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DRAFT TANZANIA STANDARDS

Municipal and industrial wastewaters: General tolerance limits for use 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 change present 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 as 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 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. Wastewater use standards ensure appropriate health and environmental protection and thus provide public confidence in use 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 use 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 treatment facility (WWTF), it must be ensured the beneficiary has a common understanding on the application of the facility and will in fact use that treated wastewater. The legal requirements and guidelines for use, health standards, and groundwater protection should be complied.

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

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

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

a) Phyical parameters.
b) agronomic parameters: essential nutrients (nitrogen, phosphorus and potassium) and salinity factors (total salt content, chloride, boron, and sodium concentration);
c) other chemical element parameters (heavy metals);
d) microbial parameters.
e) The standard applies to all type of irrigation methods which include surface, drip and overhead irrigation. However, a buffer zone of 50m – 100m from residential area and roads shall be established when using overhead method in restricted irrigation.

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

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
means the application of a specific amount of water at a particular location in order to meet the requirements of a crop growing at that location in amounts that are appropriate to the crop's stage of growth. It can also mean the application of water in amounts necessary to bring soil to the desired moisture level prior to crop planting

3.4 raw wastewater

wastewater that 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. This kind of irrigation excludes salad crops and vegetables that are eaten raw.

3.7 unrestricted irrigation
use of treated wastewater for non-potable applications in settings where public access is not restricted. It is for irrigation of all crops,

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

3.10 wastewater treatment facility
is a facility in which a combination of various processes (e.g., physical, chemical and biological) are used to treat industrial wastewater and remove pollutants

3.11 Industrial wastewater
is the aqueous discard that results from substances having been dissolved or suspended in water, typically during the use of water in an industrial manufacturing process or the cleaning activities that take place along with that process

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 irrigation	Restricted irrigation	Test method
Colour (TCU)	≤50	≤50	ISO 7887: 1994, Water quality – Examination and determination of colour – Section 3: Determination of true color using optical instruments
Temperature range (ºC)	20 -35	20-35	See annex A (To attach from TZS 860)
Temperature change (ºC)	± 3	± 5	See Annex A
Total suspended solids (mg/L)	≤100	≤100	APHA 2540D
Total Dissolved Solids (TDS) (mg/L)	≤ 450	≤1200	ISO 11923

Electrical Conductivity (*µS/cm)*	≤1000	≤1000	ISO 7888

1.2 Chemical Parameters

Parameter	Unrestricted irrigation	Restricted irrigation	Test method
pH	6.5 – 9.0	6.5 – 9.0	TZS 861: Part 2 /ISO 10523– Electrometric method
Biochemical Oxygen Demand (BOD_5) at 20 ºC (mg/L)	≤ 50	≤50	TZS 861: Part 3 /ISO 5815– Five-day BOD method
Chemical Oxygen Demand (COD) (mg/L)	≤100	≤100	TZS 861: Part 4 – Dichromate digestion method
Total organic carbon (TOC) (mg/L)	≤ 25	≤100	APHA 5310 B
Sodium adsorption ratio (SAR)	≤3	3 – 9	

1.3 Inorganic Parameters

Parameter	Unrestricted irrigation (mg/l)	Restricted irrigation (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	Beryllium-ICP Method
Cadmium (Cd)	≤0.01	≤0.01	TZS 861: Part 7 / ISO 8288– Flame atomic absorption spectrometry
Chromium (Cr)	≤0.1	≤0.1	ISO 8288
Chromium VI (Cr^{+6})	≤0.1	≤0.1	TZS 861: Part 9
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^-)	≤ 4	≤4.0	ISO 10359
Iron (Fe)	≤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 (Mn)	≤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	ICP Method
Nickel (Ni)	≤0.20	≤0.5	TZS 861: Part 7 / ISO 8288– Flame atomic absorption spectrometry
Vanadium (V)	≤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 (CN)	≤0.01	≤0.05	ISO 6703
Selenium (Se)	≤0.02	≤0.02	ICP Method
Sulphate (SO_4^{2-})	≤200	≤500	APHA 4500 E

1.4 Nutrient

Parameter	**Unrestricted irrigation (mg/l)**	**Restricted irrigation (mg/l)**	**Test method**
Nitrates (NO_3^-)	≤45	≤50	APHA standard methods: 4110 B. Ion chromatography with chemical suppression of eluant conductivity
Total Nitrogen	≤70	≤70	ISO 5663
Ammonium nitrogen	≤20	≤30	APHA 4500 D
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
Magnesium	≤29	≤29	ISO 7980
Calcium	≤100	≤100	ISO 6058

1.5 Organic Parameters

Parameter	**Unrestricted irrigation (mg/l)**	**Restricted irrigation (mg/l)**	**Test method**
1, 1, 2 –Trichloroethane	≤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	ISO 10301: 1997
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)
Polychlorinated biphenyl (PCBs)	≤0.003	≤0.003	TZS 1403:2016 / ISO 6468

1.6 Biological Parameter

Parameter	**Unrestricted irrigation**	**Restricted irrigation**	**Test method**
Total Coliforms(CFU/100ml)	≤10000	≤100,000	ISO 6222:1999, Microbiological methods
E *coli* (CFU/100ml)	≤10 or below detection limit	≤100	ISO 9308
Fecal Coliform (CFU/100ml)	≤1000	≤100,000	ISO 9308
Nematodes (Helminth eggs) (egg/L)	≤1	≤ 5	APHA 10750 B

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 1.0ºC, 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:

$$\Delta T = \left[\frac{(T' - t)(T' - V_0)}{K}\right] \times \left[1 + \frac{(T' - t)(T' + V_0)}{K}\right] + L$$

Where:

$\Delta T' =$ correction to be added algebraically to uncorrected reading

$T' =$ uncorrected reading at reversal

$t =$ temperature at which thermometer is read,

$V_0 =$ volume, of small bulb end of capillary up to 0ºC 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*.