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DRAFT TANZANIA STANDARDS

Municipal and industrial wastewaters: General tolerance limits for reuse of treated wastewater in irrigation.

0. Foreword

The increasing water scarcity and water pollution control efforts in many countries have necesitated treated municipal and industrial wastewater a viable economic option of augmenting the existing water supply. This is more so, especially when compared to expensive alternatives such as desalination or the development of new water sources involving dams and reservoirs. Reuse of treated wastewater makes it possible to close the water cycle at a point closer to cities by producing "new water" from municipal or Industrial wastewater and reduces untreated wastewater discharge to the environment.

The problem of water resources is aggravating as a result of accelerated urbanization, population growth, industrial and agricultural development. In addition to these factors, climate changes represent a substantial risk because it affects considerably both water resources and crops. Globally, agriculture is the largest consumer of water, accounting for approximately 70% of all freshwater. Farmers in many arid and semiarid areas are forced to find solutions to irrigate their crops, so they often must use treated, untreated or undiluted wastewater which is cheaper than other water sources. Increasing water needs (for drinking, food and irrigation) make the use of effluents (treated wastewater) an effective solution to solve the problem of water scarcity, to save significant quantities of drinking water, to reduce the use of chemical fertilizers (nutrients in the wastewater can replace conventional fertilizers), thereby protecting the environment and improving crop yield.

Treated wastewater effluent for reuse in irrigation purposes has added benefit of availing nutrients hence reducing the demand for commercial fertilizer. Another advantage is irrigation using treated wastewater effluent provides a reliable water supply as effluent is continuously produced. Recognizing that the water demands for irrigation vary seasonally, a storage system or a combination with other reuse schemes should be well planned. Water reuse standards ensure appropriate health and environmental protection and thus provide public confidence in reuse practices in order to enhance water reuse at Tanzania level
While reuse has a number of advantages, it is not without potential risks mainly related to public health and the environment effects, especially when low-quality water is used. Potential constrains could also be economic feasibility and lack of cultural acceptance of reuse, requiring the appropriate and standardized options of treatment facility and reuse option.

The decision for the most feasible treated wastewater effluent reuse application requires a regional survey of supply of wastewater and (seasonally varying) demand for reuse water to match the source and reuse option. Before the reuse option is included in the design of a wastewater facility (WWTF), it must be ensured the beneficiary has a common understanding on the application of the facility and will in fact reuse that treated wastewater. The legal requirements and guidelines for reuse, health standards, and groundwater protection should be compiled.

In the preparation of this Tanzania Standard, considerable assistance was drawn from the following:

WHO Wastewater quality guidelines for agricultural use
Report of the Effluent Standards Committee prepared by Effluents Standards Committee (1977)

In routine monitoring, different validated test methods may be used as long as they give reliable results. However, in case of disputes, the reference methods prescribed in this Tanzania Standard shall be used.

1. Scope

Wastewater reuse standards provide requirement for treated effluents discharged from municipal and industrial establishments intended for irrigation purposes. The standards provide specifications for treated effluent for reuse in the following applications;

a) unrestricted irrigation of agricultural crops.
b) restricted irrigation of agricultural crops, public and private gardens and landscape areas.

The water reuse standards cover the parameters intended to be used for treated effluents from municipal and industries. These include the following:

a) agronomic parameters: nutrients (nitrogen, phosphorus and potassium) and salinity factors (total salt content, chloride, boron, and sodium concentration);
b) other chemical element parameters (heavy metals);
c) microbial parameters.
d) Phyical paremeters.
e) The standard applies to all type of irrigation methods which include surface, drip and overhead irrigation.

The standards do not cover requirements for hazardous effluents such as radioactive materials, hospital wastes and chemical waste from laboratories.

2. Normative References

The following referenced documents are indispensable for the application of this Tanzania Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

TZS 861: 2006, *Municipal and industrial wastewaters test methods*

TZS 861: 2006 Part 10, *Municipal and industrial wastewaters sampling methods*

TZS 4: 1979, *Rounding off numerical values*

TZS 90: 1980, *Water, sewerage and industrial effluents – Glossary of terms*

3. Terms and definitions

For the purpose of this Tanzania Standard, and the normative references, unless the context specifically indicates otherwise, the following terms and phrases shall have the meanings respectively ascribed to them by this section.

3.1 effluent
water or wastewater discharged from a containing space such as treatment plant, industrial process, lagoon, etc.

3.2 health
state of complete physical, mental and social well-being and not merely the absence of disease or infirmity

3.3 irrigation
process by which water is diverted from a river or pumped from a well and used for the purpose of agricultural production

3.4 raw wastewater
Wastewater which has not undergone any treatment

3.5 reservoir
system to store temporarily unused Treated Wastewater (TWW) depending on the demand for water irrigation and the treatment plant discharge

3.6 restricted irrigation
use of TWW for non-potable applications in settings where public access is controlled or restricted by physical or institutional barriers

3.7 unrestricted irrigation
use of TWW for non-potable applications in settings where public access is not restricted

3.8 wastewater
Water discharged after being used, or produced by a process, and which is of no further immediate value to that process.

3.9 water reuse
use of treated wastewater for beneficial use

4 Requirements

The permissible limits for municipal and industrial wastewaters intended to be used for irrigation purposes shall be as shown in table 1.1 -1.6 below.

Permissible limits

1.1 Physical Parameters

Parameter	Unrestricted	Restricted	Test method
Colour	50 TCU	50 TCU	ISO 7887: 1994, Water quality – Examination and determination of colour – Section 3: Determination of true color using optical instruments
pH range	6.5 – 9.0	6.5 – 9.0	TZS 861: Part 2 /ISO 10523– Electrometric method
Temperature range	20 -35^{o}C	20-35^{0}C	See annex A (To attach from TZS 860)
Temperature change	± 3 ^{0}C	± 5 ^{0}C	
Total suspended solids	≤60 mg/L	≤60 mg/L	

1.2 Chemical Parameters

Parameter	Unrestricted	Restricted	Test method
BOD_5 at 20 ^{o}C (mg/L)	≤25	≤50	TZS 861: Part 3 /ISO 5815– Five-day BOD method
COD (mg/L)	≤30	≤60	TZS 861: Part 4 – Dichromate digestion method
Total Dissolved Solids (mg/L)	≤ 450	≤1200	ISO 11923
Total organic carbon (TOC) (mg/L)	≤ 25	≤100	APHA 5310 B
Sodium adsorption ratio (SAR)	≤3	3 – 9	
Electrical Conductivity	≤1000	≤1000	

1.3 Inorganic Parameters

Parameter	Unrestricted limits (mg/l)	Restricted limits (mg/l)	Test method
Aluminium (Al)	≤2.0	≤5.0	TZS 861: Part 7 /ISO 8288– Direct nitrous oxide-Acetylene flame atomic absorption spectrometry
Arsenic (As)	≤0.05	≤0.1	TZS 861: Part 8 / ISO 11885– Manual hydride generation - Atomic absorption spectrometry
Beryllium (Be)	≤0.10	≤0.10	
Cadmium (Cd)	≤0.01	≤0.01	TZS 861: Part 7 / ISO 8288– Flame atomic absorption spectrometry
Chromium (Cr)	≤0.1	≤0.1	ISO 6222:1999, Microbiological methods
Chlorides (Cl^-)	≤70	<350	APHA Standard Methods: 4110 B. Ion chromatography with chemical suppression of eluant conductivity
Cobalt (Co)	≤0.05	≤1.0	TZS 861: Part 7 /ISO 8288– Flame atomic absorption spectrometry
Copper (Cu)	≤0.20	≤0.50	TZS 861: Part 7 / ISO 8288- Flame atomic absorption spectrometry
Fluorides (F^-)	≤1.0	≤4.0	APHA standard methods: 4110 B. Ion chromatography with chemical suppression of eluant conductivity
Iron	≤5.0	≤5.0	TZS 861: Part 7 / ISO 8288– Flame atomic absorption spectrometry
Lead (Pb)	≤0.1	≤0.5	TZS 861: Part 7 / ISO 8288)– Flame atomic absorption spectrometry
Manganese	≤0.20	≤5.0	TZS 861: Part 7 / ISO 8288– Flame atomic absorption spectrometry
Mercury (Hg)	≤0.002	≤0.005	TZS 861: Part 10 – Cold-vapor atomic absorption spectrometry
Boron (B)	≤0.7	≤2.0	
Nickel (Ni)	≤0.20	≤0.5	TZS 861: Part 7 / ISO 8288– Flame atomic absorption spectrometry
Vanadium	≤0.1	≤1.0	TZS 1929 / ISO 15586: 2003, Water quality – Determination of trace elements using atomic absorption spectrometer with graphite furnace
Zinc (Zn)	≤2.0	≤5.0	TZS 861: Part 7 – Flame atomic absorption spectrometry
Cyanide	≤0.01	≤0.05	ISO 6703
Selenium (Se)	≤0.02	≤0.02	
Sulphate (SO_4^{2-})	≤200	≤500	
Aluminium (Al)	≤2.0	≤4.0	TZS 861: Part 7 /ISO 8288– Direct nitrous oxide-Acetylene flame atomic absorption spectrometry
Arsenic (As)	≤0.05	≤0.1	TZS 861: Part 8 / ISO 11885– Manual hydride generation - Atomic absorption spectrometry

1.4 Nutrient

Parameter	Unrestricted limits	Restricted limits	Test method

	(mg/l)	(mg/l)	
Nitrates (NO_3^-)	≤45	≤50	APHA standard methods: 4110 B. Ion chromatography with chemical suppression of eluant conductivity
Total Nitrogen	≤25	≤35	ISO 5663
Ammonium nitrogen	≤20	≤30	
Phosphorus Total (as P)	≤5	≤10	TZS 861: Part 6 / **ISO 15681**– Colorimetric-ascorbic acid method
Total Kjeldahl Nitrogen (as N)	≤45	≤70	TZS 861: Part 5 – Kjeldahl method

1.5 Organic Parameters

Parameter	**Unrestricted limits (mg/l)**	**Restricted limits (mg/l)**	**Test method**
1, 1, 2 –Trichloroethane (mg/L)	≤0.06	≤0.1	TZS 861 / GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)
1,1,1 - Trichloroethane	≤3.0	≤3.0	TZS 861 / GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)
1,2 – Dichloroethylene	≤0.2	≤0.5	TZS 861 / GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)
1,2 - Dichloroethane	≤0.04	≤0.1	TZS 861 / GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)
1,3 - Dichloropropene	≤0.2	≤0.3	TZS 861 / GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)
Alkyl benzene sulfonate (ABS)	0	≤0.001	TZS 1407 / ISO 7875 – 1: 1996, Determination of surfactants – Part 1: Determination of anionic surfactants by measurement of the methylene blue index (MBAS)
1,3 - Dichloropropene	≤0.2	≤0.2	
Aromatic nitrogen containing compounds (e.g., aromatic amines)	≤0.001	≤0.002	APHA standard methods 6410: Liquid-liquid extraction GC/MS method
cis-1,2 - Dichloroethylene	≤0.4	≤0.4	TZS 861 / GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)
Dichloromethane	≤0.2	≤0.2	TZS 861 / GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)

Oil and grease (fatty maters and hydrocarbons)	≤5	≤5	APHA standard methods 5520
Organochlorine pesticides (Cl)	0	≤0.001	TZS 1403:2016 / GC ECD (ISO 6468: 1996, Water quality – Determination of certain organochlorine insecticides, polychlorinated biphenyls and chlorobenzenes – Gas chromatographic method after liquid-liquid extraction)
Other aromatic and/or aliphatic hydrocarbons not used as pesticides	≤0.05	≤0.05	TZS 1403:2016 / GC ECD (ISO 6468: 1996, Water quality – Determination of certain organochlorine insecticides, polychlorinated biphenyls and chlorobenzenes – Gas chromatographic method after liquid-liquid extraction)
Pesticides other than organochlorines	≤0.01	≤0.01	TZS 1403:2016 / GC ECD (ISO 6468: 1996, Water quality – Determination of certain organochlorine insecticides, polychlorinated biphenyls and chlorobenzenes – Gas chromatographic method after liquid-liquid extraction)
Phenols	≤0.002	≤0.002	TZS 1403:2016 / GC ECD (ISO 6468: 1996, Water quality – Determination of certain organochlorine insecticides, polychlorinated biphenyls and chlorobenzenes – Gas chromatographic method after liquid-liquid extraction)
Tetrachloroethylene	≤0.1	≤0.1	TZS 861 / GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)
Tetrachloromethane	≤0.02	≤0.02	TZS 861 / GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)
Trichloroethylene	≤0.3	≤0.3	TZS 861 / GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)
PCBs	≤0.003	≤0.003	TZS 1403:2016 / ISO 6468

1.6 Biological Parameter

Parameter	**Unrestricted**	**Restricted**	**Test method**
Total Coliforms	≤300 cfu/100mL	≤10,000 cfu/100mL	ISO 6222:1999, Microbiological methods
E Coli	≤10 cfu/100mL or below detection limit	≤100cfu/100mL	ISO 9308
Fecal Coliform	≤200 cfu/100 ml	≤1,000cfu/100mL	ISO 9308

Nematodes (Helminth eggs)	<1egg/L	5eggs/L	

Appendix

Depth temperature measurement

Depth temperature required for limnological studies may be measured with a reversing thermometer, thermophone, or thermistor. The thermistor is most convenient and accurate; however, higher cost may preclude its use. Calibrate any temperature measurement devices with TBS–certified thermometer before field use. Make readings with the thermometer or device immersed in water long enough to permit complete equilibration. Report results to the nearest 0.1 or 1.0°C, depending on need.

The thermometer commonly used for depth measurements is of the reversing type. It often is mounted on the sample collection apparatus so that a water sample may be obtained simultaneously. Correct readings of reversing thermometers for changes due to differences between temperature at reversal and temperature at time of reading. Calculate as follows:

$$\Delta T = \left[\frac{(T'-t)(T'-V_\circ)}{K}\right] \mathrm{X} \left[1+\frac{(T'-t)(T'+V_\circ)}{K}\right] + L$$

Where:

ΔT	correction to be added algebraically to uncorrected reading,
T'	uncorrected reading at reversal,
t	temperature at which thermometer is read,
V_o	volume, of small bulb end of capillary up to 0°C graduation
K	constant depending on relative thermal expansion of mercury and glass (usual value of K = 6100), and
L	calibration correction of thermometer depending on T'

If series observations are made it is convenient to prepare graphs for a thermometer to obtain ΔT from any values of T' and t.