Cold-rolled steels for enameling

Technical Terms of Delivery

voestalpine Stahl GmbH
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Introduction

Modern enameling methods place high demands on the quality of the applied substrate. In following this trend, voestalpine Stahl GmbH delivers conventional cold-rolled enameling steels in compliance with all the pertinent standards and delivery conditions.

Pursuant to prEN 10209, the following standardized steel grades are included in the product range:

Steel grades

Comparison table

Steel grade pursuant to prEN 10209	Enameling methods	Applications
DC01EK	Conventional enameling Single-coating/single-fire enameling Double-coating/single-fire enameling	Kitchen ovens, baking sheets, oven doors, cooking hobs, cover panels, signs, bathtubs, shower trays, stovepipes
DC04EK		
DC05EK		
DC06EK		
DC03ED TiVac		
DC04ED TiVac		

The two steel grades DC01EK and DC04EK vary primarily in their forming behavior and were developed for enameling processes that place the highest demands on the surface cleanliness of the substrate. These are specific methods of applying special enamels (such as pyrolytic enamel) without pickling and/or double-coat/single-fire enameling, in particular on a powder basis. The excellent properties of enameling are attained by adjusting a special chemical combination in connection with high-convection glowing under an atmosphere of pure hydrogen.

Steel grade DC05EK is similar in its basic composition to DC04EK and was developed for the sanitary systems industry especially for the production of bathtubs. This is an aluminum-killed steel that is designed for optimum formability and resistance to fish scales by adjustment of the chemical composition and special annealing. This steel grade is applied where the forming stress is not extreme or the applied enameling methods exclude Ti-alloyed IF steel for technical reasons.

The DC03ED and DC04ED steel grades included in EN 10209, for which decarburization is required during the liquid phase, are not manufactured. Respective alternatives are available in the form of special IF enameling steels, depending on the applied enameling process.

The mechanical properties are guaranteed for a period of six months from the time the products are made available. Freedom from flow lines is guaranteed for this time period.

Mechanical and technological properties

Transverse test samples

Steel grade	Designation of standard prEN 10209	0.2% Yield point [1) 2)] $R_{p\,0.2}$ [MPa]	Tensile strength R_m [MPa]	Elongation to fracture [3)] A_{80} [%] min.	Vertical anisotropy r_{90} min.
DC01EK	DC01EK	140 - 270	270 - 390	30	-
DC04EK	DC04EK	140 - 220 [4)]	270 - 350	36	-
DC05EK	DC05EK	140 - 220 [4)]	270 - 350	36	1.5
DC06EK	DC06EK	120 - 190	270 - 350	38	1.6
DC03ED TiVac	DC03ED	120 - 240	270 - 370	34	-
DC04ED TiVac	DC04ED	120 - 210	270 - 350	38	-

1) The lower yield point R_{eL} L applies when the yield point is pronounced.

2) Maximum values of roughly 20 MPa higher are permissible for the 0.2% yield point at thicknesses $0.5 < d \leq 0.7$ mm.

3) Minimum values of roughly 2 units lower are permissible for the yield point at thicknesses $0.5 < d \leq 0.7$ mm.

4) Steel grades DC04EK and DC05EK can be delivered upon special request at the time of the order in thicknesses of 0.7 mm to 1.5 mm with $Rp_{0.2} \leq 210$ MPa and $A_{80} \geq 38\%$. The manufacturer reserves the right to select the roughness values from among the range of mat surface types.

The mechanical properties apply to transverse test samples.

Chemical composition

Mass %

Steel grade	Designation of standard prEN 10209	C max.	Ti max.	Mn max.	P max.	S max. [1)]
DC01EK	DC01EK	0.08	-	0.6	0.045	0.05
DC04EK	DC04EK	0.08	-	0.5	0.03	0.05
DC05EK	DC05EK	0.08	-	0.5	0.025	0.05
DC06EK	DC06EK	0.02	0.3	0.5	0.02	0.05
DC03ED TiVac	DC03ED	0.02	0.3	0.4	0.035	0.05
DC04ED TiVac	DC04ED	0.02	0.3	0.4	0.03	0.05

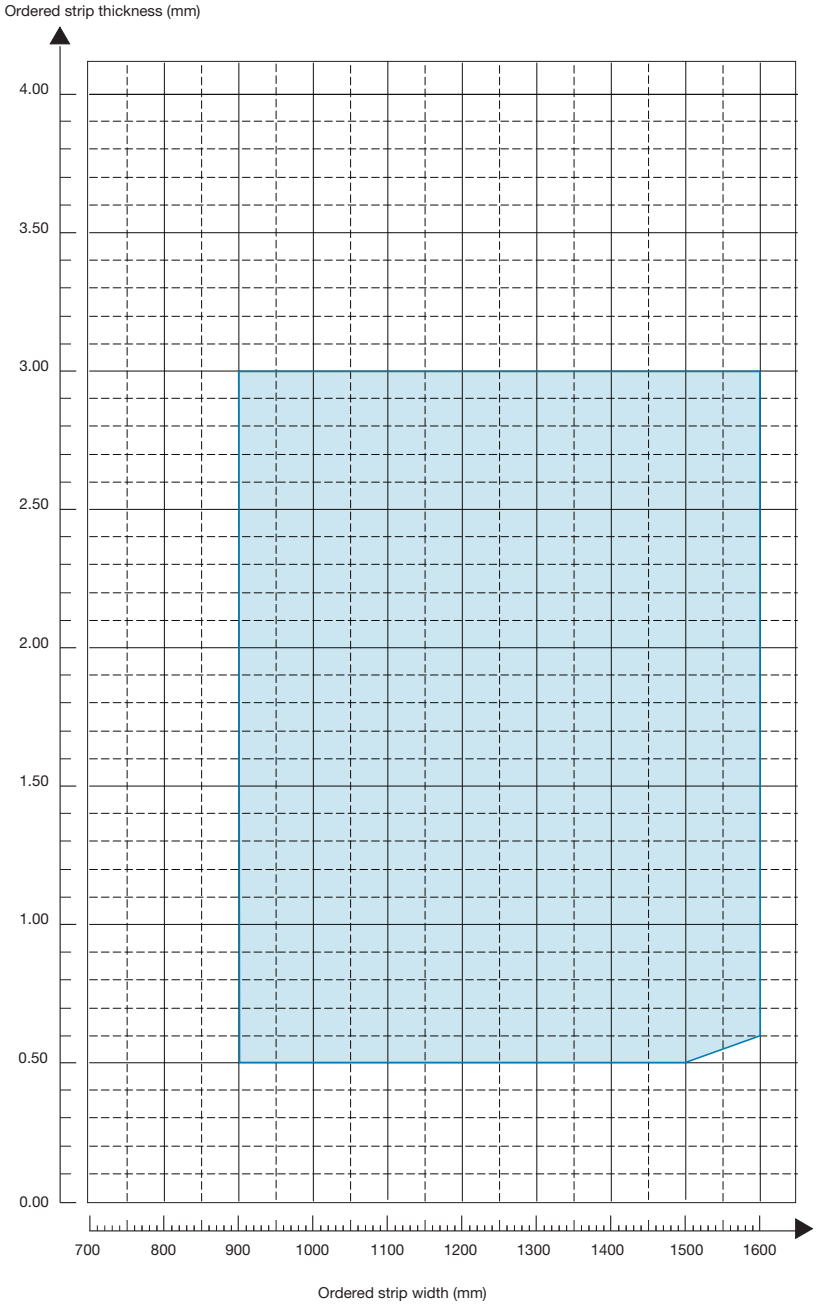
1) These steel grades can be S-alloyed to increase resistance to fish scaling.

The chemical composition complies with the standards defined in prEN 10209.

Available dimensions

DC01EK, DC04EK

Available dimensions cold-rolled steels for enameling



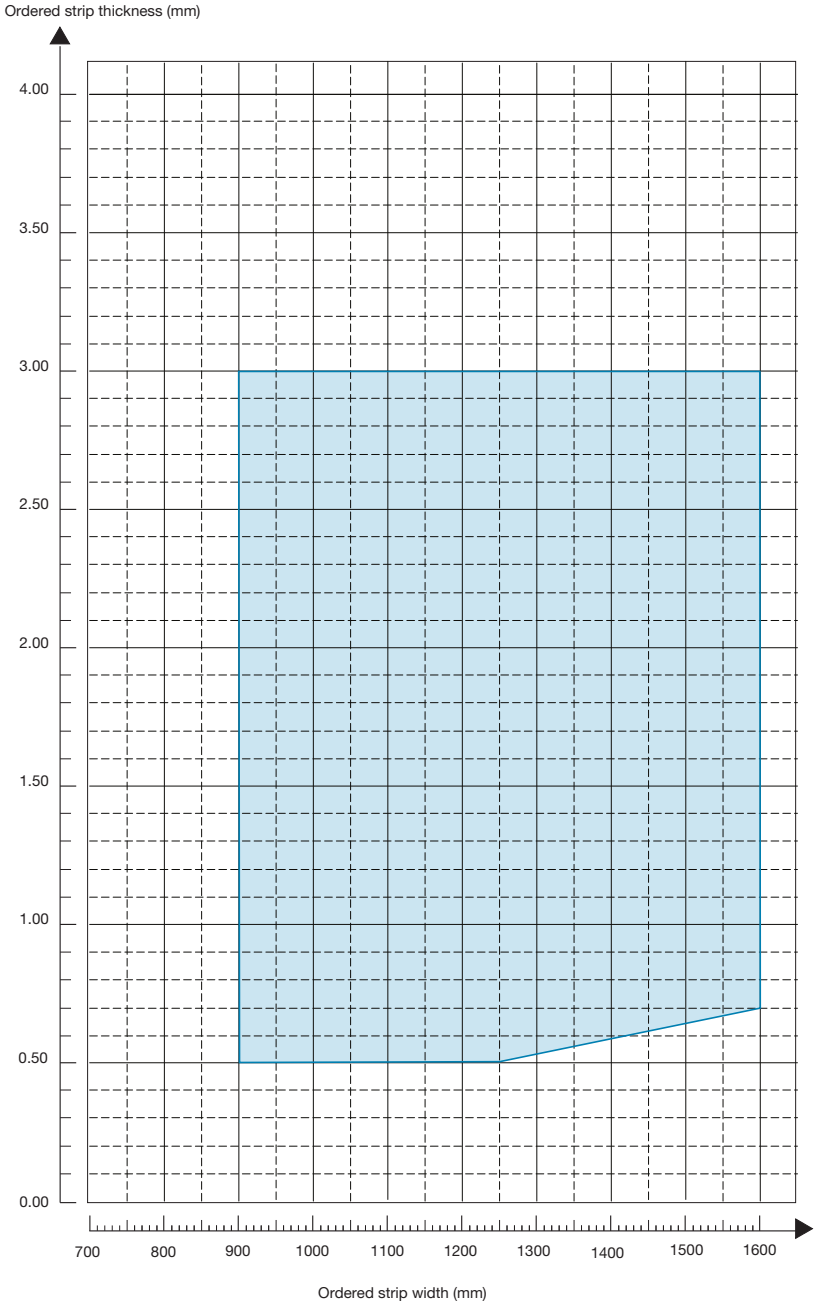
The graphics refer to thickness values with symmetrical thickness tolerances.

The maximum width is reduced by 20 mm if the width tolerance is limited or if the edge is cut.

Please contact our sales departments for widths below 900 mm (production scheduling for center slitting and longitudinal slitting lines).

DC03ED TiVac, DC04ED TiVac, DC06EK

Available dimensions cold-rolled steels for enameling



The graphics refer to thickness values with symmetrical thickness tolerances.

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Please contact our sales departments for widths below 900 mm (production scheduling for center slitting and longitudinal slitting lines).

DC05EK

Available dimensions cold-rolled steels for enameling

Available dimensions upon request.

Dimensioning tolerances

Generally pursuant to EN 10131. Deliveries with narrower tolerances are available upon request.

Surface

Surface type

In accordance with the definition in prEN 10209.

Surface quality

Marking and properties as defined in EN 10130 and prEN 10209. The general design is mat (Ra = 0.6–1.9 µm), except for applications in the sanitary systems industry. Here the surface design is usually rough (Ra > 1.6 µm pursuant to the definition in EN 10130 and prEN 10209).

Surface roughness must be specified in the order. Deliveries with narrower Ra values are available upon request.

Determination of the mean Ra roughness value is subject to a wavelength limit of 2.5 mm in accordance with EN 10049 (standard length of 12.5 mm).

Available dimensions

Cold-rolled steels for enameling

Thickness [1] [mm]		Width [mm]		Maximum outside diameter [mm]	Inner diameter roughly [mm] max.	Coil weight [t] max.
≥ 0.50	≤ 3.00	≥ 600	≤ 785	2000	600/500	-
≥ 0.50	≤ 3.00	> 785 [2]	< 900 [2]	2000	600/500	-
≥ 0.50	≤ 3.00	≥ 900	≤ 1600 [3]	2000	600/500	32

[1] Inner diameter roughly 500 mm only up to < 2.50 mm (for thicknesses ≥ 2.50 mm only upon request).

[2] Width range between > 785 and < 900 mm only upon request.

[3] With limited width tolerance of 1,580 mm max.

Inspection and Testing

Mechanical-technological inspection

Tensile testing in accordance with EN 10002/1.

Enameling

As defined in prEN 10209. Tests with fish-scale-sensitive enamels as standard output controls are conducted upon request. Conditions for pretreatment and enameling in performing these tests are subject to agreement between the manufacturer and the customer. The definitions set forth in prEN 10209 apply to the guaranteed limit values of hydrogen permeability.

Test unit

Specific tests are restricted to a test unit of 20 tons or a portion of 20 tons of the same rolling unit. In the case of strip, a coil of more than 20 t is considered to be a test unit.

Certificate of material tests

In the event a certificate is desired, one of the test certificates defined in EN 10204 is subject to agreement at the time of the order.

Processing information

Welding behavior

Cold-rolled enameling steels can be welded with the same welding parameters used for welding methods tested for conventional cupping steels. However, the utilized welding method must be adapted to enameling methods in order to avoid enameling errors in the area of weld seams or spots.

Heat treatment

Consultation is mandatory in the event thermal treatment is performed that deviates from the conventional single-fire enameling process (including intermediate annealing).

Consultation and definition of the applied substrate

Knowledge of the used enameling method, including the pretreatment method, is of significant importance, especially in the case of cold-rolled enameling steels. A questionnaire is available on the following page for such cases. Our technical experts from quality management and surface engineering research will be pleased to provide you with additional information.

Questionnaire for the selection of cold-rolled steels for enameling

Customer: _____

Enameling works: _____

Application: _____

	Enameling	
	wet	**powder**
Base enameling and conventional enameling (primer + cover coat, double fire)	☐	☐
Base enameling without pickling (with subsequent enamel coating)	☐	☐
Base enameling without pickling (acid-resistant, visible base)	☐	☐
2-coating/single-fire enameling without pickling Direct enameling without bonding oxides in the frit (with pickling + Ni dip)	☐	☐

Other processes: _____

Type of enameling: _____

Annealing temperature: _____ °C **Annealing time:** _____ Min.

	Pickling				
	Type of pickling	Concentration %	Concentration g/l	Temperature °C	Time min.
1. Pickling (rust removal)					
2. Pickling (intense)					
Pickling compounds					

Desired pickling removal: min. _____ max. _____ g/m² surface

	Nickel plating				
	pH value	Concentration %	Concentration g/l	Temperature °C	Time min.
Ion-exchange nickel plating					
Reduction nickel plating					
Bath additions					

Desired Ni coating: min. _____ max. _____ g/m² surface

Name: _____ **Date:** _____

Department: _____ **Tel.:** _____

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High-quality materials are the basis for our products. We strive to be the best partner for our customers and want to provide them with the best-possible solution. We focus our expertise on two aspects:
The personal aspect, with dedicated and highly competent employees
The technical aspect, with high-quality methods, products and services.

The companies in the voestalpine Steel Division and their employees understand partnership to be the following:

- Understanding for their customers' business
- Expertise and reliability
- Responsibility for satisfactory project completion
- Partnerships based on trust

Many years of successful partnerships with our customers prove our point.

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