Technical Information
GL19

Performance Pigments and Colors

Stove Tile Catalogue

In this Technical Information bulletin we are introducing a selection of glazes and colour combinations for stove tiles.

Additionally, several useful specialty frits for glaze corrections are listed.

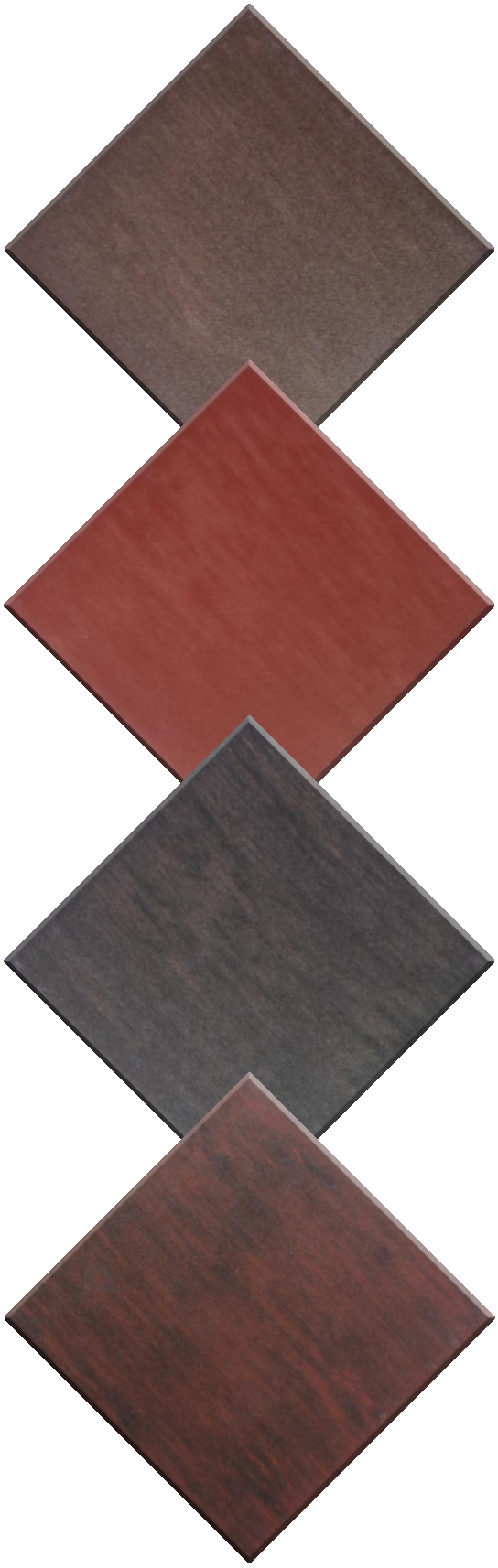
A catalogue with the most common glaze defects is provided as well.

At the end of this bulletin, a table with the glaze properties is given.

The here mentioned glazes and frits resemble only a small selection of our complete product range. Please let us know if your desired glaze is not included.
For assistance in selecting and adapting your glazes, please call our technical service department.

Content

Fashionable colours for superior designs



Variation 1:
Brown wiped

Underglaze		Decorating glaze	
40 525 F	100,0	40 525 F	100,0
$ZrSiO_4$	2,0	$ZrSiO_4$	2,0
230 967	1,0	250 942	0,6
260 952	1,0	260 946	7,0
260 954	0,6	260 952	1,0
260 955	3,0		
spray evenly		sprinkle thickly and wipe with a sponge immediately	

Variation 2:
Red wiped

Underglaze		Decorating glaze	
40 525 F	100,0	40 525 F	100,0
260 952	4,0	230 942	5,0
270 944	5,0	260 952	0,5
		270 946	1,0
spray evenly		sprinkle thickly and wipe with a sponge immediately	

Variation 3:
Dark brown wiped

Underglaze		Decorating glaze	
40 525 F	100,0	40 525 F	100,0
240 942	2,0	230 946	2,0
260 955	8,0	230 967	2,0
		260 946	2,0
		260 952	0,4
		270 946	2,0
spray evenly		sprinkle thickly and wipe with a sponge immediately	

Variation 4:
Dark red wiped

Underglaze		Decorating glaze	
40 525 F	100,0	40 525 F	100,0
260 952	4,0	240 942	2,0
270 944	5,0	260 955	8,0
spray evenly		sprinkle thickly and wipe with a sponge immediately	

Stylish design in up-to-date combinations

Orange in combination with chocolate brown

Orange

Underglaze; evenly sprayed

40 525 F	100,0
238 512	6,0
SnO_2	5,0
ZnO [1]	7,0

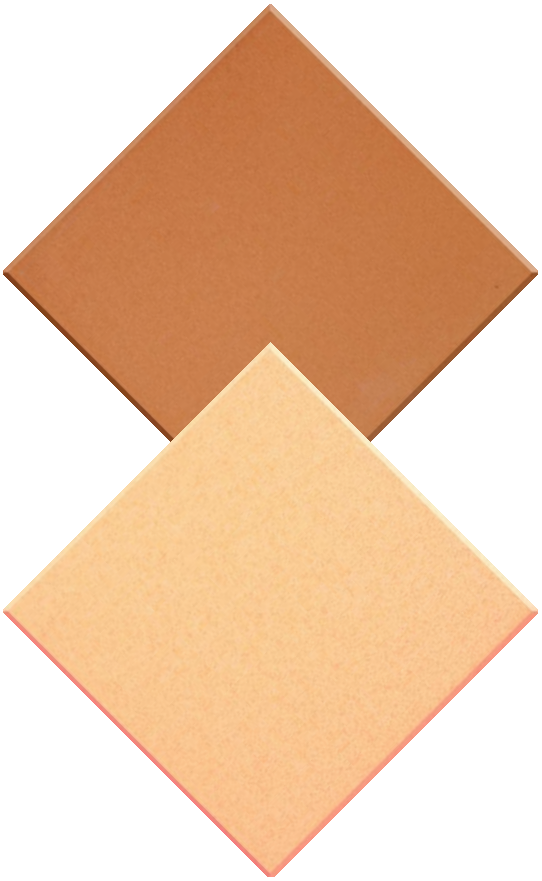
Stippling glaze 1		Stippling glaze 2	
40 525 F	100,0	VTR 102	100,0
230 944	5,0		
230 967	1,0		
270 946	1,0		

Chocolate brown

Underglaze; evenly sprayed

40 525 F	100,0
$ZrSiO_4$	2,0
230 967	1,0
260 952	1,0
260 954	0,6
260 955	3,0

Stippling glaze 1		Stippling glaze 2	
40 525 F	100,0	VTR 102	100,0
240 942	2,0		
260 955	8,0		



Yellow - orange in combination with sand

Yellow - orange

Glaze, evenly sprayed

40 545 TM	100,0
230 967	7,5
270 946	2,0
248 030	2,0

248 030, only stirred in

Sand

Underglaze; evenly sprayed		Decorating glaze; sprinkeled	
FCM 61094	100,0	40 545 TM	100,0
		230 944	4,0
		230 967	1,0
		260 946	4,0

[1] GHS symbol 09, H phrase 410

Stylish design in up-to-date combinations

Rosé in combination with dark brown

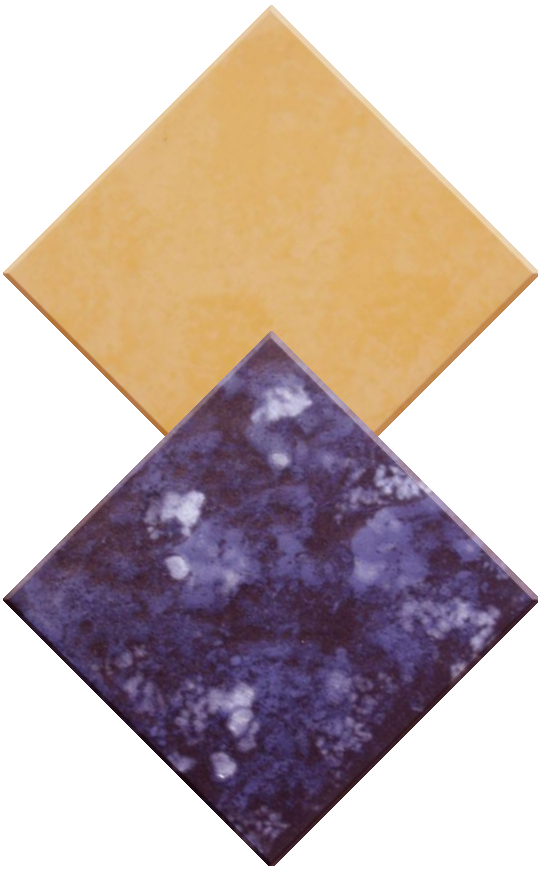
Rosé underglaze		Rosé stippling glaze	
40 525 F	100,0	40 525 F	100,0
230 942	1,5	230 942	2,0
		260 946	2,0
		270 944	1,0

Dark brown

Underglaze, evenly sprayed

40 525 F	100,0
240 942	2,0
260 955	8,0

Stippling glaze 1		Stippling glaze 2	
40 525 F	100,0	VTR 102	100,0
$ZrSiO_4$	2,0		
230 967	1,0		
260 952	1,0		
260 954	0,6		
260 955	3,0		



Sunny yellow in combination with blue

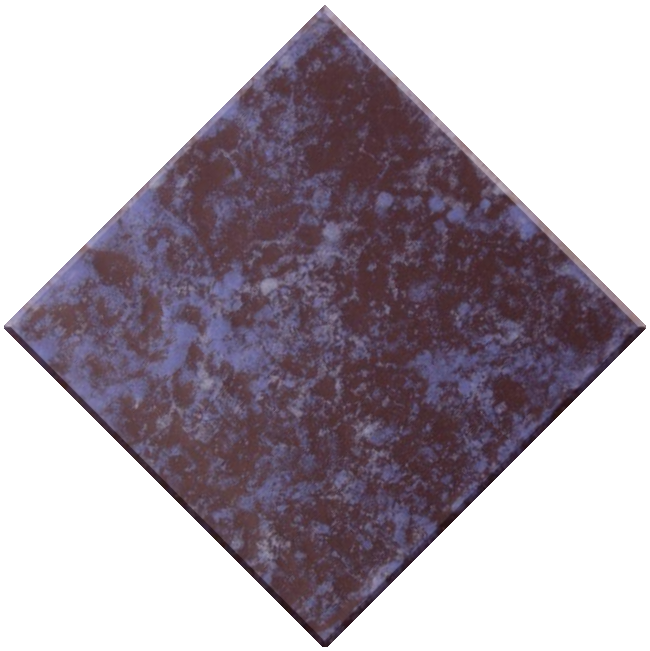
Sunny yellow underglaze		Sunny yellow stippling glaze	
40 525 F	100,0	40 525 F	100,0
230 967	2,0	230 967	8,0

Blue

Underglaze, evenly sprayed		Stippling glaze 1	
40 525 F	100,0	40 525 F	100,0
220 946	5,0	250 946	6,0
240 942	2,0		

Stippling glaze 2		Stippling glaze 3	
40 525 F	100,0	VTR 102	100,0
250 946	6,0		

Conventional colours with a modern touch



Variation 1
Black - blue marbled

Underglaze, evenly sprayed

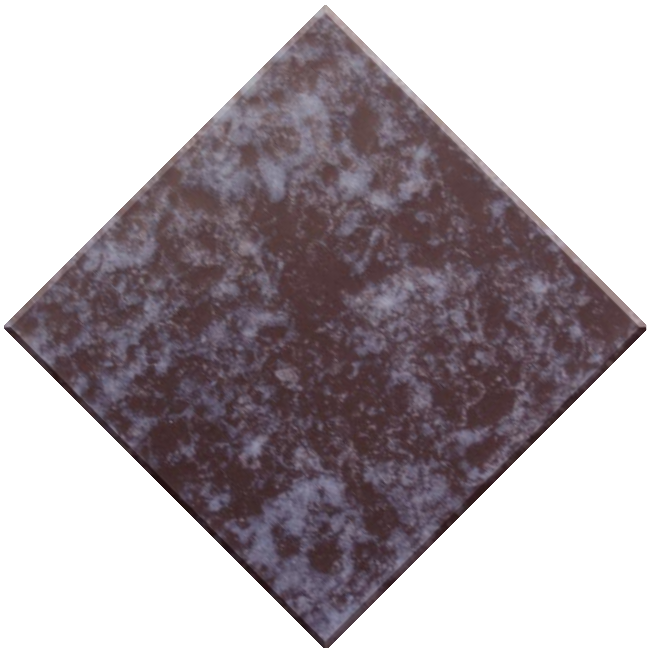
40 525 F	100,0
230 942	5,0

Stippling glaze 1

40 525 F	100,0
250 946	6,0

Stippling glaze 2

40 525 F	100,0
250 946	6,0
220 943	0,4



Variation 2
Black - grey marbled

Underglaze, evenly sprayed

40 525 F	100,0
230 942	5,0

Stippling glaze 1

40 525 F	100,0
250 942	6,0

Stippling glaze 2

40 525 F	100,0
250 946	6,0

Sophisticated look for a cosy atmosphere

Variation 1: Red

Underglaze		Decorating glaze	
VBC 13	100,0	49 485 TM	100,0
		230 942	5,0
		260 946	1,0
		270 547	2,0
speckle		spray evenly	

Variation 2: Light blue

Underglaze		Decorating glaze	
VBC 13	100,0	49 485 TM	100,0
250 946	6,0	250 946	6,0
240 942	0,2		
speckle		spray evenly	

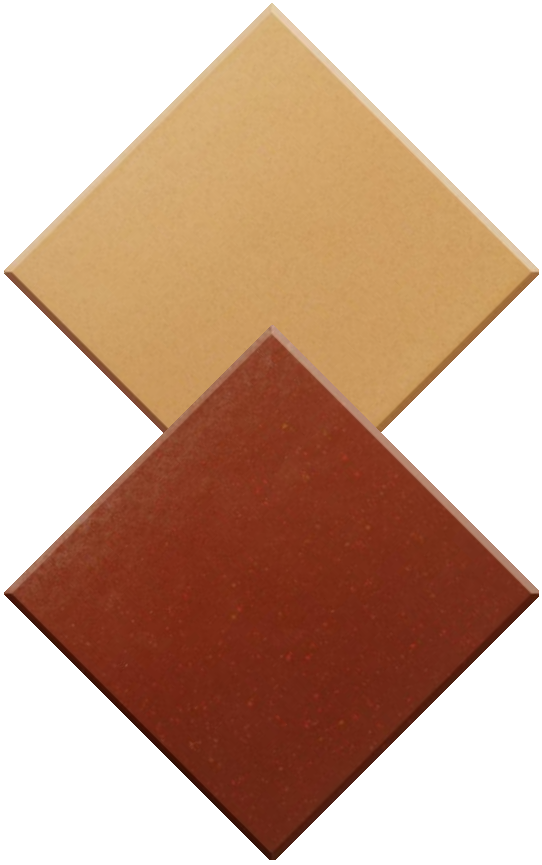
Variation 3: Salmon

Underglaze		Decorating glaze	
VBC 13	100,0	49 485 TM	100,0
230 942	2,0	230 944	5,0
230 946	1,0	230 967	1,0
230 967	6,0	270 946	1,0
270 547	1,0		
speckle		spray evenly	

Variation 4: Green

Underglaze		Decorating glaze	
VBC 13	100,0	49 485 TM	100,0
250 946	6,0	250 955	6,0
240 942	0,2		
speckle		spray evenly	

Up-to-date designs show the latest trends



Combination A

43 554 TM	100,0
230 944	6,0
230 967	4,0
270 944	0,5
stir into the ready to use glaze slip	
279 992 GR	2,0

40 525 F	100,0
260 952	4,0
270 944	10,0
stir into the ready to use glaze slip	
43 557 GR	4,0
47 319 GR	4,0

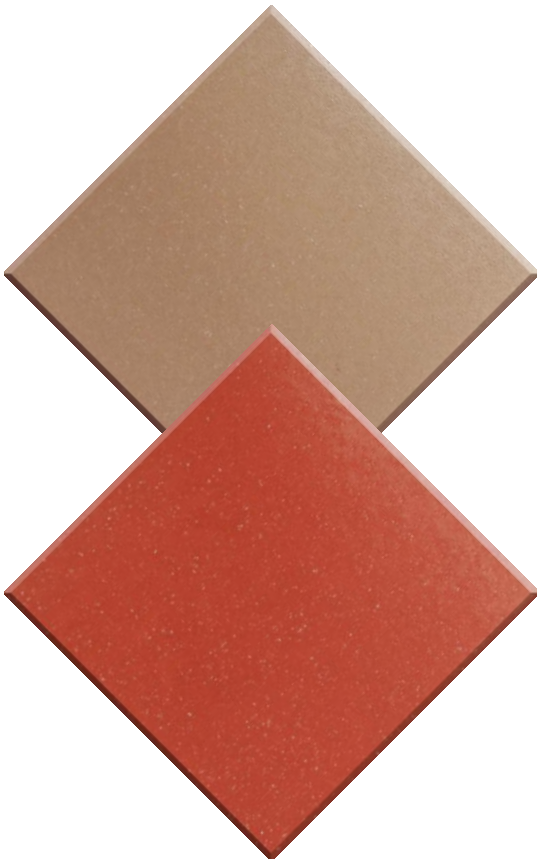
Combination B

43 554 TM	100,0
$ZrSiO_4$	10,0
230 967	0,6
250 955	0,2
260 954	1,0
stir into the ready to use glaze slip	
50 559 GY	5,0
59 568 GY	5,0

40 525 F	100,0
$ZrSiO_4$	5,0
210 960	1,2
250 955	3,8
260 954	1,6
stir into the ready to use glaze slip	
269 984 GR [1]	2,0

[1] H phrase 412

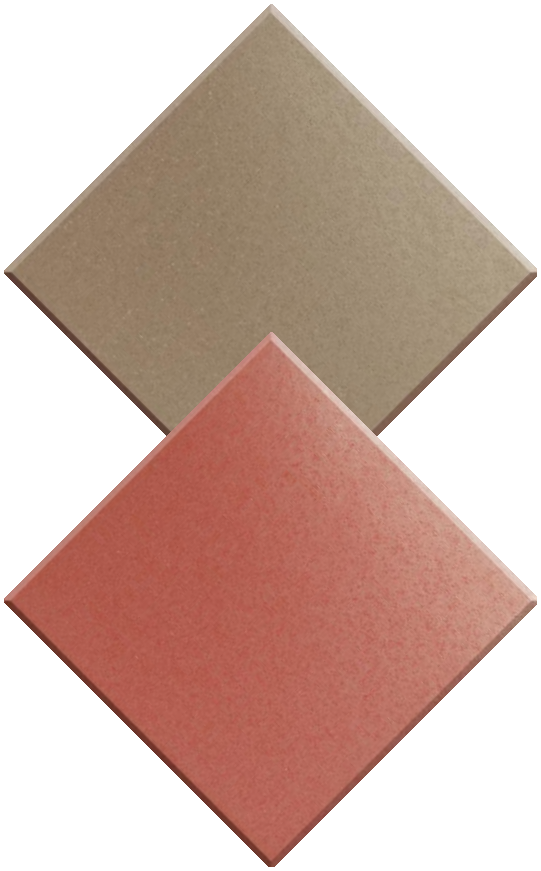
Up-to-date designs show the latest trends



Combination C

43 554 TM	100,0
$ZrSiO_4$	5,0
210 960	0,8
250 942	3,0
260 952	2,0
stir into the ready to use glaze slip	
50 559 GY	5,0
59 568 GY	5,0

40 525 F	100,0
270 561	12,0
stir into the ready to use glaze slip	
50 559 GY	5,0
59 568 GY	5,0

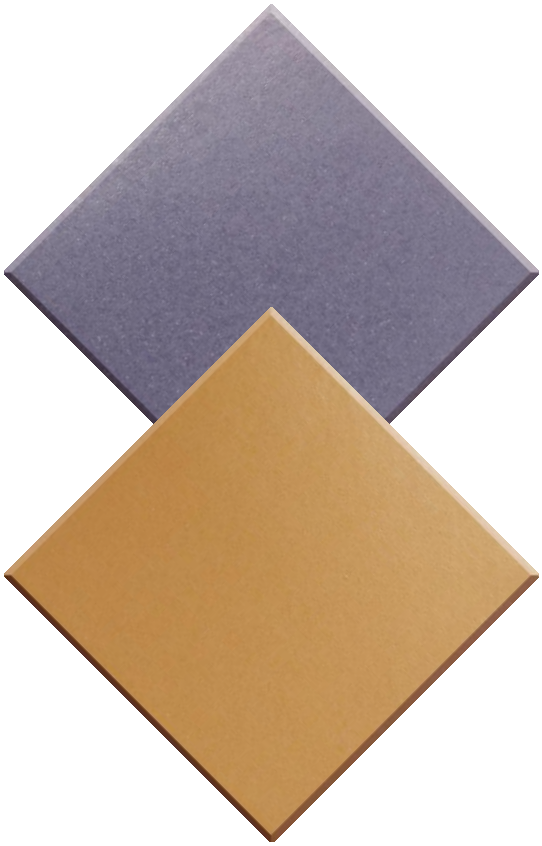


Combination D

43 554 TM	100,0
$ZrSiO_4$	5,0
210 960	1,2
250 955	3,8
260 954	1,6
stir into the ready to use glaze slip	
50 559 GY	5,0
59 568 GY	5,0

43 554 TM	100,0
270 561	12,0
stir into the ready to use glaze slip	
50 559 GY	5,0
59 568 GY	5,0

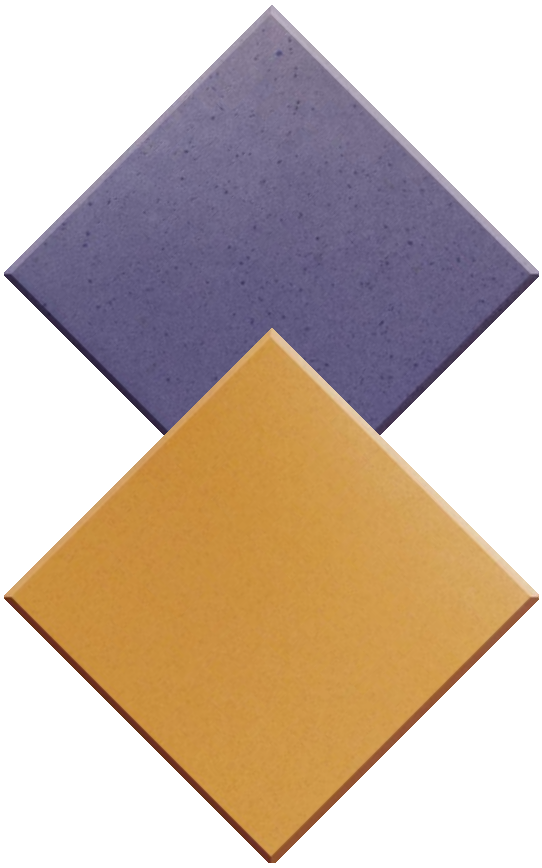
Up-to-date designs show the latest trends



Combination E

43 554 TM	100,0
250 946	6,0
240 942	0,2
stir into the ready to use glaze slip	
50 559 GY	5,0
59 568 GY	5,0

43 554 TM	100,0
230 944	6,0
230 967	4,0
270 944	0,5
stir into the ready to use glaze slip	
50 559 GY	5,0
59 568 GY	5,0



Combination F

43 554 TM	100,0
250 946	6,0
240 942	0,2
stir into the ready to use glaze slip	
42 246 GR	4,0
45 164 GR	4,0

43 554 TM	100,0
230 946	6,0
230 967	4,0
270 944	0,5
stir into the ready to use glaze slip	
279 992 GR	2,0

Up-to-date designs show the latest trends

Combination G

FCM 61094	100,0
stir into the ready to use glaze slip	
279 992 GR	2,0

43 554 TM	100,0
220 946 [2]	5,0
stir into the ready to use glaze slip	
50 559 GY	5,0
59 568 GY	5,0

Combination H

43 554 TM	100,0
stir into the ready to use glaze slip	
279 992 GR	2,0

43 554 TM	100,0
220 943	6,0
220 946	3,0
250 946	2,0
stir into the ready to use glaze slip	
42 246 GR	4,0
45 164 GR	4,0

Traditional colours with modern appearance

Warmth and cosiness

40 5245 F		100,0
Iron oxide		4,0

40 5245 F		100,0
Iron oxide		4,0
Manganese oxide	[1]	2,0

40 5245 F		100,0
Iron oxide		4,0
Manganese oxide	[1]	3,0

40 5245 F		100,0
Manganese oxide	[1]	4,0

[1] GHS symbol 07, H phrases 302, 332

Traditional colours with modern appearance

Solidity

40 5245 F	100,0
Copper oxide [1]	4,0
Iron oxide	1,0

40 5245 F	100,0
Copper oxide [1]	3,0
Iron oxide	1,0

40 5245 F	100,0
Copper oxide [1]	4,0
Iron oxide	1,0
Cobalt oxide [2]	0,5

40 5245 F	100,0
Cobalt oxide [2]	2,0

[1] GHS symbol 09, H phrase 400
[2] GHS symbol 08, H phrase 334, 412

Traditional colours with modern appearance

40 5245 F	100,0
Iron oxide	4,0

40 5245 F	100,0
Copper oxide [1]	3,0
Iron oxide	1,0

40 5245 F	100,0
Copper oxide [1]	4,0
Iron oxide	1,0

40 5245 F	100,0
Iron oxide	4,0
Manganese oxide [2]	2,0

40 5245 F	100,0
Iron oxide	4,0
Manganese oxide [2]	3,0

40 5245 F	100,0
Copper oxide [1]	4,0
Iron oxide	1,0
Cobalt oxide [3]	0,5

40 5245 F	100,0
Cobalt oxide [3]	2,0

40 5245 F	100,0
Manganese oxide [2]	4,0

[1] GHS symbol 09, H phrase 400
[2] GHS symbol 07, H phrases 302, 332
[3] GHS symbol 08, H phrases 334, 412

Special Frits

FTR 90 167	lead free; frit with a c.t.e. of 150 ($*10^{-7}$/K); for correction of chipping
FTR 90 255	lead free; frit with a c.t.e. of 40 ($*10^{-7}$/K); for correction of hair cracks
FTR 90 5123 [1]	lead mono silicate
FTR 90 352	lead containing frit with 21.0 weight-% lead; zinc base for silk-matt effect glazes
FTR 90 420	lead free; ZnBa frit, base for matt elimination glazes
FTR 90 427	lead free; lithium frit; for correction of surface tension; causes effects and crystals
FTR 90 428	lead free; together with the frit FTR 90 420 used as a base for effect glazes with matt to silk-matt appearance
11.37048.09	lead free; barium frit; base for stone matt glazes

[1]GHS symbol 07, 08, 09, H phrases 302, 332, 360Df, 373, 410

Glaze Properties

Product no.	**Type**	**% PbO**	**C.T.E. [10^{-7}/K]**	**glossy**	**matt**	**Firing temperature °C**
VTR 102	transparent glaze	0	64	**x**		980 - 1070
VTR 40 5245 F	transparent glaze	14	55	**x**		1040 - 1080
VTR 40 525 F	matt glaze	0	57		**x**	1020 - 1100
VTR 40 545 TM	matt glaze	0	62		**x**	1020 - 1080
VBC 43 554 TM	effect glaze	0	62		**x**	1020 - 1140
FCM 61094	matt glaze	19	55		**x**	1040 - 1100
VBC 13	opaque glaze	0	58	**x**		980 - 1060
VBC 49 485 TM	effect glaze	0	65		**x**	1000 - 1100

Glaze Defects

Why do glaze defects occur? In the following chapter the most common defects and hints to avoid them are given.

Overfiring or Underfiring
The most common reasons for glaze defects are underfiring or overfiring.
Underfiring causes a dry, scratchy surface. Often this can be cured by a second firing at a higher temperature.

Overfiring causes the glaze to flow. The glaze is then thinner at the top and thicker at the bottom. Sometimes it even drops from the body. Strongly overfired ceramics may also show pinholes and pitting, if the glaze reaches its evaporation temperature. Overfiring cannot be corrected.

Differing Coefficients of Thermal Expansion
The body and the glaze may have very different coefficients of thermal expansion (c.t.e.). If the c.t.e. of the glaze is too high, it might lead to the formation of cracks. If it is too low, it might cause chipping.
A too low c.t.e. might be adjusted by adding 2 to 7 % of the frit 90 167. If the c.t.e. is too high, 5 to 10 % of the frit 90 255 might correct this.

Application Problems and Adhesion of the Unfired Glaze
Wrong application of the glaze is the reason for several glaze defects. A too thin application might result in rough surfaces and also influence the glaze colour. A glaze application that is too thick promotes running and blistering. Uneven application causes stains and stripes, in the colour as well as in the surface structure.
Mistakes during application also influence the adhesion of the glaze to the body. The body must be clean and dry before the glaze is applied. If a second glaze should be applied on top, the first must be dried completely before doing so. Adhesion problems often cause a rolling off of the glaze.
Adhesion problems might be avoided by testing the glaze slip before application. The weight per litre and the viscosity should be measured.
To keep the glaze slip from settling, a suspending agent should be used. When glazing raw bodies, adhesive should always be used.

Hair Cracks, Chipping and Peeling
Hair crack formation means the formation of a network of finer or thicker cracks in the fired glaze, sometimes directly after firing, sometimes later. Except in some special glazes, the formation of cracks is not desired.
There are several reasons for the formation of hair cracks. Normally cracks are occuring if the coefficient of thermal expansion of the glaze is too high. Due to the tension during cooling the glaze is crazing. The addition of the frit 90 255 and/or kaolin might help.

Cracks can also be caused by thermal shock due to a too fast temperature change. Longer soaking times and slower cooling help to avoid these cracks. A thinner layer of glaze or the addition of silica to the body are also advantageous.

In case of porous bodies with unglazed areas, moisture might be absorbed, which may lead to an expansion of the body. Then the body should be fired at a higher temperature or more calc spar should be added to the body.

Peeling and chipping is caused by a glaze c.t.e. that is too low. In this case the frit 90 167 should be added to the glaze.
Firing at lower temperatures and faster cooling could help. Perhaps also the feldspar and/or clay content of the body may be increased.

Very important is the formation of a good intermediate layer, that means the adhesion of the glaze to the body. A good intermediate layer is able to equalize the tension between glaze and body. Longer firing cycles and a sufficient soaking time enhance the formation of the intermediate layer.

Rolling off or Contraction of the Glaze after Firing
When rolling off or contracting, the glaze leaves empty areas on the body after firing.
Rolling off occurs if the glaze is not sticking to the body correctly. This might be the case if the body was not completely free of grease, dirt or moisture, or if the surface of the body is too smooth. Also a too thick layer of glaze can cause adhesion problems. Sometimes a glaze that is milled too fine can be the reason for rolling off.
Rolling off also occurs if the raw glaze was not dried long enough.
Too much opacifier may also lead to rolling off. Matt glazes with a high content of clay tend to rolling off, like too viscous glazes do.

If the surface tension is too high, the glazes might contract to droplets. This can be cured by additions of lithium, alkali or lead, which lower the surface tension.

Blistering and Pinholes

Blisters and pinholes are often formed by evaporating gas from the body or from the glaze while melting during the firing.
In most cases the outgassing process leaves enough time for the glaze to flow back and form an even surface. If there is too much gas or the glaze is too viscous, the glaze might solidify although the gas has not evaporated completely. After firing, blisters and pinholes remain.

Outgassing may have different reasons. Air in the body is often already formed during processing or due to the degradation of finished body material. In order to reduce air bubbles in the body, opening materials can be used.
In the glaze, the formation of blisters is enhanced by too thick glaze layers or too high surface tension or viscosity.

Mistakes during firing also increase the formation of blisters: too high temperature, a reductive kiln atmosphere at the beginning, too short firing cycles or too short soaking times. The kiln should be well ventilated at all times.

Matt Stains, Glossy Areas and Discolourations

One can distinguish between matt areas in a glossy glaze and glossy areas in a matt glaze. Additionally, discolourations or traces on fired pieces may occur.

There are several reasons for matt stains. Among them are inhomogenious glaze applications or too low firing temperatures. The evaporation of fluxes, e.g. lead, during firing leaves no damage if the ventilation flaps of the kiln are left open. If there is excess water during heating, a good ventilation also helps.

Glossy areas often are caused by too thin glaze layers or temperatures that are too high. The kiln atmosphere may be improved by sufficient air supply while heating and slow cooling.

Discolourations often are formed by evaporated metal oxides, which were added to the glaze in pure form or as part of a colour stain, e.g. chromium, copper or cobalt oxide. If the evaporation is very high without proper ventilation, even tiny crystals may occur. Only a sufficient ventilation of the kiln may solve the problem.

PPC●IS●GL19●11/12●E
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