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Treated wastewater reuse for irrigation — Guidelines for the adaptation of irrigation systems and practices to treated wastewater

Réutilisation des eaux usées traitées en irrigation — Lignes directrices pour l'adaptation des systèmes et pratiques d'irrigation aux eaux usées traitées

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Foreword

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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 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 282, *Water reuse*, Subcommittee SC 1, *Treated wastewater reuse for irrigation*.

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.iso.org/members.html.

Introduction

Irrigation is gaining importance all over the world, and the lack of water available from surface or groundwater is driving the introduction of treated wastewater for this purpose. Accordingly, some adaptation is needed to the equipment included in the irrigation system to ensure its proper functioning.

The composition of treated wastewater (TWW) is different from that of freshwater. TWW contains more nutritional elements and microbial populations. It is also characterized by a higher salt concentration, anions and cations with a high precipitation potential of sediments of low solubility salts. These characteristics can severely disrupt the operation of the TWW irrigation systems, which can result in poor performance of the system, and potentially harmful to the environment.

Changes in water quality of reservoirs or secondary water resources can affect the water systems' efficiency, as all parts of the irrigation system, such as filters, pipes and emitters, can be adversely affected by low quality water.

The transport efficiency of irrigation equipment is dependent on the quality of the treated wastewater used, due to several factors such as:

— formation of biofilm on interior pipe walls,

— scale precipitation, organic material and fertilizers, and

— excess build-up of sediment.

Irrigation systems clogging types can be classified into three categories:

— organic and inorganic particles (minerals) sedimentation,

— chemical precipitation of low solubility salts, and

— biofouling -attachment/detachment of microorganism colonies on the irrigation system interior surface, which results in biofilm development.

This document provides guidelines on how to use TWW in or with irrigation systems and to protect them from clogging.

Treated wastewater reuse for irrigation — Guidelines for the adaptation of irrigation systems and practices to treated wastewater

1 Scope

This document provides guidelines to planners and practitioners on how to adjust irrigation equipment so as to allow direct utilization of treated wastewater (TWW) for irrigation. It deals with the adjustment of all components of irrigation systems to TWW quality in respect to physical, chemical and biological parameters.

This document provides guidelines on how to protect irrigation equipment so as to guarantee water systems functionality at high levels of efficiency.

This document includes recommendations for

a) pumping stations,

b) filtration,

c) water network systems,

d) irrigation equipment: emitters (drippers, sprinklers, mini sprinklers, micro sprinklers, sprayers and irrigation machine (sprinklers and sprayers),

e) physical treatment of irrigation equipment, and

f) chemical treatment of irrigation equipment.

This document defines TWW parameters at the irrigation system inlet after a wastewater treatment plant, in order to allow optimal and continual functioning of the irrigation systems and to allow uniformity of emitters' discharge.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 Treated wastewater (TWW)

3.1.1
wastewater
water arising from any combination of domestic, industrial or commercial activities, which can include surface runoff and any accidental sewer inflow/infiltration water and which can include collected storm water, discharged to the environment or sewer

[SOURCE: ISO 20670:2018, 3.80]

3.1.2
treated wastewater
TWW
wastewater that has gone through physical, chemical and/or biological processes to remove contaminants

3.1.3
clogging capacity meter
device used for measuring the time to reach a specified pressure loss across a standard filter screen, at a constant flow rate

[SOURCE: ISO 18471:2015,3.2]

3.1.4
biofilm
attached/detached microorganism colonies on the irrigation systems' interior surface, which results in organic matter development

3.1.5
self-cleaning strainer
filter located in the reservoir that protects the pumping chamber from clogging and has continuous flushing capability

3.1.6
bottom pumping chamber
subsystem that pumps water from the bottom of a water source such as a reservoir or pond, which includes pumping equipment, motors, piping, valves and liquid level controls

3.1.7
floating suction head
unit pumping TWW from the upper level of the reservoir whose pumping point level can be adjusted according to the quality of TWW

3.2 Filtration

3.2.1
filtration
physical process that separates solid particles from water, by passing the water through a physical porous barrier to trap and separate suspended solids from the water

Note 1 to entry: Examples of barrier include media bed, surface or depth filter, screen, disc or membrane.

[SOURCE: ISO 20670:2018, 3.27, modified — Note 1 to entry, the word “disc” has been added.]

3.2.2
nominal flow rate of filtration
flow rate through a filter for proper filtration, as declared by manufacturer

[SOURCE: ISO 9912–1:2004, 2.37]

3.2.3
check filter
filter located before the irrigation emitters (drip, sprayers and micro sprinklers)

3.2.4
flushing differential pressure
differential pressure between two points, one upstream and one downstream of the filter media, which initiates the flushing cycle

3.2.5
emitter
dripper
device fitted to an irrigation lateral and intended to discharge water in the form of drops or recommended continuous flow at flow rates not exceeding 24 l/h except during flushing

Note 1 to entry: Other emitters flow at flow rates between 24 l/h and 60 l/h.

[SOURCE: ISO 16075–1:2015, 3.4.3]

3.2.6
on-line emitter
emitter intended for installation in the wall of an irrigation lateral, either directly or indirectly by means such as tubing

[SOURCE: ISO 16075–1:2015, 3.4.12]

3.2.7
in-line emitter
emitter intended for installation between two lengths of pipe in an irrigation lateral

[SOURCE: ISO 9261:2004, 3.2]

3.2.8
unregulated dripper
non-pressure compensating emitter/emitting pipe

Note 1 to entry: An unregulated dripper's flow rate varies with inlet water pressure.

[SOURCE: ISO 9261:2004, 3.10]

3.2.9
regulated dripper
pressure compensating emitter/emitting pipe

Note 1 to entry: A regulated dripper maintains a relatively constant flow rate at varying water pressures.

[SOURCE: ISO 9261:2004, 3.8]

3.2.10
sprinkler
water distribution device of a variety of sizes and types, for example, impact sprinkler, fixed nozzle, sprayer, irrigation gun

[SOURCE: ISO 16075-1:2015, 3.4.24]

3.2.11
rotating sprinkler
device which by its rotating motion around its vertical axis distributes water over a circular area or part of a circular area

[SOURCE: ISO 15886-1:2012, 2.38]

3.2.12
irrigation sprayer
device which discharges water in the form of fine jets or in a fan shape without rotation movements of its parts

[SOURCE: ISO 16075-1:2015, 3.4.7]

3.2.13
center pivot
automated irrigation machine consisting of a number of self-propelled towers supporting a pipeline rotating around a pivot point and through which water supplied at the pivot point flows radially outward for distribution by sprayers or sprinklers located along the pipeline

[SOURCE: ISO 16075-1:2015, 3.4.2]

4 TWW quality monitoring for micro-irrigation

4.1 General

4.1.1 Micro-irrigation equipment should be adapted to the quality of the given water.

4.1.2 Water quality parameters should fulfill the recommended values shown in Table A.1 and Table B.1.

4.1.3 Since TWW quality changes from season to season, from month to month, from week to week, from day to day or even during the course of one day, TWW users should closely monitor the TWW quality in the system at key points, to be able to respond to quality changes, which can otherwise quickly clog the entire micro-irrigation system.

4.1.4 Monitoring of TWW quality (see 4.2) can provide users with efficient real-time information.

4.1.5 Changes in TWW quality should be responded to by the adaptation of irrigation parameters, such as flow reduction, filters insertion and chemical treatments.

4.1.6 The quality of TWW should be monitored using the devices listed in 4.2, and according to the procedure described in 4.3.

4.2 TWW quality monitoring devices

4.2.1 Flushing counter for automated filters

A flushing counter for automated filters monitors changes that occur between one period of flushing and the next period of flushing.

A change in flushing frequency should indicate changes in water quality.

4.2.2 pH level sensor

A pH level sensor indicates calcium and calcium carbonate levels, as well as the expected efficiency of any injected chlorine (see Annex C).

4.2.3 Clogging capacity meter

A clogging capacity meter provides immediate information about changes in TWW and identifies the main material causing the clogging.

The clogging capacity meter allows a thorough examination of water quality changes and clogging causes throughout the water supply — from the pump to the dripperlines.

4.2.4 Chlorine demand sensor

A chlorine demand sensor informs TWW users about changes in the concentration of slime or organic matter in the water.

4.3 TWW quality monitoring procedure

4.3.1 The quality of TWW should be monitored in accordance with the requirements of the irrigation system, the plantation and the crop.

4.3.2 The monitoring procedure should depend on water quality.

4.3.3 The monitoring procedure should start at the TWW reservoir and continue through the main head system, while checking the filters, all the way through to the last emitter.

5 TWW reservoirs

5.1 General

Reservoirs for TWW systems balance any disproportions between the TWW routine production and the TWW irrigation consumption throughout the year. Such reservoirs are normally open to the atmosphere.

5.2 TWW reservoir safety

The design of reservoir systems should include safety measures (fence construction surrounding the reservoir, signing and pipeline painting).

5.3 TWW reservoir design

In TWW reservoir design, the following parameters should be considered:

a) the type of TWW stored in the reservoir (see 5.4);

b) TWW quality (see 5.5);

c) reservoir processes affecting TWW quality and derived reservoir operation (see 5.6);

d) engineering data and design (see 5.7);

e) pumping station (see Clause 7);

f) TWW quality monitoring (see Clause 4);

g) reservoir biological and chemical treatment (see 5.8, Annex H);

h) safety measures (see 5.2).

5.4 Type of TWW stored in the reservoir

A reservoir should store TWW.

Surface runoff may also be discharged into the reservoir.

5.5 Quality of TWW stored in the reservoir

The quality of the TWW stored in the reservoir should be in accordance with Annex A of this document, and ISO 16075-1 to −4.

5.6 Reservoir processes affecting TWW quality and derived reservoir operation

The residence of TWW in an open reservoir can affect its quality, due to the following factors and processes, which can become more intensive as the TWW quality decreases.

a) growth of living organisms (bacteria, algae, algae predators, zooplankton, etc.) and organic material transformation;

b) external pollution (dust, birds, insects, fumigation);

c) climate influences;

d) surface runoff flow and rainfall over the reservoir causing a salt concentration decrease in the TWW;

e) evaporation from the reservoir causing a salt concentration increase in the TWW;

f) winds contributing to the formation of waves resulting in TWW layers inversion;

g) layers development in the reservoir;

h) chemical processes that characterize TWW open reservoir storage, e.g. rising pH levels, changes in the relative concentration of nitrogen components.

5.7 Reservoir engineering data and design

In a TWW reservoir design for irrigation, the following should be complied:

a) Engineering data should be collected;

   1) TWW data: TWW sources and discharge distribution throughout the year;

   2) soil data: type of soil, soil compatibility to reservoir construction, soil hydraulic conductivity;

   3) groundwater data: type, depth and flow direction;

b) A minimum residual TWW volume should be maintained in the reservoir while using a bottom pumping chamber, to avoid mud penetration to the irrigation system;

c) TWW level control systems should be installed to prevent overflow and control the operative storage;

d) Environmental and human health damage resulting from TWW excess overflow should be prevented;

e) The reservoir's maintenance should be tested. See an example of maintenance control guidelines in Annex G.

5.8 Biological treatment in reservoirs

5.8.1 Where oxygen levels in open reservoirs are between 0,5 mg/l to 1,0 mg/l, different types of fish can be introduced to clean the reservoir from surface and subsurface algae, and reduce filter flushing events.

An oxygen level of 1,0 mg/l or more does not require a more extensive use of oxygen fountains and/or expenses.

5.8.2 The introduction of fish can help to remove clogging causes such as algae, zooplankton in the upper part of the TWW column and algae at the bottom and walls of the reservoir.

5.8.3 The following species are generally recommended for stocking open reservoirs in warm climates. In other climates or geographical regions, the fish species selected for stocking the reservoir should reflect local species and climate conditions.

a) big-head carp,

b) grass carp to treat plants and huge algae,

c) silver carp to feed on plankton and zooplankton, and

d) black carp to feed on snails and slugs.

5.8.4 The fish population introduced into the reservoir should consist of either male fish or female fish, to avoid reproduction.

5.8.5 Death of fish in TWW reservoir should be controlled. One or more of the following methods may be used:

a) monitoring TWW quality conditions to anticipate, detect or predict distress during critical season,

b) installing aeration units where conditions of low oxygen levels are likely or known to occur, or

c) introducing freshwater.

5.8.6 To prevent conditions of distress for fish, the oxygen level should not be lower than 1 mg/l.

NOTE Oxygen levels lower than 1 mg/l can occur during early morning hours.

5.8.7 Un-ionized ammonia concentration should not be higher than 0,5 mg/l.

5.8.8 Oxygen fountains of at least 1,5 pH each should be introduced, in accordance with the size of the reservoir.

5.8.9 Oxygen fountains as well as electricity cables should be prepared in advance to allow spreading 50 metres from shoreline.

6 Filtration systems

6.1 General

6.1.1 The design of the filtration system should take into account the worst case scenario due to seasonal changes in TWW quality in a reservoir (see Annex I). Unpredicted occurring events should also be considered.

6.1.2 Where TWW is used, biofilm is often formed and developed in laterals and emitters. Filtration, a physical water treatment, removes suspended material from the water entering the system to avoid its deposition in pipes and emitters. The filtration system is a primary, multistep means that facilitates the separation and disposal of suspended materials.

6.1.3 With few exceptions such as high flow sprinklers or irrigation gun, irrigation systems should be filtered.

