometer (appropriately blanked), to attain an OD600nm of 0.8 to 1.0 (~109 cfu/ ml). Add sufficient volume of this to the spike water to attain the desired seed value.

*Preparation of Spike Water- (two device cycle volumes)*

1. The spike water is prepared using the test water.
2. Seed appropriate volume of culture suspension of the test organism to get a final concentration of ~ 5 x 107 /100 ml.
3. The spike water is to be mixed well before use.
4. Independently establish that the spike water has no adverse impact on the survival or proliferation of the bacteria.
5. Prepare fresh spike water daily and ensure day storage of spike water does not affect viability or reduce the spike numbers.

***Conditioning of Purification Device, Spiking and Sample Collection-***

1. Make sure that the device to be tested has seen at least two device cycles of test water to reduce Particles / Dirt etc. entering the output samples. This is known as the conditioning cycle. Adjust the flow rate of the test device during this conditioning cycle if desired.
2. Check that the Purification Device has been fixed properly and there is no leakage from the sides and output water comes out only from the outlet terminal. Remove and drain as much water as possible from the device taking care not to accidentally contaminate them.
3. Now add the spiked water in to the inlet/ input port.
4. Sample collection has two stages:
5. Collect the sample from the seeded water before it sees the device. This is the Influent sample, which will estimate the initial load of organisms to start with.
6. Collect the test sample, after ensuring that the sufficient volume of seeded water has passed through. This is referred to as effluent sample. Collect two 500 ml effluent samples. Analyse one sample retain the other.
7. This can be ensured by collecting the sample after the seeded water has started passing through and completed 10 bed volumes. Ensure that at least two samples of about 110 ml each are collected from a single spike for analysis. Add suitable neutraliser immediately on collection.

*5.1 Neutralization of the sample: if required, add 1ml of ( 10% Sodium thioglycollate+ 14.6% Ringers Sodium Thiosulphate) in 100 ml sample to neutralize metal ions and chlorine.*

1. After the spike water equivalent to at least 10 bed volumes of the device has passed through and all effluent samples collected, start passing through the test water without the test organism
2. This procedure (Step 4-6) is to be carried out all intended test organisms along with the bacteria.
3. Take care that there is no residual disinfectant in any of the samples.
4. The devices may have a dead volume, so please ensure that sampling is done when at least 10 bed volumes of spike water has passed through the unit and starts coming out in the effluent.

Analysis

Input sample and output samples must go through all the steps involved in analysis in identical manner. Sample number and type should be written on labels during all steps of processing.

***Bacteriological testing must take place within 1 hour of collecting the sample and it is done in 2 ways for estimation of actual log reduction*.**

1. **Standard Membrane Filtration Method.**

1.To establish the log reduction, 100 ml of the effluent should be tested.

2.100 ml of the sample is to be passed through a sterile 0.45-micron filter, which is then placed on a pre-poured MacConkey’s Agar plate and incubated at 37OC for 24-48 hrs.(mFC, MEndo agars can optionally be used as long as recognised by the regulatory bodies)

1. Standard Pour Plate Method.

1.Prepare a serial dilution of the test sample in saline.

2.Plate out undiluted and 10-2 on MacConkey’s as per standard pour plate method (1 ml per dilution per plate) and incubate at 370C for 24hrs. This should be done in duplicate.

4.Appropriate positive control (plating neat *E. coli* suspension) and negative controls (membrane, medium & saline controls) must be kept during each challenge experiment to eliminate errors due bacterial strain, media or diluent.

5.All standard precautions to be followed for bacterial testing must be strictly adhered to.

***MS2 PHAGE ATCC15597B1 PREPARATION AND ASSAY :***

**I Stock Culture Preparation Of MS2 phage**

* From the Mother culture slant of *Famp E.coli( E.coli ATCC#15597),* inoculate a loopful of culture in to Tryptic Soy Agar(TSA) slant and incubate at 35-370C for

18-24 hrs

* From the above slant, take a loopful of culture and inoculate into 10ml Tryptic Soy Broth(TSB) and incubated at 350C to 370C for 24-48 hrs
* To the above add 1ml of MS2 Phage stock (frozen culture to thawed) and incubate at 350C to 370C for 24hrs.
* Centrifuge the above at 1000 RPM for 15min.
* Take the supernatant and filter through 0.22 micron filter paper.
* Collect the filtrate, and analyze for plaques /ml and rest of the sample stored

at -200C . This MS2 preparation to be used for spiking into test water.

**II Analysis Of MS2 Phage**

Host *Famp E.coli( E.coli ATCC#15597*) preparation

1. From the Mother culture slant of *Famp E.coli( E.coli ATCC#15597),* inoculate a loop-full of culture in to Tryptic Soy Agar(TSA) slant and incubate at 35-370C for 18-24 hrs.

2. From the above slant, take a loop-full of culture and inoculate into 10ml Tryptic Soy Broth(TSB) and incubated at 350C to 370C for 4-5 hrs.

**ANALYSIS:**

* Input water is serially diluted upto 10-4/10‑5dilution and 1ml of diluted sample is taken in a sterilized test tube.
* Add 0.2ml of 4-5hr old culture of *Famp E.coli* and into this add Tryptic Soy Soft agar of about 4-5ml, mix well and pour above the Tryptic Soy Hard Agar plate, mix well.
* Similarly 1ml of effluent sample is taken in a sterilized test tube and add 0.2ml of 4-5hr old culture of *Famp E.coli* and into this add Tryptic Soy Soft agar 4-5ml, mix well and pour above the Tryptic Soy Hard Agar plate, mix well.
* Incubate the plate at a 350C to 370C for 24hrs and enumerate plaque forming units/mL**.**

**9.0 TERMS AND DEFINITIONS**

The terms and definitions described in this document pertain only to this standard.

9.1 Purified water production

The ability of the RO system to deliver treated water either in terms of direct flow, into the storage tank (just covered with a lid) or a pressurized tank under the specified test water and other conditions as per this standard. The total volume of the treated water is considered as the volume equivalent to that produced during a time period of 1 hour or the volume that is filled in the storage tank from the point when purified water started coming out of the outlet spout in case of a direct flow model, falling into the storage tank and pressurized tank till the point where production of treated water stops due to auto shut off.

9.2 Purified water production rate

The ratio of the total output (treated water) water to the total input water.

9.3 Purified water flow rate

Total volume of treated water dispended either in direct flow model or the volume filled in the storage tank from point of start of filtration in to the storage tank till the point of filtration stops due to auto shut off. The flow rate essentially expressed as total volume of treated water dispensed per hour irrespective of the model of RO system. All these data are applicable under specified conditions of test water and other test conditions.

9.4 Minimum allowable value of water efficiency:

Under prescribed testing conditions set out by this standard, the minimum purified water production rate allowed/required from the RO membrane.

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