TERMS OF REFERENCE FOR R&D PROJECT

Food and Agriculture Department

Water Purification Systems Sectional Committee, FAD 30

1 Title of the Project

Optimization of Recovery Efficiency of Reverse Osmosis-Based Point-Of-Use Water Treatment Systems

2 Background

2.1 Reverse Osmosis (RO) technology combined with sediment and carbon filters has proved to be an effective water treatment method for removing various inorganic, organic, and microbiological contaminants from the water. Realizing this fact, many manufacturers and assemblers in the organized and unorganized sectors have entered the RO water treatment market. Taking cognizance of this trend, this Indian standard IS 16240 for RO-based water treatment systems was formulated establishing minimum requirements for design and construction, performance, and testing of materials that come in contact with treated water.

2.2 IS 16240: 2023 'Reverse osmosis based point of use water treatment system for drinking purposes — Specification' prescribes the quality requirements for RO based point of use water treatment system. The standard specifies requirements for TDS reduction along with requirements of removing various chemical and microbiological contaminants from the water such as heavy metals, total pesticides, E-Coli, Cryptosporidium, etc. (IS 16240 may be downloaded from BIS website by following the link https://standardsbis.bsbedge.com/BIS_searchstandard.aspx?Standard_Number=IS+16240&id=47115).

2.3 The standard was first published in 2015 and revised in 2023. This revision was undertaken to update the standard having regard to the available technology and corresponding recovery efficiency and output water quality reliability. Requirement of recovery percentage has been increased from 20 percent to 40 percent in order to minimize water wastage. The recovery rates of RO systems vary significantly and are influenced by the quality and constituents of the feed water, type of membrane, system configuration, and system operation. While reviewing the standard, the Water Purification Systems Sectional Committee, FAD 30 emphasized the need for technical data on optimum recovery efficiency in order to have evidence-based approach in standard development. It was deliberated that generation of technical data regarding membrane performance/life of membrane vis-a-vis increase in recovery efficiency would require a study to determine the optimum recovery efficiency. This may involve quantification of increase in scaling and choking of membranes and decrease in life of membrane vis-a-vis increase in recovery efficiency of the system. It is crucial to research fouling and how it affects the output of RO water treatment systems to maximize recovery efficiency. Modelling and prediction of fouling patterns in the membrane separation process are still lacking. Furthermore, currently, there is no technical

reference/study available in India to guide PoU system manufacturers on recovery rates. The Committee therefore decided to conduct study on optimization of recovery efficiency of reverse osmosis based point of use water treatment systems and review the specified value of recovery efficiency of 40 percent in IS 16240 based on the technical data made available on optimum recovery efficiency from the study.

3 Objective

To determine optimum recovery efficiency of reverse osmosis based point of use water treatment system for drinking purposes (with a product water capacity of up to 50 litre per hour) by generating technical data regarding membrane performance/life of membrane *vis-a-vis* increase in recovery efficiency.

4 Scope

4.1 Study of existing literature on research publications, international/ regional guidelines & standards related to optimum recovery efficiency of reverse osmosis based point of use water treatment system for drinking purposes.

4.2 Conducting a series of experiments with commercial modules available in the Indian market to study the effect of recovery rate on the membrane life to achieve optimum recovery efficiency of the RO module (household). Further, the effect of feed water quality, TDS and pressure also to be studied on the membrane life and recovery rate of the PoU systems by controlling feedwater's pressure and temperature with some controlling devices.

4.3 Based on the study, computational model to be developed to predict performance parameters of membrane modules of varied sizes.

4.4 To recommend optimum recovery efficiency for reverse osmosis based point of use water treatment system for drinking purposes (with a product water capacity of up to 50 litre per hour) based on the findings of the study.

5. Research Methodology

5.1 Undertake thorough literature review as per **4.1** and prepare summary report.

5.2 Study the effect of different TDS and pressure on the membrane life and recovery rate of the PoU systems using a system consisting of a membrane module and panel to control pressure.

5.3 Analyse the fouling behaviour of the RO membrane system using an experimental setup consisting of a membrane fouling simulator (MFS). Study various types of fouling, how they form, the main parameter responsible, and how they are controlled.

5.4 Analyze the effect feed water quality, temperature and pressure through experimental study by controlling feed water's quality, pressure and temperature using membrane module and panel to control pressure and other parameters.

5.5 *Sampling plan:*

(i) Conducting a series of experiments with minimum 10 commercial modules available in the Indian market to achieve optimum recovery efficiency of the RO module (household).
(ii) Minimum two hundred modules are to be tested to generate the technical data proposed in this study

5.6 Test water shall be prepared with varied amount of contaminants (with level more than or equal to the influent challenge level as prescribed in IS 16240) to arrive at optimized recovery and hourly production rate with necessary TDS reduction, chemical reduction and microbiological reduction.

5.7 Necessary stakeholder consultation shall also be included as part of the study. Commercial companies may be contacted for obtaining data relating to membrane performance/life of membrane vis-a-vis increase in recovery efficiency.

5.8 Based on the technical data collected from the study, computational model is to be developed to predict RO performance (% salt rejection and water recovery efficiency) for water treatment of varied feed quality.

6. Expected Deliverables

6.1 Project report, in hard copy and digital formats, covering all aspects mentioned in scope.

6.2 Generation of technical data from experimental studies on effect of recovery rate on membrane fouling, TDS reduction, chemical reduction, microbiological reduction, recovery rating, hourly production rate.

6.3 Development of computational modelling to predict RO performance (% salt rejection and water recovery efficiency) for water treatment of varied feed quality.

6.4 Summary of experimental studies and Recommendation on optimum recovery efficiency of reverse osmosis based point-of-use water treatment systems based on the technical data generated from the study.

7 Timeline and Method of Progress Review

7.1 Timeline for the project is 6 months from the date of award of the project.

7.2 Stages of review:

Stage	Timeline
Stage I : Review of literature (published research, international/ regional guidelines & standards) and stakeholder consultation on optimum recovery efficiency of reverse osmosis based point of use water treatment system for drinking purposes. Preparation of plan for experiments and arrangement of necessary modules for experimental study.	Second Month
Stage II : Primary research findings on technical data from experimental studies on optimum recovery efficacy and Development of computational modelling to predict RO performance for water treatment of varied feed quality. Submission of interim report to Sectional Committee at the end of third month for review.	Third Month to Fifth Month
Stage III : Draft report submission – Sectional Committee will evaluate the draft report and provide feedback/recommend changes, if required.	End of Fifth Month

At the end of 6th month, project allottee to submit final project report incorporating recommendations/feedback of Committee.

***Note**: The timelines given above are indicative and calculation of time will start from the date of award of sanction letter for the project to the Project leader.*

8 Support from BIS

8.1 Access to Indian and International Standards

8.2 Letters from BIS to concerned stakeholders for support in research project.

9 Nodal Officer

Smt. Nitasha Doger, Scientist-D/ Joint Director, FAD, BIS may be contacted at fad-wps@bis.gov.in for any queries on the research project.