

# Resistance:

## Alkaline Solutions, Inorganic Acids, Organic Acids and Water



Process Solution	Immersion Heaters						Flat Immersion Heaters					Temperature Probes					Float Switches			Level Probes / KNS			
	PS	TG	QS	KB	TI	FC	FK	FC	FEP	PFA	F	L	B	G	M	F	L	B	B	K	T	V	G
<b>Alkaline Solutions</b>																							
Ammonium hydroxide (NH <sub>4</sub> OH)	×	×	×	+	+	+	+	+	+	+	×	+	+	+	+	+	+	+	+	+	+	+	+
Potassium hydroxide, with water (KOH)	×	×	×	+	+	+	+	+	+	+	×	+	+	+	+	+	+	+	+	+	+	+	+
Sodium hydroxide, with water (NaOH)	×	×	×	+	+	+	+	+	+	+	×	+	+	+	+	+	+	+	+	+	+	+	+
<b>Inorganic Acids</b>																							
Hydrofluoric acid (HF)	×	×	×	×	+	+	+	+	+	+	×	+	+	+	×	+	×	×	+	+	+	+	+
Aqua Regia (3HCl + HNO <sub>3</sub> ) <sup>3)</sup>	+	+	+	×	⊖	⊖	+	⊖	+	+	×	⊖	+	+	×	⊖	×	×	⊖	⊖	×	⊖	⊖
Mixed acid (HNO <sub>3</sub> /H <sub>2</sub> SO <sub>4</sub> /H <sub>2</sub> O)	+	+	+	×	×	+	+	+	+	+	×	⊖	+	+	×	⊖	×	×	+	⊖	+	+	+
Oleum (concentrated sulphuric acid) <sup>3)</sup>	⊖	+	+	×	×	⊖	⊖	⊖	⊖	⊖	×	×	×	+	×	×	×	×	×	×	×	×	×
Phosphoric acid (H <sub>3</sub> PO <sub>4</sub> )	×	×	×	⊖	×	+	+	+	+	+	+	+	+	+	+	⊖	⊖	+	+	⊖	+	⊖	+
Nitric acid (HNO <sub>3</sub> ) <sup>3)</sup>	+	+	+	⊖	+	+	+	+	+	+	×	+	⊖	+	×	+	⊖	⊖	+	+	×	+	+
Hydrochlorid acid (HCl); <10%	+	+	+	×	×	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Hydrochlorid acid (HCl); >10%	+	+	+	×	×	⊖	⊖	⊖	⊖	⊖	×	+	×	⊖	⊖	×	+	×	×	⊖	×	×	⊖
Sulphuric acid (H <sub>2</sub> SO <sub>4</sub> )	+	+	+	×	×	+	+	+	+	+	×	+	+	+	×	+	×	×	+	×	×	⊖	+
<b>Organic Acids</b>																							
Formic acid (HCOOH)	+	⊖	+	×	×	+	+	+	+	+	×	+	+	+	×	+	×	×	+	+	×	×	+
Benzoic acid (C <sub>6</sub> H <sub>5</sub> COOH)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Acetic acid (CH <sub>3</sub> COOH)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Lactic acid (CH <sub>3</sub> CHO · COOH)	+	+	+	⊖	+	+	+	+	+	+	⊖	⊖	+	+	+	⊖	⊖	⊖	+	+	+	+	+
Oxalic acid (C <sub>2</sub> O <sub>4</sub> H <sub>2</sub> · 2H <sub>2</sub> O) <sup>3)</sup>	+	+	+	×	×	+	+	+	+	+	⊖	×	+	+	+	⊖	×	×	+	×	×	+	+
Tartaric acid (C <sub>4</sub> H <sub>6</sub> O <sub>6</sub> )	+	+	+	⊖	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Citric acid (C <sub>3</sub> H <sub>4</sub> (OH)(COOH) <sub>3</sub> · H <sub>2</sub> O)	+	+	+	+	⊖	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<b>Water</b>																							
Tap-water	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Seawater	+	+	+	×	+	+	+	+	+	+	+	×	+	+	+	+	+	×	×	+	+	+	+
Distilled water, deionized (H <sub>2</sub> O)	+	+	+	⊖	+	+	+	+	+	+	+	⊖	+	+	+	+	⊖	⊖	⊖	⊖	×	⊖	⊖
Rinsing water, contamin. with alkaline (halogen-free)	⊖	⊖	⊖	+	+	+	+	+	+	+	⊖	+	+	+	+	+	+	+	+	+	+	+	+
Rinsing water, contamin. with acids (fluoride-free)	+	+	+	⊖	⊖	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Rinsing water, contaminated with fluoride	⊖	⊖	⊖	×	×	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

### Key

- When using metallic materials (KB, TI), a faulty current circuit breaker with capacitor in the earth connection is recommended in order to prevent DC current escaping.
- When using metallic materials (KB, TI), a protective potential must be applied to the immersion tube or the metallic surface has to be passivated (i.e. with HNO<sub>3</sub>). Autocatalytic functioning electrolytes (without current) tend to cause metal separation on the hot surface of the immersion tube. Therefore the specific surface loading should not exceed 2.5 w / cm<sup>2</sup>.
- Terminal casing made from PVDF recommended (BC/L and LC/L)

### Immersion Heaters Materials Legend

- PS** Special hard porcelain, glazed  
**TG** Technical glass (hydrolytic class 1, acid class 1, alkaline class 2 according to DIN 12111, 12116 & 52322)  
**QS** Quartz glass (hydrolytic class 1, acid class 1, alkaline class 1, according to DIN 12111, 12116 & 52322)  
**KB** Stainless steel (material no. 316TI)  
**TI** Titanium (material no. 3.7035)  
**FC** Polytetrafluorethylene (PTFE) - Compound
- Heating Rods / Flat Immersion Heaters Legend**  
**FK** Polytetrafluorethylene (PTFE), pure white  
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**FEP** Fluorinated ethylene propylene  
**PFA** Perfluoroalkoxy

### Temperature Probes Legend

- F** Polypropylene (PP)  
**L** Polyvinylidenfluoride (PVDF)  
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### Float Switches / Level Probes / KNS Legend

- F** Polypropylene (PP)  
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### Symbols

- + recommended
- + resistant
- ⊖ moderate
- × not suitable
- ⓘ general evaluation not possible, please enquire

# Resistance: Degreasing Solutions, Electrolytes, Autocatalytic Electrolytes



Process Solution	Immersion Heaters						Flat Immersion Heaters					Temperature Probes					Float Switches			Level Probes / KNS				
	PS	TG	QS	KB	TI	FC	FK	FC	FEP	PFA	F	L	B	G	M	F	L	B	B	K	T	V	G	
<b>Degreasing Solutions</b>																								
Acid (fluoride-free)	+	+	+	x	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Alkaline (halogen-free)	x	x	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<b>Electrolytes</b>																								
Lead bath (fluorborate)	x	x	x	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Chromium bath (H <sub>2</sub> SO <sub>4</sub> ) <sup>1) 3)</sup>	+	+	+	x	+	+	+	+	+	+	x	+	+	+	+	x	+	x	x	+	+	+	+	+
Chromium bath (mixed acids, cont. fluoride) <sup>3)</sup>	+	+	+	x	x	+	+	+	+	+	x	+	+	+	+	x	+	x	x	+	x	+	+	+
Iron bath (FeCl <sub>2</sub> · 4 H <sub>2</sub> O) <sup>1)</sup>	+	+	+	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Iron bath (FeSO <sub>4</sub> or Fe(BF <sub>2</sub> ) <sub>2</sub> ) <sup>1)</sup>	+	+	+	x	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Gold bath, cyanide <sup>1)</sup>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Gold bath, acid	+	+	+	x	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Copper bath, cyanide <sup>1)</sup>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Copper bath, acid	+	+	+	x	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Copper bath (fluorborate)	x	x	x	x	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Brass bath, cyanide <sup>1)</sup>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Nickel bath (fluorborate) <sup>1)</sup>	x	x	x	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Nickel bath (nickel-chloride / nickel-sulphate) <sup>1)</sup>	+	+	+	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Platinum bath / Palladium, acid	+	+	+	x	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Rhodium bath (H <sub>2</sub> SO <sub>4</sub> )	+	+	+	x	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Silver bath, cyanide <sup>1)</sup>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Zinc bath, alkaline, cyanide <sup>1)</sup>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Zinc bath, acid	+	+	+	x	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Tin bath, alkaline <sup>1)</sup>	x	x	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Tin bath (fluorborate)	x	x	x	x	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Tin bath (H <sub>2</sub> SO <sub>4</sub> )	+	+	+	x	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<b>Autocatalytic Electrolytes<sup>2)</sup></b>																								
Copper bath (without current), alkaline <sup>1)</sup>	+	x	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Copper bath (without current), acid	+	+	+	x	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Nickel bath (without current), alkaline <sup>1)</sup>	+	x	x	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Nickel bath (without current), acid <sup>1)</sup>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

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## Symbols

- +** recommended  
**+** resistant  
**⊖** moderate  
**x** not suitable  
**!** general evaluation not possible, please enquire

# Resistance: Additional Treatment Liquids



Process Solution	Immersion Heaters						Flat Immersion Heaters					Temperature Probes					Float Switches			Level Probes / KNS			
	PS	TG	QS	KB	TI	FC	FK	FC	FEP	PFA	F	L	B	G	M	F	L	B	B	K	T	V	G
ABS pickle ( $\text{CrO}_3/\text{H}_2\text{SO}_4$ ) <sup>3)</sup>	⊖	+	+	×	×	+	+	+	+	+	×	+	×	+	+	×	+	×	×	+	×	⊖	+
Aluminium pickling bath, containing fluoride	⊖	×	⊖	×	×	+	+	+	+	+	+	+	+	+	+	+	+	+	×	×	+	×	+
Ammonium fluoride ( $\text{NH}_4\text{F}$ )	×	×	×	×	×	+	+	+	+	+	⊖	+	+	+	⊖	+	×	×	+	×	⊖	+	
Ammonium chloride = flux bath ( $\text{NH}_4\text{Cl} + \text{ZnCl}_2$ )	+	+	+	×	+	+	+	+	+	+	+	+	+	+	+	+	+	+	×	×	+	+	+
Borax bath ( $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ )	⊖	⊖	+	+	×	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	×	⊖	+
Chromatizing bath ( $\text{H}_3\text{PO}_4/\text{CrO}_3/\text{H}_2\text{SO}_4$ ), fluoride-free	⊖	⊖	+	×	×	+	+	+	+	+	×	+	×	+	+	×	+	×	×	+	×	⊖	+
Pickling bath ( $\text{HCl}$ & / or $\text{H}_2\text{SO}_4$ ), fluoride-free	+	+	+	×	⊖	+	+	+	+	+	+	+	×	+	+	+	+	+	×	×	+	×	+
Iron III chloride solution ( $\text{FeCl}_3$ )	+	+	+	×	+	+	+	+	+	+	+	+	+	+	+	+	+	+	×	×	+	+	+
Gloss bath, chemical ( $\text{H}_3\text{PO}_4 + \text{HNO}_3$ )	⊖	⊖	+	⊖	×	+	+	+	ⓘ	ⓘ	⊖	+	×	+	+	⊖	+	+	×	+	×	×	+
Potassium permanganate, with water ( $\text{KMnO}_4$ )	+	+	+	+	+	+	+	+	⊖	⊖	⊖	+	+	+	+	⊖	+	+	+	+	+	+	+
Sodium chloride solution (containing NaCl)	+	+	+	×	+	+	+	+	+	+	+	+	×	+	+	+	+	+	×	×	+	+	+
Solder liquid, acidic (containing HCl)	+	+	+	×	×	+	+	+	+	+	+	+	×	+	+	+	+	+	×	×	⊖	×	+
Sodium hypochlorite ( $\text{NaClO}$ )	+	+	+	×	⊖	ⓘ	+	ⓘ	+	+	×	⊖	×	+	+	×	⊖	×	×	⊖	⊖	×	⊖
Sodium sulphate ( $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ )	⊖	⊖	+	×	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	ⓘ	+
Phosphate bath (iron / zinc phosphate)	×	×	×	+	×	ⓘ	ⓘ	ⓘ	ⓘ	ⓘ	+	+	⊖	+	+	ⓘ	ⓘ	⊖	⊖	+	×	×	×
Black bath ( $\text{HNO}_3 + \text{FeCl}_3$ ) <sup>3)</sup>	+	+	+	×	+	+	+	+	+	+	×	+	×	+	+	×	+	×	×	+	+	×	+
Sealing bath = desalinated water	+	+	+	+	+	+	+	+	ⓘ	ⓘ	+	+	+	+	+	+	+	+	ⓘ	ⓘ	ⓘ	×	ⓘ
Hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) <sup>3)</sup>	+	+	+	⊖	⊖	+	ⓘ	ⓘ	ⓘ	ⓘ	⊖	+	⊖	+	⊖	+	⊖	⊖	ⓘ	ⓘ	ⓘ	×	ⓘ

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**+** resistant  
**⊖** moderate  
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# The Properties of the Materials we use



	Acid Resistance	Alkaline Resistance	Thermal Resistance	Breakage Resistance	For	Against
<b>Stainless Steel</b>	fairly good	good	high	very high	individually processable	/
<b>Titanium</b>	good	good	high	very high	individually processable	/
<b>Porcelain</b>	very good	moderate	good	moderate	good heat transfer	/
<b>Technical glass</b>	very good	moderate	good	low	/	liable to break
<b>Quartz glass</b>	very good	moderate	good	low	thermoshock resistant	thermal radiation
<b>PTFE, pure white</b>	very good	very good	low	low	clean room application	low surface loading
<b>PTFE-Compound</b>	very good	very good	low	low	highest chemical resistance	low surface loading
<b>PFA</b>	very good	very good	low	low	highest chemical resistance	low surface loading
<b>FEP</b>	very good	very good	low	low	highest chemical resistance	low surface loading
<b>PVDF</b>	very good	moderate	up to 140°C	high	/	/
<b>PP</b>	good	very good	up to 90°C	high	/	/
<b>PVC</b>	good	very good	up to 60°C	moderate	elastic	/

## General Installation Directions What you definitely need to consider!

When mounting products with terminal casing to the container rim, it is important, that the terminal casing does not submerge into the process liquid or is exposed to highly concentrated steam. Direct exposure of the underside of the casing to steam must be prevented by suitable installation measures (i.e. holding sleeve HM or a flange).

Treatment liquids which can cause encrusting to heated surfaces (i. e. potassium permanganate, phosphate baths) should be heated with a low immersion tube surface loading of 2 w / cm<sup>2</sup> maximum.

The information on the resistance of the various materials should be considered as a recommendation and only refers to solutions with water ranging from 0°C to 100°C. The chemical composition and characteristics common to surface technology and frequently used liquids form the basis of this information.

We would draw your attention to the fact that we accept no responsibility for the accuracy of this information, because the multifarious factors that are under the control of the user can fundamentally affect and change the resistance of the listed materials. Only in cases where we are given precise information on the essential parameters, we are able to confirm the resistance in writing and will accept liability on the basis of our terms of delivery which are explicitly part of this resistance list.

This does not claim to be a complete list of all process liquids that are used in the surface treatment industry.

