ISO/~~TS~~ DTS 21152~~-#: ####(X)~~

ISO/TC 282/SC~~ 04/WG 6~~ 4

Secretariat: SAC

Date: 2024-09-04

Guidance on water conservation techniques of circulating cooling water in thermal power plants

~~DTS stage~~

Contents

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 (see www.iso.org/directives).

~~Attention is drawn~~ISO draws attention to the possibility that ~~some of~~ the ~~elements~~implementation of this document may ~~be~~involve the ~~subject~~use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents~~.~~. 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 (see).~~

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

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/~~TC282~~TC 282, *Water reuse*, Subcommittee SC 4, *Industrial water reuse*.

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

Water plays an important role in transferring energy, cooling and cleaning in the process of thermal power generation. According to the statistics of the International Energy Agency (IEA) and China Water Resources Bulletin, fossil fuel power generation used ~~around~~approximately 189,6 billion cubic metres of freshwater in 2021, accounting for almost 50 % of global energy system ~~fresh water~~freshwater withdrawals and 5 % of total global freshwater withdrawals. In China, water withdrawal for thermal power generation in 2021 ~~accounts~~accounted for ~~about~~approximately 17,7 % of the industrial water withdrawal, of which cooling water in thermal power plants ~~accounts~~accounted for approximately 50 %. To save water resources, improve circulating cooling water use efficiency and help thermal power plants to enhance water ~~conservations~~conservation, work efficiently and orderly, and thus improve the economic and social benefits of thermal power plants, it is important to formulate guidance for the conservation of water ~~in thermal power plants which is~~ used as circulating cooling water in thermal power plants.

The quantity~~,~~ of circulating cooling water used in thermal power plants~~,~~ ranges from tens to hundreds of thousands of cubic metres based on their operating capacity. The reduction of ~~water use in~~ circulating cooling water~~,~~ use should consider the water quality, pipe materials, water treatment, chemicals and other factors. Meanwhile, to achieve water conservation purposes, the ~~utilization~~use of residual heat of high temperature circulating water ~~should be considered~~ to reduce the temperature of circulating water in the cooling tower ~~to achieve water conservation purpose~~should be considered. Cycles of concentration is an important index for evaluating water conservation of circulating cooling water, while the amount of make-up water is closely related to the cycles of concentration of circulating cooling water. The higher the concentration, the better water conservation efficiency. However, with higher concentrations, the cost and difficulty of water treatment ~~will~~ also increase exponentially.

~~For different make-up water quality, circulating~~Circulating cooling water quality control index and water conservation processes ~~are also different~~differ based on the quality of make-up water. Researchers and engineers should standardize the water conservation process of circulating cooling water in thermal power plants ~~based on~~by fully considering the cycles of concentration and other relevant influencing factors, to provide standardized technical guidance for the targeted stake holders (~~i.e.,~~ policy makers, managers, technical consultants, designers, operators of water treatment systems, etc.).

Through analysis and research on the circulating cooling water conservation technology in thermal power plants, this document sets up a scientific and objective technical control index, management guidance and implementation methods that ~~is~~are helpful to improve the efficiency of circulating cooling water conservation ~~efficiency~~ and the standardization of technical transformation of thermal power plants.

Starting from the perspective of water conservation management and technology, this document provides acceptable operation control specifications for common processes of circulating cooling water conservation for most stakeholders, to improve the operation efficiency and management level of circulating cooling water conservation, which is conducive to guiding the development of specialization, normalization and standardization of circulating cooling water conservation.

This document establishes the technical guidance and recommendations for circulating cooling water conservation technology, provides research direction of circulating cooling water conservation technology, improves the water conservation efficiency, and promotes the transformation of circulating cooling water conservation technology to higher efficiency, lower energy consumption, environment friendly and resource saving, in the end realizing sustainable development.

Guidance on water conservation techniques of circulating cooling water in thermal power plants

1 Scope

This document provides technical and management guidance for water conservation of indirect open recirculating cooling water systems in thermal power plants. It is applicable to circulating cooling systems that use surface water, underground water, reclaimed water, and treated domestic sewage from thermal power plant as the make-up water and use physicochemical treatment methods to increase cycles of concentration, thus realizing water conservation and increasing water use efficiency.

This document is applicable to recirculating cooling in thermal power plants ~~fueled~~fuelled by coal, oil, natural gas, and biomass.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

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

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

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

— ~~—~~IEC Electropedia: available at https://www.electropedia.org/

3.1 Terms and definitions

3.1.1
water conservation of circulating cooling water
process to increase *cycles of concentration* (3.1.2~~(3.1.2)~~) thus increasing water use efficiency

3.1.2
cycles of concentration
ratio of the concentration of specific ions in the circulating cooling water to the concentration of the same ions in the make-up water

[SOURCE: ISO 16784-2:2006, 3.6]

3.2 Abbreviated terms

~~BOD_5: biochemical oxygen demand at five days~~

~~COD: chemical oxygen demand~~

~~NH_3-N: ammonia-nitrogen~~

~~NTU: nephelometric turbidity unit~~

~~TDS: total dissolved solids~~

~~TSS: total suspended solids~~

BOD_5 biochemical oxygen demand at five days

CFU	colony forming unit
COD	chemical oxygen demand
NH_3-N	ammonia-nitrogen
NTU	nephelometric turbidity unit
TDS	total dissolved solids
TSS	total suspended solids

4 General

The following principles should be followed for water conservation of circulating cooling water in thermal power plants:

— ~~Develop~~Users should develop efficient circulating cooling water treatment technology, improve the cycles of concentration under the premise of ensuring system safety and energy saving~~;~~.

— ~~Be~~ Users should be aware of the requirements of local environment protection regulation~~;~~.

— ~~Use water~~Water treatment chemicals with high efficiency, low toxicity and good chemical stability~~,~~ should be used; biodegradable water treatment chemicals should be given priority~~,~~; toxic and harmful water treatment chemicals should be strictly restricted.

5 Circulating cooling water quality recommendations

5.1 Water quality recommendations of make-up water

When surface water, underground water, seawater, reclaimed water, and treated domestic sewage from thermal power ~~plant~~plants are used as make-up water for circulating cooling water system in power plants, the ~~source water quality, water~~ quality of the source water and of the circulating cooling water and the working conditions should be ~~analyzed,~~analysed, and technical and economic comparison should be made to select the appropriate cycles of concentration. Table B.1~~See Table B.1~~ in Annex B~~Annex B for~~ contains water quality recommendations when surface water, underground water is used as make-up water for circulating cooling water system after pre-treatment. Table B.2~~See Table B.2~~ in Annex B~~Annex B for~~ contains water quality recommendations when reclaimed water is used as make-up water for circulating cooling water system after pre-treatment. When treated domestic sewage from thermal power plant is used as make-up water for circulating cooling water system, the water quality after treatment should not be lower than the recommendations ~~of Table B.2~~ in Table B.2~~Annex B. See Table B.3~~ in Annex B. Table B.3 in Annex B~~Annex B~~ contains water quality recommendations when seawater is used as ~~makeup~~make-up water of circulating cooling water system.

5.2 Water quality recommendations of circulating cooling water system

The water quality of circulating cooling water ~~system~~systems using surface water, underground water, reclaimed water, and domestic sewage from thermal power ~~plant~~plants as make-up water should meet the recommendations of Table 1~~Table 1.~~.

Table 1 — Water quality recommendations of circulating cooling water ~~system~~systems using surface water, underground water, reclaimed water, and domestic sewage from thermal power ~~plant~~plants as make-up water

Parameters	Units	Recommended values
pH (25~~ºC)~~ °C)	—	~~[~~7,5~~-~~ to 8,8~~]~~

Parameters	Units	Recommended values
TSS	mg/l	≤ 100
(CO_3^{2-}) + (HCO_3^{-}) [a]	mg/l	[400, to 500]
SiO_2	mg/l	[150, to 200]
(Mg^{2+}) ÷: (SiO_2) [a]	mg/l	≤ 60 000
(Ca^{2+}) ÷: (SO_4^{2-}) [a]	mg/l	≤ 2,5× × 10^6
$(Ca^{2+} + Mg^{2+})$ ÷: (CO_3^{2-}) [a]	mg/l	2× × 10^6 ~ to 4× × 10^6
Cl^-	mg/l	According to the material of heat exchange
COD_{Cr}	mg/l	≤ 100
NH_3-N	mg/l	≤ 10 (≤ 5 for copper tube condenser)
TDS [b]	mg/l	≤ 5 000
Conductivity [b]	µS/cm	≤ 8500 8 500

[a] Ca^{2+}, Mg^{2+}, HCO_3^- and CO_3^{2-} are calculated by $CaCO_3$(mg/l).

[b] Conductivity and TDS are non-binding parameters, only for reference. Common parameters having great effect on corrosion and scaling in water have been listed in this table. Although other dissolved ions contribute to the conductivity and TDS, they generally have little effect on corrosion and scaling, so these two parameters are only given as reference indicators for water quality.

The water quality of circulating cooling water systemsystems using seawater as make-up water should be determined through the dynamic simulation test of scale and corrosion inhibitor (Annex A(Annex A),), or it should be controlled according to the recommendations of Table 2Table 2..

Table 2 — Water quality recommendations of circulating cooling water systemsystems using seawater as make-up water

Parameters	Units	Recommended values
TSS	mg/l	≤ 30
Turbidity	NTU	≤ 20
pH (25°C) °C)	—	[8,0, to 9,0]
M alkalinity (calculated by $CaCO_3$)	mg/l	≤ 350
Ca^{2+}	mg/l	≤ 1 000
Mg^{2+}	mg/l	≤ 3200 3 200
Total Fe	mg/l	< 1,0
Cl^-	mg/l	≤ 45 000
SO_4^{2-}	mg/l	≤ 6 000
(Cu^{2+}) [a]	mg/l	≤ 0,1
Oils	mg/l	< 5
residualResidual chlorine [b]	mg/l	0,1 to 1,0 (or lower, meet environmental requirements)
TDS [c]	mg/l	100 000
Conductivity [c]	mS/cm	≤ 150

[a] Monitor The copper ion concentration in seawater circulating cooling water systems containing copper materials should be monitored.

Parameters	Units	Recommended values
[b] The concentration of free residual chlorine should be controlled when adding oxidizing biocides. [c] Conductivity and TDS are non-binding parameter, only for reference. Common parameters having great effect on corrosion and scaling in water have been listed in this table. Although other dissolved ions contribute to TDS, they generally have little effect on corrosion and scaling, so these two parameters are only given as reference indicators for water quality.		

The total number of heterotrophic bacteria in circulating cooling water should not be more than 1 ~~×~~ × 10^5 CFU/ml, and the amount of biological slime should not be more than 3 ml/m^3.

6 Technical guidance for water conservation of circulating cooling tower

6.1 Basic guidance

6.1.1 ~~6.1.1~~ The selection of cycles of concentration in circulating cooling water system should comprehensively consider the water source conditions, water quantity and water quality balance, environmental protection requirements, circulating cooling water system material and other factors. Scale and corrosion inhibition test (Annex C~~(Annex C)~~) should be performed, and technical and economic ~~**comparison**~~comparisons should be made~~,~~; dynamic simulation test of scale and corrosion inhibitor should be used when necessary. Within the safe range of scale and corrosion inhibition, the cycles of concentration should be increased as much as possible. The calculation of cycles of concentration should refer to Annex D~~**Annex D**~~.

6.1.2 ~~6.1.2 **Side**~~A side-stream treatment system should be set up if ~~**the**~~ key ~~**index**~~indexes such as TSS, NH_3-N and salt content significantly exceed the water quality recommendations of the circulating cooling water system after increasing cycles of concentration, leading to potential risks of system corrosion, blockage and scaling.

6.1.3 ~~6.1.3**The**~~The side-stream treatment of circulating cooling water includes side-stream filtration, softening or desalination process. The selection of a side-stream treatment process should be determined by a comprehensive comparison of the circulating cooling water quality, the type and volume of pollutants to be removed and other factors. The calculation of side-stream treatment volume should refer to Annex F~~**Annex F**~~.

6.1.4 ~~6.1.4~~ Side-stream filtration treatment should be set up after technical and economic comparison when ~~**the**~~ there are more than 5 cycles of concentration of circulating cooling water system ~~**are more than 5**~~, or if there is severe seasonal sandstorm.

6.1.5 ~~6.1.5~~ When reclaimed water is used as make-up water for circulating cooling water, if the water quality does not meet the recommendations of Table B.2~~**Table B.2**~~ in Annex B~~**Annex B,**~~, then the treatment process and operation control scheme of circulating cooling water should be determined by scale and corrosion inhibition test and dynamic simulation test of scale and corrosion inhibitor.

6.1.6 ~~6.1.6~~ When a clarification tank is used to treat circulating cooling water blowdown, the influence of ~~**influent**~~ temperature fluctuation on the treatment effect should be taken into account. Automatic temperature regulation device and air separation device should be installed. The influent temperature variations of the clarification tank should not be more than 2~~°C/~~ °C/h.

6.2 Guidance for treatment of circulating cooling with water quality stabilizer

6.2.1 General

Water quality stabilization treatment is essential to circulating cooling water treatment, whether it is to adopt natural balance of pH treatment or other ~~treatment~~treatments such as softening, adding acid, desalting or partial desalting. Water quality stabilization ~~treatment~~treatments includes scale and corrosion inhibition, microbial control and other technologies.