



SLOVENSKI STANDARD
SIST DIN 19643-2:2003

01-maj-2003

Priprava bazenske vode za plavalne in kopalne bazene - 2. del: Kombinacija postopkov: adsorpcija, flokulacija, filtracija, kloriranje

Treatment of water of swimming-pools and baths - Part 2: Combination of process: Adsorption, flocculation, filtration, chlorination

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Ta slovenski standard je istoveten z:

ICS:

13.060.25 Voda za industrijsko uporabo Water for industrial use

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Treatment and disinfection of water used in bathing facilities

Part 2: Combined adsorption, coagulation, filtration and chlorination method

DIN
19643-2

ICS 13.060.30

Descriptors: Water treatment, bathing facilities, requirements.

Supersedes parts of
DIN 19643, April 1984
edition.

Aufbereitung von Schwimm- und Badebeckenwasser –
Teil 2: Verfahrenskombination: Adsorption – Flockung – Filtration –
Chlorung

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

Foreword

This standard has been prepared by Technical Committee IV 13 of the *Normenausschuß Wasserwesen* (Water Practice Standards Committee).

This revision of DIN 19643 is in response to article 11 of the *Bundesseuchengesetz* (German Federal Communicable Diseases Act) which deals with water for swimming pools and public baths. The *Legionella pneumophila* and trihalomethane (haloform) values specified in the regulation which implements this article (the *Schwimm- und Badebeckenwasserverordnung* (German Regulation on water used in bathing facilities))* have been incorporated into the present standard.

At the same time, the standard was divided into several parts. Part 1 specifies general requirements, while subsequent parts deal with different combinations of water treatment methods. Additional parts can now be added to the series as the state of the art develops.

To ensure proper application of this standard, water treatment systems should be designed, built and monitored only by experienced specialists. Attention is drawn to *DVGW-Arbeitsblätter* (DVGW Codes of practice) W 200 and W 201, which specify procedures for certifying water treatment experts.

Amendments

This standard differs from DIN 19643, April 1984 edition, as follows:

- a) The standard now consists of four parts.
- b) The treatment process has been supplemented to include adsorption on powdered activated carbon.
- c) The standard has been brought in line with the state of the art.

Previous edition

DIN 19643: 1984-04.

1 Scope

This standard specifies a method for the treatment of water in bathing facilities (except therapeutic pools), combining adsorption, coagulation, filtration, and chlorination.

This standard is to be used together with DIN 19643-1.

*) Currently at draft stage.

Continued on pages 2 to 8.

Translation by DIN-Sprachendienst.

In case of doubt, the German-language original should be consulted as the authoritative text.

2 Normative references

This standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the titles of the publications are listed below. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

DIN 19603	Activated carbon for water treatment – Technical delivery conditions
DIN 19605	Fixed-bed filters for water treatment – Design and components
DIN 19623	Filter sand and gravel for water filters – Technical delivery conditions
DIN 19624	Precoat filters for water treatment
DIN 19643-1	Treatment and disinfection of water used in bathing facilities – General requirements
DIN 38409-7	German standard methods for the examination of water, waste water and sludge – Parameters characterizing effects and substances (group H) – Determination of acidity and alkalinity (H7)
DIN 66131	Principles of determining the effective surface area of solid particles by the Brunauer, Emmett and Teller (BET) gas adsorption method
DIN EN 878	Chemicals used for treatment of water intended for human consumption – Aluminium sulfate
DIN EN 881	Chemicals used for treatment of water intended for human consumption – Aluminium chloride, aluminium chloride hydroxide and aluminium chloride hydroxide sulfate (monomeric)
DIN EN 882	Chemicals used for treatment of water intended for human consumption – Sodium aluminate
DIN EN 888	Chemicals used for treatment of water intended for human consumption – Iron(III) chloride
DIN EN 890	Chemicals used for treatment of water intended for human consumption – Iron(III) sulfate
DIN EN 891	Chemicals used for treatment of water intended for human consumption – Iron(III) chloride sulfate
DIN EN 896	Chemicals used for treatment of water intended for human consumption – Sodium hydroxide
DIN EN 897	Chemicals used for treatment of water intended for human consumption – Sodium carbonate
DIN EN 898	Chemicals used for treatment of water intended for human consumption – Sodium hydrogen carbonate
DIN EN 899	Chemicals used for treatment of water intended for human consumption – Sulfuric acid
DIN EN 936	Chemicals used for treatment of water intended for human consumption – Carbon dioxide
DIN EN 939	Chemicals used for treatment of water intended for human consumption – Hydrochloric acid*)

DVGW-Arbeitsblätter (DVGW Codes of practice)**)

DVGW-Arbeitsblatt W 200 *Zertifizierung von Unternehmen für Wasseraufbereitungsanlagen – Anforderungen und Prüfung* (Certification of water treatment plant manufacturers – Requirements and testing)

DVGW-Arbeitsblatt W 201 *Zertifizierung von DVGW-Sachverständigen für Wasseraufbereitung – Anforderungen und Prüfung* (Certification of DVGW experts for water treatment – Requirements and testing)

DVGW-Arbeitsblatt 240 *Beurteilung von Aktivkohlen für die Wasseraufbereitung* (Assessment of activated carbon for water treatment)

3 Principle

Dissolved and dispersed colloidal organic impurities are first partially adsorbed onto powdered activated carbon. In the subsequent stage, dispersed colloidal impurities and very fine particles of the activated carbon are destabilized by coagulation using iron(III) or aluminium salts, and orthophosphates are precipitated. During this process, the pH value of the raw water is kept within a range consistent with the type of coagulant used. The mixture of contaminated activated carbon, iron(III) phosphate or aluminium phosphate, and colloids is then removed by filtration. The filtrate is chlorinated and fed to the bath or pool water. In some cases, the stage of adsorption onto powdered activated carbon is not necessary (see subclause 4.3).

The maximum load capacity factor, k , obtained is $0,5 \cdot \text{m}^{-3}$, equivalent to a treated water volume of 2 m^3 per person.

*) Currently at draft stage.

**) Obtainable from *Wirtschafts- und Verlagsgesellschaft Gas und Wasser mbH*, Postfach 14 01 51, D-53056 Bonn.

4 Procedure

4.1 Acidity adjustment

4.1.1 General

To achieve satisfactory coagulation, the acidity, $K_{S4,3}$ (cf. DIN 38409-7), of the raw water shall be adjusted to a given minimum value, unless the acidity of the filling water is high enough to preclude that of the raw water from dropping below the minimum value. Acidity adjustment shall be made by adding an aqueous solution of sodium carbonate or sodium hydrogencarbonate to the raw water via a feeder.

4.1.2 Reagents

Sodium carbonate (as in DIN EN 897) or sodium hydrogencarbonate (as in DIN EN 898) shall be used for acidity adjustment.

4.1.3 Minimum acidity

When the method as described in this standard is used for bathing facilities other than hot whirlpool baths (with in-house treatment system), $K_{S4,3}$ shall be not less than 0,7 mol/m³, and, when this method is used for hot whirlpool baths (with in-house treatment system), $K_{S4,3}$ shall be not less than 0,3 mol/m³.

4.1.4 Check

After the reagents added have been thoroughly dispersed, the acidity shall be determined to check for compliance with the values specified in subclause 4.1.3.

4.2 pH value adjustment

4.2.1 General

For satisfactory coagulation and adequate disinfection with the lowest possible consumption of disinfectant, the pH value of the water shall be adjusted to a preset value using a feeder which automatically controls the pH value. The reagents added shall be thoroughly mixed with the water before they reach the pH sensor and the sampling point.

4.2.2 Reagents

The following reagents shall be used for pH value adjustment:

- sodium carbonate (as in DIN EN 897) or sodium hydroxide (as in DIN EN 896) if the pH value of the raw water is too low;
- carbon dioxide (as in DIN EN 936), hydrochloric acid (as in DIN EN 939), sulfuric acid (as in DIN EN 899), or sodium hydrogensulfate if the pH value of the raw water is too high.

4.2.3 pH value range

The pH shall range between 6,5 and 7,2 if aluminium salts are used for coagulation and between 6,5 and 7,5 (or 7,8 in the case of sea water) if iron salts are used for coagulation.

4.2.4 Check

After the reagents have been added, check whether the preset pH value is maintained to within $\pm 0,1$, using a pH meter.

4.3 Adsorption on powdered activated carbon

4.3.1 General

Powdered activated carbon shall be introduced into the treatment system in an amount proportional to the flow. The carbon may be added directly to wetting devices and pumped into the water stream of the system. Alternatively, an activated carbon/water suspension may be added, but it will be necessary to agitate such a suspension constantly and keep its pH value below 2 by adding acid in order to avoid microbial contamination. If the potential of the filling water for forming haloforms is low, the addition of powdered activated carbon will not be necessary when DIN 19605 filters are used. Nevertheless, provision shall be made for retrofitting if it is found that required values for combined chlorine and haloforms are not maintained.

4.3.2 Powdered activated carbon

The carbon powder used for water treatment shall be as specified in DIN 19603, and shall have a particle size distribution as given in table 1, in compliance with *DVGW-Arbeitsblatt W 240*.

Table 1: Particle size distribution of powdered activated carbon

Particle size, mm	Percentage by mass
Above 0,071	Below 25
Below 0,045	Above 50

To ensure that the activated carbon is added at a reliable rate under operational conditions, the percentage oversize (specifically that having a diameter greater than 1 mm) shall be minimized.

To ensure that the adsorption capacity is adequate, the total effective surface area of particles (determined by the BET method as in DIN 66131), shall be greater than 900 m²/g.

The composition of the filling water may be subject to great regional variation; therefore, before a final choice is made, different types of carbon shall be tested prior to treatment, in order to compare their ability to adsorb the pollutants to be removed.

4.3.3 Minimum quantity of powdered activated carbon to be added

When the method described in this standard is used for bathing facilities other than hot whirlpool baths (with in-house treatment system), the minimum quantity of activated carbon added shall be 1 g/m³ to 3 g/m³ (with the concentration required being determined experimentally and the design of the feeder permitting addition at a rate of 3 g/m³). In the case of hot whirlpool baths (with in-house treatment system), the minimum quantity added shall be 3 g/m³.

Provided the requirements specified in table 2 of DIN 19643-1, April 1997 edition, are complied with, it will not be necessary to add activated carbon between the bathing sessions.

4.3.4 Check

After the activated carbon has been thoroughly dispersed, the activated carbon content shall be determined, and compliance with the requirements specified in subclause 4.3.3 shall be checked.

4.4 Coagulation

4.4.1 General

After the acidity and pH value of the water have been adjusted, coagulant shall be added continually so that it is evenly distributed across the water surface, using a feeder.

The coagulant shall be rapidly and completely mixed with the water directly at the feed point. This can be achieved, for example, by means of a sudden change in pipe diameter (e.g. by reducing the pipe diameter by 30 %) immediately downstream of the feed point. The reaction time prior to the water entering the liquid head of the filter shall be at least ten seconds, with the flow velocity of the water not exceeding 1,5 m/s. After flocs have formed in the reaction section, care shall be taken to ensure that they are not destroyed by internal pipe fittings.

Throttle valves shall only be fitted upstream of the reaction section or downstream of the filter section.

Provided the requirements specified in table 2 in DIN 19643-1 are complied with, it will not be necessary to add coagulant between bathing sessions.

The addition of coagulant shall not be interrupted while powdered activated carbon is being added.

4.4.2 Coagulants

The following may be used as coagulants:

- aluminium sulfate, as in DIN EN 878;
- aluminium chloride hexahydrate, as in DIN EN 881;
- sodium aluminate, as in DIN EN 882;
- aluminium chloride hydroxide or aluminium chloride hydroxide sulfate, as in DIN EN 881;
- iron(III) chloride hexahydrate, as in DIN EN 888;
- iron(III) chloride sulfate solution, as in DIN EN 891;
- iron(III) sulfate, as in DIN EN 890.

4.4.3 Minimum quantity of coagulant to be added

The minimum quantity of coagulant added shall be 0,05 g/m³ for aluminium salts (expressed as Al) and 0,1 g/m³ for iron salts (expressed as Fe).

4.4.4 Check

The correct performance of the coagulation process shall be checked by verifying compliance with the requirements set out in table 4 (at filter outlet) (cf. subclause 4.5.4).

4.5 Filtration

4.5.1 General

The water shall be filtered to remove virtually all of the contaminated powdered activated carbon, destabilized colloids, precipitated aluminium phosphate or iron phosphate, and aggregated and encapsulated microorganisms which have escaped the action of the disinfectant in the pool. Matter retained by the filters shall be removed by backwashing.

DIN 19605 filters or DIN 19624 filters shall be used for filtration. They shall be operated for not less than 24 hours.

4.5.2 DIN 19605 filters (rapid filters)

4.5.2.1 Size fractions, bed heights and filtration rates

The size fractions, bed heights and filtration rates for single-medium filters using filter sand as in DIN 19623 shall be as specified in table 2, those for multi-media filters as specified in table 3.

4.5.2.2 Backwashing filters

To backwash filters, the filter beds shall be fluidized and expanded by at least 10 % in order to remove substances retained in the filter, particularly any significant microorganisms found in the bath or pool water. When the backwashing process is complete, the filter bed shall be deaerated.

The backwashing operation shall be automatic and shall not be interrupted. The amount of water required for backwashing shall be available before the backwashing operation is started. In addition, care shall be taken to ensure that the wastewater can flow off without hindrance; if necessary, a collecting tank shall be provided for wastewater.

When closed filters are being backwashed, the space above the filter bed shall be connected to the atmosphere by vent pipes.

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Backwashing of single-medium sand filters (0,71 mm to 1,25 mm size fraction)¹⁾

a) Guide values for backwashing programme using air and water

The backwashing programme shall comprise the following stages:

Stage 1: Venting the filter container and lowering the water level to the top of the outlet funnel, then backwashing with water of flow velocity about 60 m/h to 65 m/h, at 25 °C for about three minutes.

Stage 2: Flushing with air of flow velocity about 60 m/h for about five minutes;

Stage 3: Backwashing with water of flow velocity about 60 m/h to 65 m/h, at 25 °C for three to five minutes.

Stage 4: Discharging the first filtrate as waste.

Stage 5: Re-establishing water treatment operations.

b) Guide values for backwashing programme using water only

The backwashing programme shall comprise the following stages:

Stage 1: Venting the filter container and lowering the water level to the top of the outlet funnel, the backwashing with water of flow velocity about 60 m/h to 65 m/h, at 25 °C for six to seven minutes.

Stage 2: Discharging the first filtrate as waste.

Stage 3: Re-establishing water treatment operations.

Backwashing multi-media filters

The principles governing the backwashing of multi-media filters are the same as those for single-medium filters. However, after flushing filters with air, about two minutes shall be allowed for the filter material to deaerate before backwashing with water is started.

Backwashing with air and water shall not be combined unless specified by the manufacturer.

Flow velocities and backwash times shall be selected to suit the type of filter material used and the backwashing water temperature.

At a water temperature of 25 °C, the water flow velocity shall be 50 m/h to 55 m/h for the a/d material combination listed in table 3, and 60 m/h to 65 m/h for the b/d, b/e and c/e material combinations.

¹⁾ Filter sands of other size fractions will require different backwashing conditions.

Table 2: Size fractions, bed heights and filtration rates for single-medium sand filters

Parameter	Unit	Open rapid filters	Closed rapid filters
Size fraction	mm	0,71 to 1,25	
Minimum bed height	m	0,9	1,2
Minimum freeboard	m	25% of filter material bed height + 0,2 m	
Maximum filtration rate	m/h		
– for fresh water		12	30
– for sea water and brackish water with a concentration above 2 000 mg/l		12	20

Table 3: Size fractions, bed heights and filtration rates for multi-media filters²⁾

Parameter	Unit	Open rapid filters	Closed rapid filters
With addition of powdered activated carbon			
Size fraction c	mm	0,71 to 1,25	
e	mm	≈ 1,4 to 2,5	
Sand/antracite filter		c/e	
Without addition of powdered activated carbon			
Size fraction a	mm	0,4 to 0,8	
b		0,63 to 1,0	
c		0,71 to 1,25	
d		≈ 0,6 to 1,6	
e		≈ 1,4 to 2,5	
Filter material combinations:			
– Sand/antracite		a/d, b/d, c/e	
– Sand/pumice		a/d, b/e, c/e	
– Sand/lignite coke		a/d, b/e, c/e	
– Sand/pitch coke or petroleum coke		b/d, c/e	
With or without addition of powdered activated carbon			
Minimum bed height	m		
– Sand		0,6	0,6
– Top layer		0,4	0,6
Minimum freeboard	m	25% of filter material bed height + 0,2 m	
Maximum filtration rate	m/h		
– for fresh water		15	30
– for sea water and brackish water with a concentration above 2 000 mg/l		15	20

4.5.3 Filtration using DIN 19624 filters (precoat filters)**4.5.3.1 Initial precoat**

The initial precoat shall consist of a mixture of powdered activated carbon and kieselguhr in a ratio by mass of 1 : 1 to 1 : 8, depending on the properties of the powdered activated carbon, applied at a rate of 0,7 kg to 0,8 kg per m² of filter area.

After the filter has been cleaned, it shall be precoated before the start of each filtration, to form a new active filter bed (cf. subclause 4.3).

The initial filtrate shall either be run off as waste or recirculated (i.e. passed through the filter again).

²⁾ Other combinations of filter materials and size fractions will need to be determined by experiment.

4.5.3.2 Filtration rate

Depending on the filter type and sequence of operations, the filtration rate shall be selected as specified in DIN 19624, taking the rated pollution load of the bath or pool water into account.

For pressure and vacuum filters having an initial precoat, permissible filtration rates are from 2 m/h to 8 m/h.

4.5.3.3 Backwashing filters

The backwashing operation shall be automatic. The filter surfaces may be cleaned by backwashing or spraying. Used precoat materials shall be discarded.

4.5.4 Check

Check whether the values given in table 4 are complied with throughout the filtration process.

Table 4: Filtration requirements

Subclause as in table 2 of DIN 19643-1	Parameter	Unit	Requirement (upper limit)
5.3.1.1	<i>Pseudomonas aeruginosa</i> at (36 ± 1) °C	1/(100 ml)	n.d. ³⁾
5.3.1.2	<i>Escherichia coli</i> at (36 ± 1) °C	1/(100 ml)	n.d. ³⁾
5.3.1.3	<i>Legionella pneumophila</i> at (36 ± 1) °C	1/(100 ml)	n.d. ³⁾
5.3.1.5	Colony forming units (CFU) at (36 ± 1) °C	1/ml	100
5.3.2.2	Turbidity	FNU ⁴⁾	0,1
—	Activated carbon concentration	mg/l	0,020
5.3.2.6	Oxidizability of Mn VII → II above that of filling water, expressed as O ₂ content ⁵⁾	mg/l	0
	Consumption of KMnO ₄ above that of filling water, expressed as KMnO ₄ content ⁵⁾	mg/l	0
5.3.2.10	Combined chlorine ^{6), 7)}	mg/l	0,20
5.3.2.11	Haloforms, expressed as chloroform content ^{6), 7)}	mg/l	0,020
—	Orthophosphates, expressed as phosphorus content	mg/l	0,005
—	Iron ⁹⁾	mg/l	0,020
—	Aluminium ⁹⁾	mg/l	0,050

³⁾ n.d. – not detectable.
⁴⁾ FNU: formazine nephelometric unit.
⁵⁾ If the oxidizability of the filtrate is lower than that of the filling water for an unoccupied pool, this lower value shall be used as the reference value; if, however, the oxidizability of the filling water is lower than 0,5 mg/l O₂ or lower than 2 mg/l KMnO₄, these values shall be used as reference values.
⁶⁾ Existing systems that do not meet these requirements should be retrofitted within five years following publication of this standard.
⁷⁾ Does not apply to cold-water plunge pools with a volume of 2 m³ or less and which have a continuous filling water flow.
⁸⁾ In the case of water containing bromides and iodides, free and combined bromine or iodine shall be expressed as chlorine.
⁹⁾ Permitted only where the appropriate additives are present.

4.6 Chlorination**4.6.1 General**

See clause 11 of DIN 19643-1 for details of chlorination.

4.6.2 Chlorine concentration

To combat communicable diseases, chlorine shall be added while the water treatment system is operating, i.e. even when the bathing facility is closed. The free chlorine concentration in bath or pool water shall be 0,3 mg/l to 0,6 mg/l, except for hot whirlpool baths, where the concentration shall be 0,7 mg/l to 1,0 mg/l.