TG Steels

TGE23

GROUPER

Hot work tool steel engineered for giga casting: optimized combination of toughness and hot properties

TGE 23 GROUPER;

- is a remelted steel ensuring an excellent level of cleanliness with a very high homogeneity.
- has a very good hot strength and tempering back resistance.
- has an excellent toughness.
- has a good polishability, and is good for texturing.
- can also be welded and exhibits good machinability.
- has a very good suitability for surface treatments such as gas, ionic or salt bath nitriding, as well as PVD or CVD coatings.

Applications

TGE 23 GROUPER can be used for high demand hot work applications like die casting, high speed forging and extrusion.

TGE 23 GROUPER is the optimum choice for light alloys medium and big sized die casting molds especially for giga casting.

TGE 23 GROUPER can also be used for molds used in the plastic transformation when the highest mechanical properties are required *(e.g. molds for transparent parts in reinforced plastics)*.

Compared to CUDA PRIME steel *(1.2343)*, TGE 23 GROUPER has a better tempering resistance and better toughness.

Main properties

- Excellent toughness
- Good polishability
- Very good hot strength and tempering back resistance
- High hardenability
- Suitable for surface treatments

Chemical composition *(typical)*

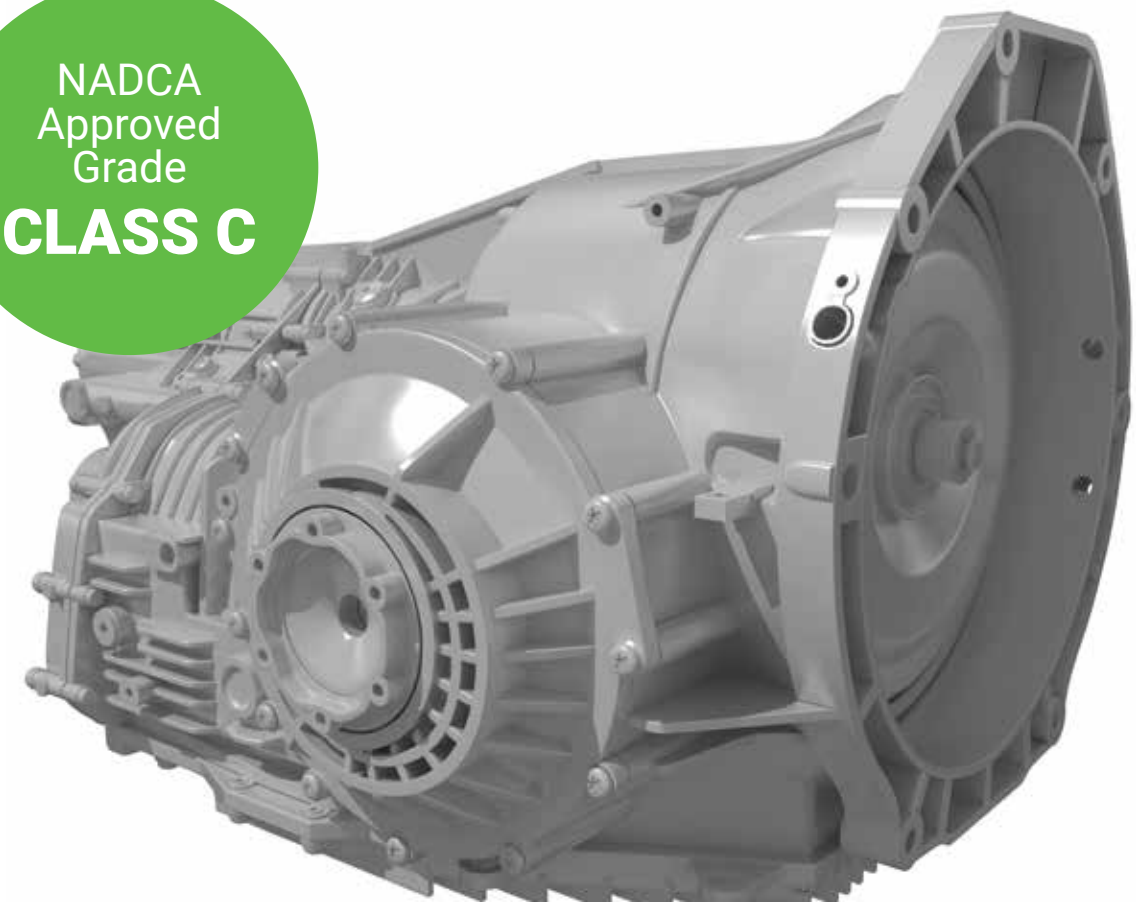
C	Mn	Si	P	S	Cr	Mo	V
0.37	0.40	0.30	0.010	0.001	5.00	2.20	0.45

Designation

Werkstoff Nr	ISO	China GB	JIS Japan	UK	AISI USA	Russia Gost	AFNOR	Other / Special
1.2367 Mod ESR	X38CrMoV5-3 Mod	-	-	-	-	-	-	NADCA Grade C

NADCA Approved Grade

CLASS C



Structure

The structure of the TGE 23 GROUPER is fine and homogeneous without precipitation or alignments of carbides.

The TGE 23 GROUPER is NADCA certified *(date: 22.01.2025)* according to NADCA # 207 - 2024

SEGREGATION

According to NADCA # 207 - 2024, AS1 - AS4 *(annealed conditions)*

MICROSTRUCTURE

According to NADCA # 207 - 2024, HS1 - HS4 *(heat treated conditions)*

The cleanliness of TGE 23 GROUPER which is a electro slag remelted steel *(ESR)* is very high and according to ASTM E 45 - 95 method A it is at most equal to: fine series: A0.5 - B0.5 - C0 - D1.5 / thick: A0.5 - B0.5 - C0- D1 with B + C + D ≤ 2.5 This level of cleanliness guarantees the highest polishability of TGE 23 GROUPER.

Hardness at the time of delivery

Annealed for 220 HB max.

Typical mechanical properties in hardened conditions *(results from internal tests not indicated on the certificates)*

TS MPa	YS 0.2% MPa	Elongation %	Hardness HRC	KV J 20°C
1490	1200	13	44	32
1650	1380	12.5	48	25
1900	1550	12	52	16

Physical properties

Temperature	20°C	400°C	600°C
Volumic mass kg/m³	7800	7700	7580
Young Modulus N/mm²	210000	185000	145000
Thermal conductivity W/m.K	29	31	32
Coefficient of linear expansion 10^{-6}/K	12.1	12.7	13.2

Heat treatment

SOFT ANNEALING

Temperature: 830 - 870°C, duration 1h + 1h for 25 mm thickness. Slow cooling in the furnace *(10 to 20°C/h)*. The atmosphere in the furnace must be reducing to avoid decarburization of the steel.

STRESS RELIEVING

After machining, it is recommended to perform stress relieving at 650°C for a minimum of 2 hours, followed by slow cooling in the furnace to 450°C.

AUSTENITIZATION

In order to avoid any risk of cracking it is recommended to preheat in 3 steps.

- 1st preheating step:
  temperature: 600°C time: 30 s/mm of thickness
- 2nd preheating step:
  emperature: 820°C time: 30 s/mm of thickness
- 3rd preheating step:
  temperature: 900°C time: 15 s/mm of thickness

Recommended austenitizing temperature: 1010 - 1030°C. The holding time should not be too long to avoid a risk of grain coarsening and a loss of toughness. It is recommended to keep the part at the austenitizing temperature 30 minutes per inch of thickness as soon as the temperature of the surface reach the austenitization temperature.

QUENCHING MEDIUM

Oil at 80°C, vacuum *(pressure > 6 bars)*, salt bath 500 - 550°C.
To ensure good toughness, treatment with oil or salt bath is preferable.

TEMPERING

To ensure a minimum residual austenite rate as well as greater tool stability, it is essential to perform a double tempering. Each tempering is followed by a cooling under 100°C.

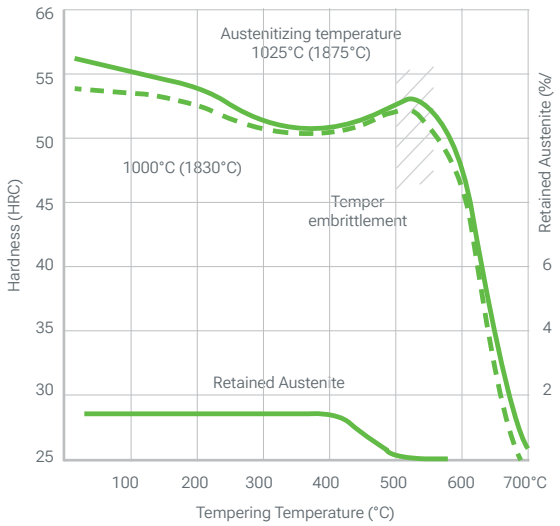
Each tempering time must be at least equal to 1h + 1h for 25 mm of thickness of the treated part *(equivalent thermal thickness)*.

Note: in order to avoid any precipitation of secondary carbides leading to decrease the toughness of the steel a tempering temperature in the range 500 -550°C is not recommended.

RECOMMENDED HARDNESS

- Die casting tools: 42 to 46 HRC
- Hot forging tools: 44 to 52 HRC
- Extrusion dies for light alloys: 46 to 50 HRC

TEMPERING CURVE



Surface treatment

NITRIDING

TGE 23 GROUPER can be nitrided at temperatures less than or equal to 20°C below tempering temperatures without risk of deterioration of the mechanical characteristics.

With gas nitriding at 520°C *(25 h)* the surface hardness is 1080 HV1 with a diffusion layer of 0.2 mm.

PVD, CVD

TGE 23 GROUPER is suitable for all kinds of PVD and CVD treatment as soon as the treatment temperature is 30°C lower than the last tempering temperature.

Polishing

TGE 23 GROUPER is suitable for polishing in the heat treated condition and it can be used for applications requiring a mirror polished level *(Rt ≤ 0.5 µm, CNOMO level 1, Rugotest N1)* as used for parts requiring a mirror polishing level.

Optimal polishing is achieved by performing consecutive steps with similar roughness and stopping each step as soon as the last scratch from the previous step disappears.

Texturing

TGE 23 GROUPER is suitable for chemical or laser texturing.

Machining

The machining parameters below are given for information only and must be adapted according to the equipment and usual machining conditions. *(data valid in the annealed conditions)*

TURNING

	Carbide tool		HSS tool
	Rough machining	Finishing	Finishing
Cutting speed m/min	140 - 180	180 - 230	17 - 22
Feed mm/r	0.2 - 0.4	0.1 - 0.2	0.1 - 0.3
Depth of cut mm	2 - 4	0.5 - 2	0.5 - 2

MILLING: SURFACING

	Milling with carbide tools		Solid tool
	Rough machining	½ Finishing	Finishing
Cutting speed m/min	160 - 180	180 - 200	150 - 180
Feed mm/r	0.35	0.2 - 0.15	0.15 - 0.05
Depth of cut mm	1 - 3	1 - 2	1 - 0.5

DRILLING: HSS TWIST DRILL

Drill diameter mm	Cutting speed m/min	Feed mm/t
< 5	14 - 18	0.05 - 0.15
5 - 10	14 - 18	0.15 - 0.20
10 - 15	14 - 18	0.20 - 0.25
15 - 20	14 - 18	0.25 - 0.30

DRILLING: CARBIDE DRILL

	Carbide type		
	Indexable insert	Solid carbide	Carbide tip
Cutting speed m/min	180 - 210	120 - 140	55 - 80
Feed mm/t	0.05 - 0.15	0.10 - 0.25	0.15 - 0.25

FINE GRINDING

General indications for grinding wheels to be used on TGE 23 GROUPER in the heat treated condition. Usually, rather soft vitrified aluminum oxide grinding wheels *(grades G for plane grinding to K for cylindrical grinding)* are used.

Particular attention will be paid to effective cooling of the surface during grinding to prevent degradation of the material surface.

ELECTRO-DISCHARGE MACHINING

TGE 23 GROUPER is also suitable for EDM machining *(wire or electrode)*. Preferably, the machining will be carried out with a low current density and a high frequency in order to limit the thickness of the white layer as much as possible.

Then it is necessary to carry out a stress relieving at 25°C below the last tempering in order to reduce the level of residual stresses *(which could lead to a risk of cracking)* and to carry out a polishing to completely remove the white layer formed during the discharge machining process.

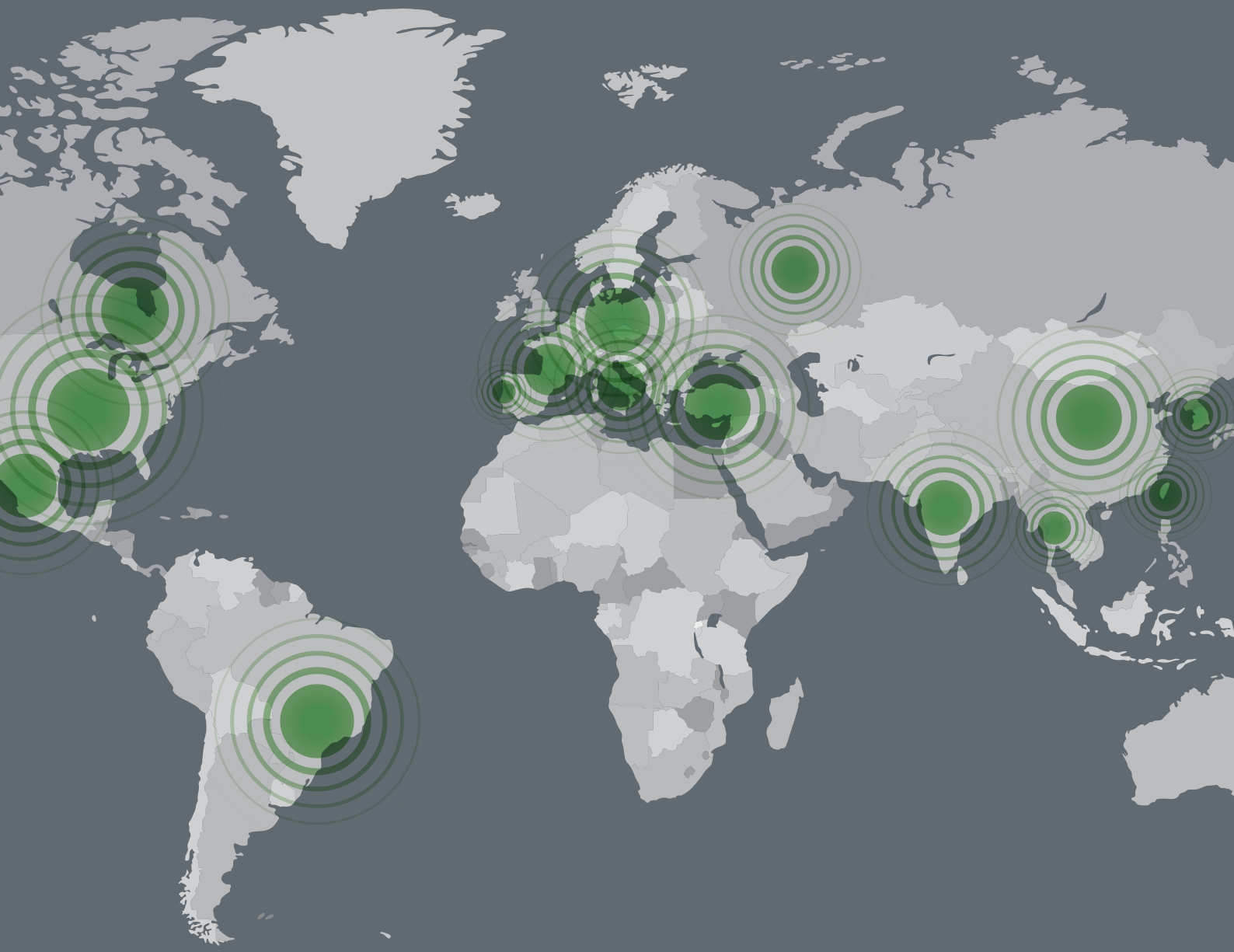
Welding

It is not recommended to weld TGE 23 GROUPER but if this is mandatory it could be welded either in the annealed condition *(better)* or in the heat treated condition.

- Method: TIG
- Feeder wire: AISI H11 *(in order to avoid any porosity it is recommended to preheat the wire at 105 - 115°C before welding).*
- Preheating: 350°C.

Hold at 200°C during the welding operation with a maximum interpass temperature at 480°C. Slow cooling *(max 20°C/h)* after welding.

- Post treatment:
  - » In the treated state: tempering at 20°C below the last tempering temperature with a tempering time at least equal to 1h + 1h for 25 mm of thickness of the treated part *(equivalent thermal thickness)*.
  - » In the annealed state: carry out a soft annealing under the usual conditions: temperature: 840 - 870 C, duration 1h + 1h for 25 mm of thickness. slow cooling in the furnace *(10 to 20°C/h).*



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