INTERNATIONAL STANDARD



First edition 2020-12

Water Reuse in Urban Areas — Guidelines for reclaimed water treatment: Design principles of a RO treatment system of municipal wastewater

iTeh STANDARD PREVIEW (standards.iteh.ai)

<u>ISO 23070:2020</u> https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c-56d43860f5ca/iso-23070-2020



Reference number ISO 23070:2020(E)

iTeh STANDARD PREVIEW (standards.iteh.ai)

<u>ISO 23070:2020</u> https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c-56d43860f5ca/iso-23070-2020



COPYRIGHT PROTECTED DOCUMENT

© ISO 2020

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office CP 401 • Ch. de Blandonnet 8 CH-1214 Vernier, Geneva Phone: +41 22 749 01 11 Email: copyright@iso.org Website: www.iso.org

Published in Switzerland

Contents

Page

Forew	ord		v			
Introd	uction		vi			
1	Scope		. 1			
2	-	ntive references				
3		and definitions				
_		viated terms				
4						
5		ation of RO treatment systems for reclaimed water				
	5.1	Overview				
	5.2	Design considerations				
		5.2.1 Safety considerations				
		5.2.2 Stability considerations				
	F 0	5.2.3 Economy considerations				
	5.3	RO system components				
		5.3.1 General 5.3.2 Feed water source				
		5.3.3 Pre-treatment unit				
		5 1 1				
		5.3.6 Post treatment unit5.3.7 Water quality and performance monitoring system	J			
6		ical considerations of pre-treatments ten.ai)				
	6.1	Quality considerations of feed water				
		6.1.1 General water quality index 2020				
		6.1.2 httpsSilt.density.index.log/standards/sist/0d354e33-e1-f8-43bd-b35e-	6			
		6.1.3 Organic index _{6d43860f5ca/iso-23070-2020}	6			
		6.1.4 Biological index				
		6.1.5 Oxidation-reduction potential				
	6.2	Selection of mechanical pre-treatments				
		6.2.1 Clarification				
		6.2.2 Media/Multimedia filtration				
		6.2.3 Activated carbon filtration				
		6.2.4 Microfiltration and ultrafiltration				
	6.0	6.2.5 Cartridge filtration				
	6.3	Chemical pre-treatments				
		6.3.1 Antiscalants				
		6.3.2 Chemical oxidizers for disinfection of the feed				
		6.3.3 Reductants6.3.4 Non-oxidizing biocides	Ծ 0			
		-				
7	Techn	Technical and structural considerations of RO unit				
	7.1	Components				
		7.1.1 RO feed pumps				
		7.1.2 R0 membrane modules				
		7.1.3 Pressure vessels				
	7.2	Selection of RO membranes				
		7.2.1 Membrane materials				
		7.2.2 Membrane modules				
	7.3	RO unit configuration	10			
8	Opera	ting conditions and maintenance system	11			
	8.1	Operating conditions				
		8.1.1 Pressure				
		8.1.2 Temperature				

10 RO concentrate management 17 11 Emergency response plan 17 Annex A (informative) Example of an RO treatment system for reclaimed water 19 Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070:2020 22 https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c- 20			8.1.3 Feed water flow and permeate flux	
8.2 R0 performance parameters 12 8.2.1 Permeate flow rate 12 8.2.2 Salt rejection 13 8.2.3 Pressure drop 13 8.3 Automatic chemical dosing system 13 8.3.1 Dosing point 13 8.3.2 Dosing method 13 8.3.1 Dosing method 13 8.4.2 Control and monitor system of R0 performance 13 8.4.1 Instrumentation 13 8.4.2 Control system 14 8.4.3 Monitoring system 14 8.4.4 Control system 14 8.5.1 Physical cleaning 14 8.5.2 Chemical cleaning 14 8.5.3 Chemical cleaning 14 8.5.4 Integrity testing of R0 systems 15 8.7 System failure 16 9 Post-treatment unit 17 10 RO concentrate management 17 11 Emergency response plan 17 Annex A (informative) Information of chlorine disinfection for the inf				
8.2.1 Permeate flow rate 12 8.2.2 Salt rejection 13 8.2.3 Pressure drop 13 8.3 Automatic chemical dosing system 13 8.3.1 Dosing point 13 8.3.2 Dosing method 13 8.3.1 Dosing method 13 8.3.2 Dosing method 13 8.3.2 Dosing method 13 8.4.4 Instrumentation 13 8.4.5 Control system 14 8.4.6 Control system 14 8.4.7 Control system 14 8.4.8 Monitoring system 14 8.5.1 Physical cleaning 14 8.5.2 Chemical cleaning 14 8.5.2 Chemical cleaning 14 8.5.3 Physical cleaning 14 8.5.1 Physical cleaning 14 8.5.2 Chemical cleaning 14 8.5.3 Rof System failure 16 9 Post-treatment unit 17 10 RO concentrate manage			F	
8.2.2 Salt rejection 13 8.2.3 Pressure drop 13 8.2.3 Pressure drop 13 8.3 Automatic chemical dosing system 13 8.3 Automatic chemical dosing system 13 8.3.1 Dosing point 13 8.3.2 Dosing method 13 8.3.4 Control and monitor system of RO performance 13 8.4.1 Instrumentation 13 8.4.2 Control system 14 8.4.3 Monitoring system 14 8.4.4 Rotic performance 14 8.5.1 Physical cleaning 14 8.5.2 Chemical cleaning 17 10 RO concentrate management 17 11 Emergency response plan 17 </th <th></th> <th>8.2</th> <th></th> <th></th>		8.2		
8.2.3 Pressure drop 13 8.3 Automatic chemical dosing system 13 8.3.1 Dosing point 13 8.3.2 Dosing method 13 8.3.4 Control and monitor system of RO performance 13 8.4.1 Instrumentation 13 8.4.2 Control system 14 8.4.3 Monitoring system 14 8.5 Cleaning system 14 8.5.1 Physical cleaning 14 8.5.2 Chemical cleaning 14 8.5.1 Physical cleaning 14 8.5.2 Chemical cleaning 14 8.5.3 Post-treatment unit 17 10 RO concentrate management 17 11 Emergency response plan 17 Annex A (informative) Example of an RO treatment system for pectaimed water 19 Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070-2020 22 https://standards.itch				
8.3 Automatic chemical dosing system 13 8.3.1 Dosing point 13 8.3.2 Dosing method 13 8.3.4 Control and monitor system of RO performance 13 8.4.1 Instrumentation 13 8.4.2 Control system 14 8.4.3 Monitoring system 14 8.4.4 R.4.3 Monitoring system 14 8.5 Cleaning system 14 8.5.1 Physical cleaning 14 8.5.2 Chemical cleaning 14 8.5.3 Chemical cleaning 14 8.6 Integrity testing of RO systems 15 8.7 System failure 16 9 Post-treatment unit 17 10 RO concentrate management 17 11 Emergency response plan 17 Annex A (informative) Example of an RO treatment system for pectaimed water 19 Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 <td< th=""><th></th><th></th><th>,</th><th></th></td<>			,	
8.3.1 Dosing point 13 8.3.2 Dosing method 13 8.4 Control and monitor system of RO performance 13 8.4 Control system 13 8.4.1 Instrumentation 13 8.4.2 Control system 14 8.4.3 Monitoring system 14 8.5 Cleaning system 14 8.5.1 Physical cleaning 14 8.5.2 Chemical cleaning 14 8.6 Integrity testing of RO systems 15 8.7 System failure 16 9 Post-treatment unit 17 10 RO concentrate management 17 11 Emergency response plan 17 11 Emergency response plan 17 Annex A (informative) Example of an RO treatment system for reclaimed water 19 Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070:2020 22 https://standards.itch ai/catalog				
8.3.2 Dosing method 13 8.4 Control and monitor system of RO performance 13 8.4.1 Instrumentation 13 8.4.2 Control system 14 8.4.3 Monitoring system 14 8.5 Cleaning system 14 8.5.1 Physical cleaning 14 8.5.2 Chemical cleaning 14 8.5.2 Chemical cleaning 14 8.5.2 Chemical cleaning 14 8.6 Integrity testing of RO systems 15 8.7 System failure 16 9 Post-treatment unit 17 10 RO concentrate management 17 11 Emergency response plan 17 Annex A (informative) Example of an RO treatment system for reclaimed water 19 Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070:2020 22 https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c- 20		8.3		
8.4 Control and monitor system of RO performance 13 8.4.1 Instrumentation 13 8.4.2 Control system 14 8.4.3 Monitoring system 14 8.5 Cleaning system 14 8.5.1 Physical cleaning 14 8.5.2 Chemical cleaning 14 8.6 Integrity testing of RO systems 15 8.7 System failure 16 9 Post-treatment unit 17 10 RO concentrate management 17 11 Emergency response plan 17 Annex A (informative) Example of an RO treatment system for reclaimed water 19 Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070:2020 22 https://standards.iteh ai/catalog/standards/sist/0d354e33-e118-43bd-b35c- 20				
8.4.1 Instrumentation 13 8.4.2 Control system 14 8.4.3 Monitoring system 14 8.4.3 Monitoring system 14 8.5 Cleaning system 14 8.5.1 Physical cleaning 14 8.5.2 Chemical cleaning 14 8.5.2 Chemical cleaning 14 8.6 Integrity testing of RO systems 15 8.7 System failure 16 9 Post-treatment unit 17 10 RO concentrate management 17 11 Emergency response plan 17 Annex A (informative) Example of an RO treatment system for reclaimed water 19 Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070:2020 22 https://standards.itch.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c- 20		.		
8.4.2 Control system 14 8.4.3 Monitoring system 14 8.5 Cleaning system 14 8.5 Cleaning system 14 8.5.1 Physical cleaning 14 8.5.2 Chemical cleaning 14 8.6 Integrity testing of RO systems 15 8.7 System failure 16 9 Post-treatment unit 17 10 RO concentrate management 17 11 Emergency response plan 17 11 Emergency response plan 17 Annex A (informative) Example of an RO treatment system for reclaimed water 19 Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070:2020 22 https://standards.itch.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c- 20		8.4		
8.4.3 Monitoring system 14 8.5 Cleaning system 14 8.5.1 Physical cleaning 14 8.5.2 Chemical cleaning 14 8.6 Integrity testing of RO systems 15 8.7 System failure 16 9 Post-treatment unit 17 10 RO concentrate management 17 11 Emergency response plan 17 Annex A (informative) Example of an RO treatment system for reclaimed water 19 Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070/2020 22 https://standards.itch.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c- 20				
8.5 Cleaning system 14 8.5.1 Physical cleaning 14 8.5.2 Chemical cleaning 14 8.6 Integrity testing of RO systems 15 8.7 System failure 16 9 Post-treatment unit 17 10 RO concentrate management 17 11 Emergency response plan 17 Annex A (informative) Example of an RO treatment system for reclaimed water 19 Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070:2020 22 https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c- 22				
8.5.1 Physical cleaning 14 8.5.2 Chemical cleaning 14 8.6 Integrity testing of RO systems 15 8.7 System failure 16 9 Post-treatment unit 17 10 RO concentrate management 17 11 Emergency response plan 17 Annex A (informative) Example of an RO treatment system for reclaimed water 19 Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070:2020 22 https://standards.itch.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c- 22		o =		
8.5.2 Chemical cleaning 14 8.6 Integrity testing of RO systems 15 8.7 System failure 16 9 Post-treatment unit 17 10 RO concentrate management 17 11 Emergency response plan 17 Annex A (informative) Example of an RO treatment system for reclaimed water 19 Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070:2020 22 https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c- 20		8.5		
8.6 Integrity testing of RO systems 15 8.7 System failure 16 9 Post-treatment unit 17 10 RO concentrate management 17 11 Emergency response plan 17 Annex A (informative) Example of an RO treatment system for reclaimed water 19 Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070:2020 22 https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c- 22				
8.7 System failure 16 9 Post-treatment unit 17 10 RO concentrate management 17 11 Emergency response plan 17 Annex A (informative) Example of an RO treatment system for reclaimed water 19 Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070:2020 22 https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c- 20		0.6		
9 Post-treatment unit 17 10 RO concentrate management 17 11 Emergency response plan 17 Annex A (informative) Example of an RO treatment system for reclaimed water 19 Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070:2020 22 https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c- 20				
10RO concentrate management1711Emergency response plan17Annex A (informative) Example of an RO treatment system for reclaimed water19Annex B (informative) Information of chlorine disinfection for the influent of an RO system20Annex C (informative) Maturity level of technologies applied to RO concentrate treatment21BibliographyISO 23070:202022https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c-		8.7	System failure	16
11 Emergency response plan 17 Annex A (informative) Example of an RO treatment system for reclaimed water 19 Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070:2020 22 https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c-	9	Post-t	reatment unit	17
Annex A (informative) Example of an RO treatment system for reclaimed water 19 Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070:2020 22 https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c-	10	RO co	ncentrate management	
Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070:2020 22 https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c-	11	Emer	gency response plan	17
Annex B (informative) Information of chlorine disinfection for the influent of an RO system 20 Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070:2020 22 https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c-	Annex	A (info	ormative) Example of an RO treatment system for reclaimed water	
Annex C (informative) Maturity level of technologies applied to RO concentrate treatment 21 Bibliography ISO 23070:2020 22 https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c-	Annex	B (info	ormative) Information of chlorine disinfection for the influent of an RO system	20
Bibliography ISO 23070:2020 22 https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c-	Annex	c (info	ormative) Maturity level of technologies applied to RO concentrate treatment	21
https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c-				
	DIDIIO	graphy		
56d43860f5ca/isc-23070-2020			56d43860f5ca/iso-23070-2020	

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. <u>www.iso.org/directives</u>

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. www.iso.org/patents

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

This document was prepared by Technical Committee 150/TC 282, *Water reuse*, Subcommittee SC 2, *Water reuse in urban areas*.

<u>ISO 23070:2020</u>

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.wiso.org/members.html.

Introduction

Over the past decade, with an increasing demand of high-quality reclaimed water, reverse osmosis (RO) has been widely applied as an important option for municipal wastewater reclamation. RO is a water purification technology that uses a semipermeable membrane to remove ions and dissolved organic micropollutants from feed water. In reverse osmosis, an applied pressure is used to overcome osmotic pressure, a colligative property that is driven by chemical potential differences of the solvent, a thermodynamic parameter. The automatic operation, small footprint and consistent high permeate quality are the advantages of an RO process, which make it widely recognized. The reclaimed water produced by an RO system could be used as boiler replenishing water, water for industrial production and so on.

Compared with seawater and industrial wastewater, municipal wastewater has its distinctive features. The total dissolved solid (TDS) concentration in seawater is mainly in the range of 30,000 to 45,000 mg/l^[1], while the TDS concentration in secondary effluent of municipal wastewater ranges from 100 to 3,000 mg/l^[2]. Thus, the RO system of municipal wastewater could achieve higher recovery efficiency with much lower operational pressure compared with that of seawater. However, the dissolved organic matter (DOM) concentration in secondary effluent is in the range of 5 to 20 mg/l as dissolve organic carbon $(DOC)^{[2]}$, which is much higher than that in seawater (<2 mg/l)^[1]. Furthermore, the components of the DOM in secondary effluent are much more complicated than those in seawater. Long-term operation of the RO system for municipal wastewater reclamation could lead to serious organic and biological fouling. Therefore, in order to provide the stable operation, the distinctive features of municipal wastewater should be taken into consideration in the design of the RO unit as well as the pre-treatment unit. The design experience of the RO system for other water sources (e.g., seawater and industrial wastewater) could not be applied directly to municipal wastewater.

This document provides guidelines for the planning and design of an RO treatment system for water reuse applications in urban areas. This document is applicable to practitioners and regulatory authorities who intend to implement principles and decisions on water reuse in a safe, reliable and sustainable manner. https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c-

56d43860f5ca/iso-23070-2020

This document addresses an RO treatment system in its entirety (e.g. reclaimed water sources, pretreatment process, RO treatment process, post treatment process, performance of RO system, operation and maintenance and monitoring, usage of reclaimed water).

Water Reuse in Urban Areas — Guidelines for reclaimed water treatment: Design principles of a RO treatment system of municipal wastewater

1 Scope

This document provides guidelines for the planning and design of a reverse osmosis (RO) treatment system of municipal wastewater. This document is applicable to practitioners and authorities who intend to implement principles and decisions on RO treatment of municipal wastewater in a safe, reliable and sustainable manner. This document addresses RO treatment systems of municipal wastewater in their entirety and is applicable to any RO treatment system component.

This document provides:

- standard terms and definitions;
- a description of the system components of an RO treatment system of municipal wastewater;
- design principles of an RO treatment system of municipal wastewater;
- statements on the feed water quality and technical requirements of an RO treatment system;
- guidance for operation and maintenance of an RO treatment system;
- specific aspects for consideration and emergency response.

Design parameters and/regulatory values of an RO treatment system of municipal wastewater are out of the scope of this document. 56d43860f5ca/iso-23070-2020

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 20670:2018, Water reuse — Vocabulary

3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 20670 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <u>https://www.iso.org/obp</u>
- IEC Electropedia: available at <u>https://www.electropedia.org/</u>

3.1

assimilable organic carbon (AOC)

organic carbon which can be used by microorganisms for assimilation

3.2

biodegradable dissolved organic carbon (BDOC)

organic carbon which can be used by microorganisms for assimilation as well as catabolism

3.3

concentrate

rejected stream exiting a membrane module under a cross-flow mode

Note 1 to entry: Concentrate stream contains increased concentrations of constituents over the feed stream due to the accumulation of rejected constituents by membranes in the feed stream.

[SOURCE: ASTM D6161-19^[3], modified — Note 1 to entry added.]

3.4

feed

input solution entering the inlet of a membrane module or system

[SOURCE: ASTM D6161-19^[3]]

3.5

ion exchange

process by which certain anions or cations in water are replaced by other ions by passage through a bed of ion-exchange material

[SOURCE: ISO 6107-1:2004, 46^[4]]

3.6

membrane rejection rate

relative measure of how much of the target constituent that was initially in the feed water is separated from the liquid by the membrane

Note 1 to entry: Rejection is generally expressed by 1 - C2/C1, where C1 is feed concentration and C2 is permeate concentration. To make the guideline simple the word "membrane" is frequently omitted depending on the context.

3.7

<u>ISO 23070:2020</u>

microfiltration https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c-

pressure driven membrane-based separation process designed to remove particles and macromolecules in the approximate range of 0,05 to 2 μm

[SOURCE: ASTM D6161-10^[3]]

3.8

permeate

portion of the feed stream which passes through a membrane

[SOURCE: ASTM D6161-10^[3]]

3.9

pressure drop

pressure change of the influent after the treatment by an RO system

3.10

recovery rate

ratio of the permeate volume to the feed volume

3.11

reverse osmosis

separation process where one component of a solution is removed from another component by flowing the feed stream under pressure across a semipermeable membrane that causes selective movement of solvent against its osmotic pressure difference

[SOURCE: ASTM D6161-10^[3]]

Note 1 to entry: Reverse Osmosis (RO) removes ions based on electrochemical forces, colloids, and organics down to 150 molecular weight. May also be called hyperfiltration.

3.12

silt density index (SDI)

index for the fouling capacity of water in reverse osmosis systems, measuring the rate at which a 0,45-micrometre filter is plugged when subjected to a constant water pressure of 206,8 kPa (30 psi)^[5]

[SOURCE: ASTM D4189-07 (2014)^[5]]

3.13 ultrafiltration

pressure driven process employing semipermeable membrane under hydraulic pressure gradient for the separation of components in a solution

[SOURCE: ASTM D6161-10^[3]]

Note 1 to entry: The pores of the membrane are of a size smaller than 0.1 μ m, which allows passage of the solvent(s) but will retain non-ionic solutes based primarily on physical size, not chemical potential.

4 Abbreviated terms

AOC	assimilable organic carbon
BDOC	biodegradable dissolved organic carbon
BOD	biochemical oxygen demand
CA	cellulose acetate STANDARD PREVIEW
COD	chemical oxygen demand and ards.iteh.ai)
DOC	dissolved organic carbon ISO 23070:2020
DOM	https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c- dissolved organic matter.d43860f5ca/iso-23070-2020
MF	microfiltration
NPF	normalized permeate flow
ORP	oxidation-reduction potential
RO	reverse osmosis
SDI	silt density index
ТОС	total organic carbon
TSS	total suspended solids
UF	ultrafiltration

5 Application of RO treatment systems for reclaimed water

5.1 Overview

Over the past decade, with an increasing demand for high-quality reclaimed water, reverse osmosis (RO) among other technologies has been widely applied as an important option for municipal wastewater reclamation. RO technology can achieve high removal efficiency of microbes, colloidal matter, dissolved solids, organics and inorganics from feed water. The advantages of an RO process are automatic operation and high stability of RO permeate and this makes the RO process widely accepted [6-8].

5.2 Design considerations

Generally, permeate flow rate and permeate quality are used to characterize an RO treatment system under certain feed water quality, recovery rate and operational pressure. Therefore, the main objective of designing an RO treatment system is to meet the specific consideration of permeate flow rate and quality with minimal operational pressure and the considerations about the costs of system components. Furthermore, the cleaning process and maintenance should also be taken into consideration to maintain the stable operation of the system.

5.2.1 Safety considerations

In theory, the reverse osmosis process is driven by pressure. In practice, the pressure is provided by the feed pump of the RO process, and a pressure vessel is used to hold the membrane modules and the pressurized feed water. Therefore, the design and operation of a nRO system shall meet the safety consideration for a pressurized system.

5.2.2 Stability considerations

Stability represents the ability of an RO system to provide stable permeate flow rate and water quality under certain operational conditions. In practice, because of membrane fouling, scaling or other factors which could increase the resistance, in order to maintain a stable rate of permeate flow, the operational pressure keeps increasing. When the operational pressure is too high, it is necessary to clean the RO membranes. As for permeate quality, it might deteriorate because of membrane damage, membrane degradation and membrane fouling. Therefore, the permeate quality shall be diligently monitored.

In order to enhance the stability of an RO system, provision for equalization of feed water flow prior to the pre-treatment stage and/or the RO unit may also be considered. The resultant reduced variability in influent flow rate would also allow for more consistent dosing of chemicals such as antiscalants, reductants and non-oxidizing biocides.

 Iso 23070:2020

 https://standards.iteh.ai/catalog/standards/sist/0d354e33-e1f8-43bd-b35c

 5.2.3
 Economy considerations
 56d43860f5ca/iso-23070-2020

As for the infrastructure cost of an RO system, it is necessary to meet the considerations of permeate flow rate and quality with a minimal cost of system components. As for the operational cost, it is necessary to maintain the operational stability of the whole system with reasonable operational pressure, cleaning and maintenance.

5.3 RO system components

5.3.1 General

An RO system generally consists of six essential components (see Figure 1):

- feed water source;
- pre-treatment;
- R0 treatment;
- auxiliary equipment;
- post treatment (optional depending of the reclaimed water usage and quality criteria); and
- monitor.

Each part of the system should be characterized and managed with appropriate strategies. See <u>Annex A</u> for the example of a typical RO treatment system for reclaimed water.

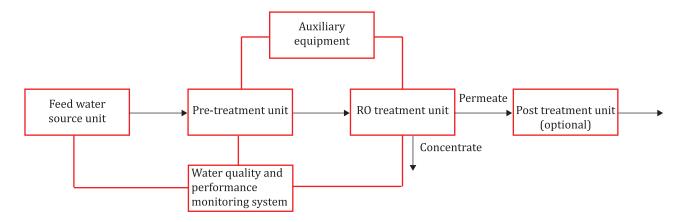


Figure 1 — The essential components of an RO treatment system for reclaimed water

5.3.2 Feed water source

Secondary or tertiary treated municipal wastewater is generally the water source to the RO process stage of the water reclamation plant.

5.3.3 Pre-treatment unit

5.3.4

The pre-treatment unit may include one or more treatment stages such as physico-chemical treatment, oxidation (e.g. ozone/AOPs), media filtration, UF/MF membrane filtration, disinfection.

(standards.iteh.ai) R0 treatment unit

The RO treatment unit generally includes a safety filter, a high-pressure pump, RO equipment and a storage tank for the effluent of RO. It is the key component of the whole RO system.

5.3.5 Auxiliary equipment

The auxiliary equipment may include the dosing and cleaning units. Several kinds of chemicals may be added, including chlorine, cleaning chemicals, antiscalants, reductants and non-oxidizing biocides (Figure 1 and Figure A.1).

5.3.6 Post treatment unit

According to the specific consideration of the end user, one or more stages shall be needed to attain the desired rejection (e.g. secondary RO, ion exchange, electrodialysis reversal). RO concentrate may require treatment. The post treatment unit will be elaborated on in <u>Clause 9</u>.

5.3.7 Water quality and performance monitoring system

In order to maintain the operational stability and safety of the whole system, monitoring equipment should be installed, including temperature meter, pressure gauge, pH meter, flowmeter, conductivity meter, ORP meter and so on.

6 Technical considerations of pre-treatments

6.1 Quality considerations of feed water

6.1.1 General water quality index

General water quality indices of the feed water for an RO system are listed in <u>Table 1</u>.

Category of water quality index	Detailed water quality index
Inorganic index	Metal cations (calcium, magnesium, iron, aluminum, etc.); Silica; Free chlorine residual; Anions (nitrate, phosphate, etc.)
Organic index	COD, BOD, TOC
Other index to be considered	pH, Silt density index (SDI), Turbidity, Oxidation-reduction potential

Metal ions and silica could be of concern for scaling.

Free chlorine residual is of concern for RO membrane oxidizing damage.

The nutrient availability, such as nitrate and phosphate, could be important factors affecting the biofouling of membranes.

Organic index is related to organic fouling and biofouling, which may become the main fouling problems when secondary or tertiary treated municipal wastewater is used as feed water. These indices are elaborated on in 6.1.3.

SDI and turbidity are related to membrane fouling caused by small particles.

6.1.2 Silt density index

Silt density index (SDI) gives the percent drop per minute in the flow rate of the water through the filter, averaged over a period of time such as 15 minutes **PREVIEW**

The measurement procedure of silt density index is as follow referring to ASTM D4189-07 (2014)^[5]:

The water sample is filtered through a 0.45 μ m membrane with a diameter of 47 mm under a constant pressure of 206.8 kPa (30 psi). At the beginning, the time needed to obtain 500 mL filtrate is t_1 . After time *T* (generally, 15 min), the time needed to obtain 500 mL filtrate become t_{25} . The SDI of the water sample could be calculated with Formula $1_{56d4386015ca/iso-23070-2020}$

$$SDI = \frac{\left(1 - \frac{t_1}{t_2}\right)\%}{t_f} = \frac{\% P}{t_f}$$
(1)

where

- $t_{\rm f}$ is the total testing time;
- t_1 is the time needed to obtain 500 ml filtrate at the very beginning;
- t_2 is the time needed to obtain 500 ml filtrate after the testing time *T* (generally, 15 min);

%*P* is plugging rate if %*P* is over 75 %, testing time *T* should be change to 10, 5 or 2 min.

Feed water with an SDI below 3, is generally considered as adequate feed water.

Other methods or indicators may be used if necessary.

6.1.3 Organic index

Generally, organic indices for an RO system include:

- Total organic carbon (TOC);
- Biochemical oxygen demand (BOD); and
- Chemical oxygen demand (COD).