



**SLOVENSKI STANDARD**  
**SIST DIN 19643-3:2003**

**01-maj-2003**

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**Priprava bazenske vode za plavalne in kopalne bazene - 3. del: Kombinacija postopkov: flokulacija, filtracija, ozoniranje, absorpcijska filtracija, kloriranje**

Treatment of water of swimming-pools and baths - Part 3: Combination of process: Flocculation, filtration, ozonization, absorbing filtration, chlorination

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**Ta slovenski standard je istoveten z:**

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**ICS:**

13.060.25      Voda za industrijsko uporabo    Water for industrial use

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	<p style="text-align: center;"><b>Treatment and disinfection of water used in bathing facilities</b></p> <p style="text-align: center;">Part 3: Combined coagulation, filtration, ozonization, sorption filtration and chlorination method</p>	<p><b>DIN</b></p> <p><b>19643-3</b></p>
<p>ICS 13.060.30</p> <p>Descriptors: Water treatment, bathing facilities, requirements.</p> <p>Aufbereitung von Schwimm- und Badebeckenwasser – Teil 3: Verfahrenskombination: Flockung – Filtration – Ozonung – Sorptionsfiltration – Chlorung</p> <p><i>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.</i></p> <p><b>Foreword</b></p> <p>This standard has been prepared by Technical Committee IV 13 of the <i>Normenausschuß Wasserwesen</i> (Water Practice Standards Committee).</p> <p>This revision of DIN 19643 is in response to article 11 of the <i>Bundesgesundheitsgesetz</i> (German Federal Communicable Diseases Act) which deals with water for swimming pools and public baths. The <i>Legionella pneumophila</i> and trihalomethane (haloform) values specified in the regulation which implements this article (the <i>Schwimm- und Badebeckenwasserverordnung</i> (German Regulation on water used in bathing facilities*)) have been incorporated into the present standard.</p> <p>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.</p> <p>To ensure proper application of this standard, water treatment systems should be designed, built and monitored only by experienced specialists. Attention is drawn to <i>DVGW-Arbeitsblätter</i> (DVGW Codes of practice) W 200 and W 201, which specify procedures for certifying water treatment experts.</p> <p><b>Amendments</b> <a href="https://standards.iteh.ai/catalog/standards/sist/17563a64-00d9-488e-a59c-1a610595f89/sist_din_19643-3-2003">https://standards.iteh.ai/catalog/standards/sist/17563a64-00d9-488e-a59c-1a610595f89/sist_din_19643-3-2003</a></p> <p>This standard differs from DIN 19643, April 1984 edition, as follows:</p> <ol style="list-style-type: none"> <li>a) The standard now consists of four parts.</li> <li>b) The standard has been brought in line with the state of the art.</li> </ol> <p><b>Previous edition</b> DIN 19643: 1984-04.</p> <p><b>1 Scope</b></p> <p>This standard specifies a method for the treatment of water in bathing facilities, combining coagulation, filtration, ozonization, sorption filtration, and chlorination. It is to be used together with DIN 19643-1.</p> <p><b>2 Normative references</b></p> <p>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.</p> <p>*) Currently at stage of draft.</p> <p style="text-align: right;">Continued on pages 2 to 8.</p> <p style="text-align: center;">Translation by DIN-Sprachendienst. In case of doubt, the German-language original should be consulted as the authoritative text.</p>		

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 19627	Ozone generators 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 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)

### 3 Principle

Dispersed colloidal impurities are first destabilized by coagulation using iron(III) or aluminium salts, and by flocculation, 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 (stage 1).

The mixture of iron(III) or aluminium phosphate, and colloids is then removed by filtration (stage 2).

The filtrate is treated with ozone to oxidize chemical constituents of water, eliminate microorganisms and inactivate viruses (stage 3).

Following that, using an activated carbon filter, those substances which have been precipitated by ozone treatment and oxidized pollutants are absorbed, and chlorine by-products and any residual ozone in the water are removed (stage 4).

The filtrate is then chlorinated and fed to the bath or pool water (stage 5).

The maximum load capacity factor,  $k$ , obtained is  $0,6 \cdot \text{m}^{-3}$ , equivalent to a treated water volume of  $1,67 \text{ m}^3$  per person.

### 4 Procedure

#### 4.1 Acidity adjustment

##### 4.1.1 General

To achieve satisfactory coagulation, the acidity,  $K_{\text{S}_{4,3}}$  (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.

\*) Currently at stage of draft.

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

#### 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/m<sup>3</sup>, 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/m<sup>3</sup>.

#### 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.

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### 4.3 Coagulation

#### 4.3.1 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.

#### 4.3.2 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.

#### 4.3.3 Minimum quantity of coagulant to be added

The minimum quantity of coagulant added shall be 0,05 g/m<sup>3</sup> for aluminium salts (expressed as Al) and 0,1 g/m<sup>3</sup> for iron salts (expressed as Fe).

#### 4.3.4 Check

The correct performance of the coagulation process shall be checked by verifying compliance with the requirements set out in table 3 (at filter outlet).

### 4.4 Filtration

#### 4.4.1 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 shall be used for filtration. They shall be operated for not less than 24 hours.

#### 4.4.2 DIN 19605 filters (rapid filters)

##### 4.4.2.1 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 1, those for multi-media filters as specified in table 2.

##### 4.4.2.2 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.

**Table 1: Size fractions, bed heights and filtration rates for single-medium sand filters**

Parameter	Unit	Open rapid filters	Closed rapid filters
Size fraction	mm	0,63 to 1,0 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

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

#### Backwashing of single-medium sand filters (0,71 mm to 1,25 mm size fraction)<sup>1)</sup>

##### 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.

<sup>1)</sup> Filter sands of other size fractions will require different backwashing conditions.

**Table 2: Size fractions, bed heights and filtration rates for multi-media filters**

Parameter	Unit	Open rapid filters	Closed rapid filters
Size fraction a b c d e	mm	0,4 to 0,8 0,63 to 1,0 0,71 to 1,25 ≈ 0,6 to 1,6 ≈ 1,4 to 2,5	
Filter material combinations: – Sand/antracite – Sand/pumice – Sand/lignite coke – Sand/pitch coke or petroleum coke		a/d; b/d; c/e a/d; b/e; c/e a/d; b/e; c/e b/d; c/e	
Minimum bed height – Sand – Top layer	m	0,6 0,4	0,6 0,6
Minimum freebord	m	25 % of filter material bed height + 0,2 m	
Maximum filtration rate for fesh water <sup>2)</sup>	m/h	15	30
2) The bed height and filtration rate for sea water and brackish water will need to be determined by experiment.			

**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 2, and 60 m/h to 65 m/h for the b/d, b/e and c/e material combinations.

**4.4.3 Check**

Check whether the values given in table 3 are complied with throughout the filtration process.

**Table 3: Filtration requirements**

Subclause as in table 2 of DIN 19643-1	Parameter	Unit	Requirement (maximum)
5.3.2.2	Turbidity	FNU <sup>3)</sup>	0,20
—	Orthophosphates, expressed as phosphorus content	mg/l	0,005
—	Iron <sup>4)</sup>	mg/l	0,020
—	Aluminium <sup>4)</sup>	mg/l	0,050
3) FNU: formazine nephelometric unit.			
4) Permitted only where the appropriate additives are present.			

## 4.5 Ozonization

### 4.5.1 General

Ozone generators shall comply with DIN 19627, with the ozone being introduced into water either directly or indirectly.

### 4.5.2 Ozone concentration

The concentration of ozone in the gas mixture shall be greater than 20 g/m<sup>3</sup> of O<sub>3</sub> under reference conditions<sup>5)</sup>. Lower ozone concentrations should be avoided since they lead to poorer absorption.

A temperature-dependent decomposition occurs simultaneously with the desired reaction between ozone and water constituents. Since the ozone decomposition rate at any point in time is proportional to the ozone concentration, ozone shall be added at the following concentrations:

- a) not less than 0,8 g/m<sup>3</sup> for water temperatures up to 28 °C;
- b) not less than 1 g/m<sup>3</sup> for water temperature above 28 °C up to 32 °C;
- c) not less than 1,2 g/m<sup>3</sup> for water temperatures above 32 °C up to 35 °C;
- d) not less than 1,5 g/m<sup>3</sup> for water temperatures above 35 °C.

Ozone shall be added at a constant rate while the treatment system is operating.

After the ozone has been thoroughly mixed with the water, the reaction time of the ozone dissolved in the filtrate (contained in a reactor protected from corrosion) shall exceed three minutes (the residence time in the liquid head compartment of the sorption filter does not count as reaction time).

If the potential of the filling water to form haloforms is high, the reaction time while in the reactor should be extended.

### 4.5.3 Check

The ozone generator shall be checked for proper functioning by comparing the actual voltage, current and gas flow with the data in the testing and acceptance records.

The redox potential of the water measured before it enters the sorption filter shall be greater than + 800 mV (Pt-Ag/AgCl 3 m KCl).

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## 4.6 Sorption filtration

### 4.6.1 General

Sorption filtration removes any residues of ozone, chlorine and its substitution products, destabilized colloids and oxidized substances from the water.

DIN 19605 filters shall be used for sorption filtration.

### 4.6.2 Size fractions, bed heights and filtration rates

Sorption filters shall satisfy the requirements specified in table 4.

Since the activated carbon is constantly consumed by sorption processes and backwashing, the bed height shall be regularly monitored and the carbon replenished when the bed height has decreased by 10 %, but in any case at least once a year.

### 4.6.3 Backwashing sorption filters

Sorption filters charged with powdered activated carbon should be backwashed with water only, but the filter bed can also be flushed with air beforehand to loosen it. Backwashing with air and water backwashing shall not be combined. The filters shall be backwashed with ozone-containing filtrate at least once a month, with an extractor for removing the exhaust air being provided in the vicinity of the drain or sewer.

The following are guide values for water backwashing sorption filters containing powdered activated carbon, taking the size fraction 1,6 mm to 2,5 mm as an example.

The backwashing programme shall comprise the following stages:

Stage 1: Venting the filter container and lowering the liquid level to about 5 cm above the surface of the filter bed.

Stage 2: Backwashing with water of flow velocity about 60 m/h to 65 m/h for about three to six minutes.

Stage 3: Discharging the first filtrate as waste.

Stage 4: Re-establishing water treatment operations.

If the filter is flushed with air (for about five minutes) before stage 2, allow about two to three minutes for the filter material to deaerate before backwashing with water is started.

Filters shall be operated for at least 48 hours, but not longer than 168 hours.

<sup>5)</sup> Temperature: 0 °C. Atmospheric pressure: 1 013,25 mbar.



Table 4: Size fractions, bed heights and filtration rates for sorption filters

Parameter	Unit	Closed rapid filters
Size fraction a	mm	0,5 to 0,6
b		0,63 to 1,0
c		0,71 to 1,25
d		1,6 to 2,5
Filter material combination: Sand/powdered activated carbon		b/a; c/d
Minimum bed height <sup>6)</sup> : – Bottom layer	m	0,4
– Top layer <sup>7)</sup>		0,7
Freeboard	m	30 % of filter bed height + 0,3 m
Maximum filtration rate	m/h	≤ 50
<p><sup>6)</sup> Values apply to filtration rates not greater than 50 m/h. They may be reduced as filtration rates decrease. The minimum volume of activated carbon shall be 14 litres per 1 m<sup>3</sup>/h and the minimum bed height 35 cm.</p> <p><sup>7)</sup> As compacted density and dechlorination capacity of activated carbon as in DIN 19603 (greater than 450 g/l and less than 10 cm respectively).</p>		

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Table 5: Filtration requirements

Subclause as in table 2 of DIN 19643-1	Parameter	Unit	Requirement (maximum)
5.3.1.1	<i>Pseudomonas aeruginosa</i> at (36 ± 1) °C	1/(100 ml)	n.d. <sup>8)</sup>
5.3.1.2	<i>Escherichia coli</i> at (36 ± 1) °C	1/(100 ml)	n.d. <sup>8)</sup>
5.3.1.3	<i>Legionella pneumophila</i> at (36 ± 1) °C	1/(100 ml)	n.d. <sup>8)</sup>
5.3.1.5	Colony forming units (CFU) at (36 ± 1) °C	1/ml	100
5.3.2.2	Turbidity	FNU <sup>9)</sup>	0,1
5.3.2.6	Oxidizability of Mn VII → II above that of filling water, expressed as O <sub>2</sub> content <sup>10)</sup>	mg/l	0
	Consumption of KMnO <sub>4</sub> above that of filling water, expressed as KMnO <sub>4</sub> content <sup>10)</sup>	mg/l	0
5.3.2.10	Combined chlorine <sup>11), 12), 13)</sup>	mg/l	< 0,1
—	Ozone concentration	mg/l	0,050
5.3.2.11	Halofoms, expressed as chloroform content <sup>11), 12)</sup>	mg/l	0,020
<p><sup>8)</sup> n.d.: not detectable.</p> <p><sup>9)</sup> FNU: formazine nephelometric unit.</p> <p><sup>10)</sup> 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 1 mg/l of O<sub>2</sub> or 4 mg/l of KMnO<sub>4</sub>, these values shall be used as reference values.</p> <p><sup>11)</sup> Existing systems that do not meet these requirements should be retrofitted within five years following publication of this standard.</p> <p><sup>12)</sup> Does not apply to cold-water plunge pools with a volume of 2 m<sup>3</sup> or less and which have a continuous filling water flow.</p> <p><sup>13)</sup> In the case of water containing bromides and iodides, free and combined bromine or iodine shall be expressed as chlorine.</p>			