



# **Commercial dishwashing & resistance of materials in dishwashers**

(Technical information sheet No. 07)

**Status: 20. April 2010**

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SILICON · ALUMINIUM  
POM · MESSING · GUSS  
NI-RESIST**

**Published by: Arbeitsgemeinschaft Gewerbliches Geschirrspülen  
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## FOREWORD

The members of the Arbeitsgemeinschaft Gewerbliches Geschirrspülen drew up the first technical information sheet on the resistance of **metal** materials in commercial warewashers as long ago as February 1968.

By dint of technological progress, a large number of other materials, principally high-grade plastics, are now used in commercial warewashers. This fact has been reflected in regular updates of this technical information sheet, and the present edition represents the current state of the art.

The properties of individual materials which are mentioned should be taken as reference values which have been verified in thousands of commercial warewashers operating under normal conditions in practice.

Depending on particular circumstances, conditions may nevertheless arise in individual cases which make it necessary for particular materials to be selected.

Particularly where modified cleaning processes such as e.g. the spraying of a concentrated alkaline solution or acid are applied, where different chemicals are used or where the process temperatures are higher, the resistance of the materials used must be critically assessed.

Should queries on this subject arise or if critical situations should arise in specific cases, this technical information sheet will be of help to the user because it is based on the **long-standing experience of all those groups involved in the warewashing process.**



# 1. Metal materials

## 1.1 Stainless steel

Stainless steel is the name used to designate steels which are alloyed with 12% or more chromium and may also contain nickel, molybdenum and other metals.

The proportions of the individual constituents can affect the degree of corrosion resistance, which can in turn also lead to changes in other properties such as temperability or magnetisability.

Stainless steels differ according to the alloy constituents and their percentage proportions. Essentially, these are chromium, nickel and molybdenum, to name just the major ones. For warewashers, the main alloy used is chromium-nickel steel with the abbreviated designation X5CrNi18-10 and material no. 1.4301.

Its significantly better corrosion resistance compared with other steels is based primarily on the presence of the so-called passive layer. This consists predominantly of chromium and nickel oxides and can regenerate if destroyed locally. Requirements for doing so are the presence of oxygen and an adequate impact time.

The passive layer may be destroyed, for example, by:

- **accumulation of certain metal particles (e.g. iron, copper, etc.)**
- **hydrochloric acid (e.g. in some cement residue removers)**
- **a high chloride load (cooking salt/food residues)**
- **mechanical action on the surface.**

Any stainless steel may corrode under adverse conditions.

**Extraneous rust** is caused by iron particles accumulating on the surface of the steel. The source of the particles may be:

- **the incoming water line**
- **wire-wool sponges with which the wash ware has been pre-cleaned**
- **paper clips, drilling chips, screws, etc., to name but a few.**

Since all these items are brought in from outside, the term 'extraneous rust' is used.

If the points of rust and their source are not removed immediately, considerable corrosion damage, even rust perforation, may result.

**Pitting corrosion** is the result of an excessively high chloride load. Pitting corrosion involves the formation of a rust-coloured spot, at the centre of which a small crater develops. If this is not removed and, above all, if the cause of the pitting corrosion is not eliminated, a hole can develop in a relatively short space of time.



High chloride loads are produced by

- *irregularities in the operation of the demineralisation unit leading to an input of regeneration salt into softened water.*
- *food residues containing a high cooking-salt load*
- *potable water supply with a high chloride content*
- *improper dosing of chlorine-based bleaching agents (disinfection components).*

In order to prevent pitting corrosion, the chloride load in the fresh water should not exceed 50 mg/l.

### **Discolorations**

Occasionally, discolorations, ranging from translucent to bold, occur in stainless steel, caused by ingredients in potable water or in food. Brown/black discolorations at the transition from the fresh water rinse to the wash zone may be due to an excessively high copper content in the fresh water rinse, e.g. dissolved from copper lines by aggressive water.

These discolourations do not constitute corrosion. They may occur not only on the inside of the machine but also on wash ware made of stainless steel. The majority of discolourations can be removed again with a suitable descaling solution (HCl-free), especially if this is done immediately after they appear.

**Planiform brown or black/brown patches - usually on the tank bottom** - can arise if a powder detergent containing caustic alkali is dosed into a still area of a tank and settles on the bottom of the tank. The same can happen if the dosing of the powder detergent containing caustic alkali is performed manually or using dosing equipment a long time before the machine is set to run. Although treatment of this kind has not previously resulted in the destruction of a tank floor, care should be taken to ensure that **no powder detergent** is allowed to settle in undissolved form over a **prolonged period**. If, however, "settling" should have occurred, the tank floors should be cleaned, leaving no residues.

*In order to prevent such occurrences, it is recommended that detergent be sprinkled over a wide area on the water surface and the machine then be started up.*

For further information, see information sheets [Commercial dishwashing & Glossary of terms](#), [Commercial dishwashing & wash ware made of metal](#) and [Commercial dishwashing & water](#).



## 1.1.1 Sheets and profile steels made of stainless steel

<b>Material No.:</b>	<b>1.4016</b>
Abbreviated designation:	X6Cr17
Application:	In part, for minor sub-assemblies.
Properties:	Magnetisable. Resistant to detergent and rinse aid solution. Resistance at welded joints is critical - these must therefore be handled carefully.
<b>Material No.:</b>	<b>1.4104</b>
Abbreviated designation:	X14CrMoS17
Application:	Like 1.4016, but for machined products.
Properties:	Like 1.4016, but not weldable.
<b>Material No.:</b>	<b>1.4301</b>
Abbreviated designation:	X5CrNi18-10
Application:	Principal construction material for warewashers; stainless steel dishes are also preferably manufactured from this material.
Properties:	Non-magnetisable. If used as prescribed, the material is resistant to all chemical stresses that occur in warewashers.
<b>Material No.:</b>	<b>1.4305</b>
Abbreviated designation:	X8CrNiS18-9
Application:	like 1.4301, but only for machined parts.
Properties:	like 1.4301, but not weldable.
<b>Material No.:</b>	<b>1.4571</b>
Abbreviated designation:	X6CrNiMoTi17-12-2
Application:	Is used for parts that are more heavily thermally and chemically loaded, e.g. steam pipes, heater coils and heavily loaded components.
Properties:	Non-magnetisable. Due to its alloying, the material has greater chemical and thermal resistance and has greater resistance to pitting corrosion. It is in other respects comparable to 1.4301.



### 1.1.2 Cast stainless steel

**Material No.:** 1.4308  
Abbreviated designation: GX5CrNi19-10  
Application: Castings, pump housings, etc.  
Properties: Comparable to 1.4301.

**Material No.:** 1.4312  
Abbreviated designation: GX10CrNi18-8  
Application: like 1.4308, but for higher-resistance castings.  
Properties: like 1.4301.

### 1.1.3 Spring steels

**Material No.:** 1.4310  
Abbreviated designation: X10CrNi18-8

**Material No.:** 1.4401  
Abbreviated designation: X5CrNiMo17-12-2

**Material No.:** 1.4568  
Abbreviated designation: X7CrNiAl17-7

### 1.1.4 Higher-resistance stainless steel alloys

**Material No.:** 1.4876 (Incoloy alloy 800)  
Abbreviated designation: X10NiCrAlTi32-20

Applications: Piping for electric heaters.

Properties: High chemical/thermal resistance and also to pitting corrosion and stress corrosion cracking.

**Material No.:** 2.4858 (Incoloy alloy 825)  
Abbreviated designation: NiCr21Mo

Application: Like 1.4876, but for even higher loadings.

Properties: Even more resistant than 1.4876.

## 1.2 Copper and copper alloys

Copper and all copper alloys are not resistant to acidic media.  
Acidic rinse aid solutions dissolve copper.



## Copper

Application: Copper is used in pipelines for fresh water and in heat exchangers. In order to ensure universal applicability, copper and copper alloys should be avoided in the rinse zone.

Properties: Resistant to potable water provided the iron content is not excessive and there is no mixed installation.

Resistance to the following is restricted:

- Acidic water (pH<7) and acidic rinse aid solution
- demineralised water (from osmosis or ion exchanger)

Copper dissolved in rinse aid solution can give rise to persistent discoloration in warewashers and on wash ware.

## Copper-nickel alloys

**Material No.:** e.g. 2.0872

Abbreviated designation: CuNi10Fe

Application: For pipelines, and in particular heat exchangers.

Properties: Like copper, but greater resistance.

## Copper-tin alloys (bronze or red bronze)

Abbreviated designation: e.g. Rg5 or Rg10.

Application: For castings, mountings, fittings, nozzles, bearings and similar parts.

Properties: More resistant than copper, has greater strength and is a good sliding material.



### **Copper-zinc alloy (brass)**

Application:	Used as cast and profile material for mountings and simple components, etc.
Properties:	Resistant to fresh water, but not resistant to alkaline detergents.

## **1.3 Aluminium alloys**

Application:	For heat exchanger fins.
Properties:	Not resistant to acids or alkaline solutions.

## **1.4 Coatings**

### **Zinc coating (galvanising)**

Application:	In water pipes and fittings outside the wash zone.
Properties:	Good corrosion protection against potable water, but not with 0°d and demineralised water.

### **Polyamide coating (Rilsan<sup>®</sup>, Ultralan<sup>®</sup> etc.)**

Application:	Coating on wire dish racks.
Properties:	Good resistance in aqueous solutions, but susceptible to surface damage by incision, impact or rupture.

Note: The functions of the coating are:

- \* to protect the non-resistant base material,
- \* to prevent metal abrasion on the wash ware.

## **2. Plastics**

### **2.1 Thermosets**

#### **Glass-fibre-reinforced polyester**

Application:	Pump impellers, pump housings, protective covers and similar parts.
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Properties: Resistant to alkaline and acidic solutions, depending on the temperature and processing.

## 2.2 Thermoplastics

### **Polyethylene (low-density polyethylene of low to medium molecular weight)**

(trade names Hostalen<sup>®</sup>, Lupolen<sup>®</sup>P and a number of others)

Abbreviated designation: LDPE.

Application: Hoses and parts with a low mechanical and thermal loading.

Properties: Good resistance to all substances occurring in warewashers.  
Low thermal resistance, soft surface, not coloured, safe in compliance with food law regulations

### **Polyethylene, of high molecular weight**

Abbreviated designation: HDPE.

Application: Plain bearings and guides.

Properties: Good sliding properties, wear-resistant and chemically very resistant, typically an engineering plastic

### **Polypropylene (Hostalen<sup>®</sup>PP, Novolen<sup>®</sup>, Vestolen<sup>®</sup>P)**

Abbreviated designation: PP.

Application: In the version stabilised for use with washing solution, the most commonly used plastic in commercial warewashers.

Properties: Resistant to alkaline and acidic solutions, shape-retentive under heat, and pressure-resistant. Smooth and hydrophobic (water-repellent) surface.

### **Polyoxymethylene (e.g. Hostaform<sup>®</sup>, Ultraform<sup>®</sup>)**

Abbreviated designation: POM.

Application: Typically an engineering plastic for more heavily loaded parts.

Properties: Not resistant to acids and acidic solutions with pH < 5. Care should be exercised when using descaling agents,



and the supplier's instructions should be followed precisely. Otherwise, similar properties to PP.

Improper use of descaling agents, such as e.g. excessively long impact times or spraying of the inside of the machine and subsequent exposure over prolonged periods and associated drying-on, will result in damage in all cases. Where descaling agents are used properly, no corrosion of parts made of POM will occur.

### **Polyvinyl chloride**

Abbreviated designation: PVC.

Application: Hoses, insulation of electric lines.

Properties: Resistant to potable water, alkaline and acidic solutions, UV-sensitive in uncoloured state, not very temperature-stable, tends to harden.

### **Polytetrafluorethylene (Teflon®)**

Abbreviated designation: PTFE.

Application: Seals, sliding materials.

Properties: Very high chemical and thermal resistance.

## **3. Permanently elastic materials (elastomers)**

Application: Elastomers are employed for seals and hoses.

The appropriate material is selected according to the mechanical, chemical and thermal loading in each case.

The following groups of materials are available to select from:

- Silicone
- Perbunan®
- Viton®
- Neoprene®
- EPDM etc.

Properties: Permanently elastic. Resistance to acids and alkaline solutions is possible, depending on the formula in each case.



**Summary table of materials which are resistant or not resistant in commercial warewashers**

<b>Material No.</b>	<b>Abbreviated designation</b>	<b>Notes on use</b>	<b>Properties</b>
1.4016	X6Cr17	For minor sub-assemblies.	Magnetisable. Resistant to detergent and rinse aid solution.
1.4104	X14CrMoS17	like 1.4016, but mainly for machining steel.	like 1.4016, but unsuitable for welding
1.4301	X5CrNi18-10	Main construction material for commercial dishwashers. Also for housings of dosing equipment.	Non-magnetisable. If used as prescribed, resistant to all loads occurring in the warewasher field, with the exception of excessive chloride loads.
1.4305	X8CrNiS18-9	Like 1.4301, but for machined parts	Like 1.4301, but not weldable
1.4571	X6CrNiMoTi17-12-2	For parts with a higher temperature loading such as electric tubular heating elements, steam tubular heating elements and risers.	Non-magnetisable. Properties like 1.4301, but, due to the alloying, increased resistance to pitting corrosion and corrosion at higher temperatures.
1.4308	GX5CrNi19-10	Castings, pump housings, etc.	Like material 1.4301
1.4312	GX10CrNi18-8	Castings, pump housings, etc.	Like 1.4301
1.4310	X10CrNi18-8	For spring elements like compression springs and tension springs.	Resume their original shape after release, unless the elastic limit has been exceeded.
1.4401	X5CrNiMo17-12-2	Like material 1.4310	Like material 1.4310
1.4568	X7CrNiAl17-7	Like material 1.4310	Like material 1.4310
1.4876	X10NiCrAlTi32-20	Piping for electric heaters	In the critical ranges from 80 - 100°C of an aqueous solution resistant to pitting corrosion and stress cracking. High Ni proportion, which is additionally stabilised with Cr and Ti.
2.4858	NiCr21Mo	Piping for electric heaters	In the critical ranges from 80 - 100°C of an aqueous solution resistant to pitting corrosion and stress cracking. High Ni proportions, which are additionally stabilised with Cr and Mo. Mo may sometimes also be replaced by Ti.



Material No.	Abbreviated designation	Notes on use	Properties
Copper	---	For pipelines for fresh water and in heat exchangers.	Resistant to potable water provided the iron content is not excessive and there is no mixed installation.
2.0872	CuNi10Fe	For pipelines, particularly in heat exchangers.	Like copper, greater resistance.
<b>Copper-nickel alloy (bronze or red bronze)</b>	Rg5 and Rg10	Castings, fittings, nozzles and bearings	More resistant than copper, has greater mechanical strength and good sliding material.
<b>Copper-zinc alloy (brass)</b>	---	Cast and profile material, simple components and nozzles, door guides, pipelines	Resistant to fresh water.
<b>Aluminium alloy</b>	---	For fins for heat exchangers	Not resistant to acids and alkaline solutions.
<b>Zinc coating</b>	---	In water pipes and fittings outside the wash zone	Good corrosion protection against potable water, but not with 0°d and demineralised water.
<b>Polyamide coating, e.g. Rilsan®</b>	---	Coating on wire dish racks	Good resistance in aqueous solutions but susceptible to surface damage.
<b>Glass-fibre-reinforced polyester (thermoset)</b>	---	Pump impellers, pump housings, protective covers.	Resistant to alkalis and acidic solutions, but this is dependent on the temperature.
<b>Polyethylene LDPE (e. g. Hostalen®, Lupolen® P)</b>	---	In hoses for feeds from dosing equipment to commercial dishwasher	Good resistance to alkalis and acidic solutions. Low thermal resistance, soft surface. Safe according to food law regulations, as contains no additives when uncoloured.
<b>HDPE polyethylene of high molecular weight</b>	---	Plain bearings and guides	Good sliding properties, wear-resistant and chemically very resistant, typically an engineering plastic
<b>Polypropylene PP (e.g. Hostalen® PP, Novolen®, Vestolen® P)</b>	---	Most used plastic in commercial dishwashers. Is used for spray systems, nozzles, covers, strainers, all-plastic racks, conveyor belts	Exceptionally resistant to alkaline and acidic solutions. Shape-retentive under heat and pressure-resistant.



Material No.	Abbreviated designation	Notes on use	Properties
<b>Polyoxymethylene POM (e.g. Hostaform<sup>®</sup>, Ultraform<sup>®</sup>)</b>	---	is used for heavily loaded parts which have to be remain accurate to size, e.g. toothed wheels in conveyor equipment, chain links, rollers, guides, scanning elements.	Typically an engineering material, similar properties to PP. Not resistant to acids.
<b>Polyvinyl chloride</b>	PVC	Hoses, insulation of electric lines	Resistant to potable water, alkaline and acidic solutions. Tends to harden.
<b>Polytetrafluor-ethylene (Teflon<sup>®</sup>)</b>	PTFE	Seals, sliding materials	Very high chemical and thermal resistance.
<b>Elastomers, e.g. Perbunan<sup>®</sup>, Viton<sup>®</sup>, Silicone, Neoprene<sup>®</sup>, EPDM</b>	---	Valves, seals, membranes, hoses, bellows, etc.	Permanently elastic. Resistance to acids and alkaline solutions is possible, depending on the formula in each case.

### Technical advice provided by the member companies of the VGG

This technical information sheet, which has been drawn up by experienced practitioners, is intended to draw the attention of the reader to the fact that commercial warewashing cannot be carried out successfully if it is approached superficially and without the appropriate involvement of all those participating in the warewashing process.

Only an understanding of the technical processes and of the interdependencies that these entail, teamwork on the part of all those involved, in particular the operator of the warewasher and his/her staff, and regular maintenance of the warewasher, dosing equipment and water treatment system by the manufacturer will produce the warewashing results expected by the user.

Consistent cooperation between warewasher, agent and dosing equipment manufacturers as well as manufacturers of water treatment equipment and wash ware will ensure constant and optimum adaptation to practical requirements, to the benefit of the customers they share and of the environment.

Enquiries regarding this technical information sheet "*Commercial dishwashing & resistance of materials in dishwashers*" should be addressed to

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