



# TGE21

## COBIA ESR

# Electroslag Remelted (ESR) hot work tool steel with good combination of toughness and hot properties for demanding hot work applications

## TGE21 COBIA ESR

- is an Electroslag Remelted (ESR) 5% Cr steel that ensures a very high level of cleanliness and homogeneity.
- has a very good toughness and ductility associated with a good enough hot strength and tempering back resistance.
- has a very good polishability, is good for texturing.
- can be used for applications requiring a mirror polished level ( $R_t \leq 0.25 \mu\text{m}$ , CNOMO level 1, Rugotest N1).
- 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

TGE21 COBIA ESR can be used for various types of aluminum die-casting molds.

TGE21 COBIA ESR can also be used for high hardness plastic molds.

TGE21 COBIA ESR is also commonly used for hot extrusion molds, forging molds and punches, high speed stamping molds, die-casting molds, plastic molds, etc.

TGE21 COBIA ESR is also commonly used in engine mold manufacturing.

## Main properties

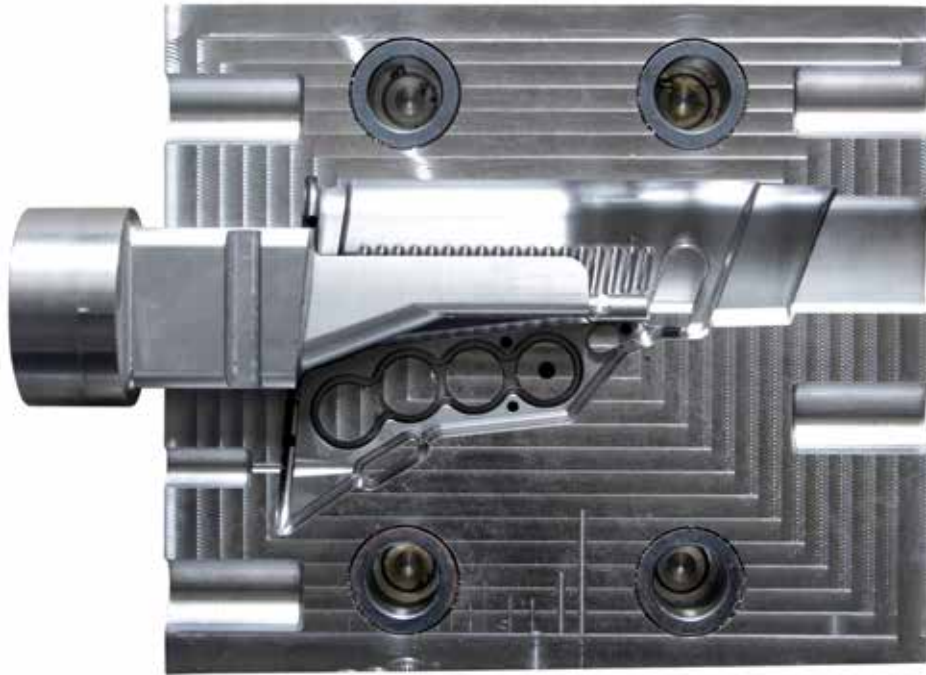
- Very good toughness and ductility
- Excellent polishability
- Good hot strength and tempering back resistance
- High hardenability
- Suitable for surface treatments

## Chemical composition (typical)

C	Mn	Si	P	S	Cr	Mo	V
0.35	0.40	0.25	< 0.010	< 0.001	5.00	1.75	0.50

## Designation

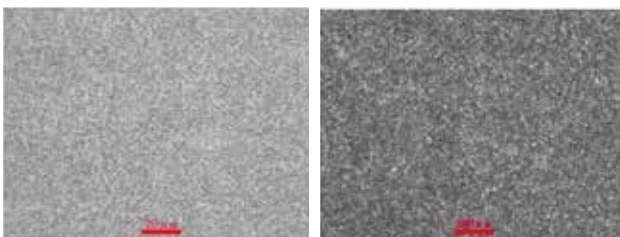
Werkstoff Nr	ISO	China GB	JIS Japan	UK	AISI USA	Russia Gost	AFNOR	Other / Special
1.2340 ESR	X37CrMoV5-1	4Cr5MoSiV1	SKD6	BH11 ESR	H11 ESR	-	-	NADCA Grade E



## Structure

The structure of the TGE21 COBIA ESR is fine and homogeneous without precipitation or alignments of carbides.

The annealed microstructure is in conformity with NADCA # 207 - 2016 standard range AS1 - AS4. Segregation: in conformity with the acceptable level of NADCA # 207 - 2016 standard



Annealed structure: AS1

Segregation: SA1

TGE21 COBIA ESR 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 - B1 - C1 - D1  
 thick: A0.5 - B0.5 - C0.5 - D0.5.  
 This level of cleanliness guarantees the highest polishability of TGE22 COBIA ESR.

## Hardness at the time of delivery

Annealed for 230 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	KU J à 20°C
1800	1540	12	52	≥17
1600	1380	12	48	≥ 18
1450	1200	13	44	≥ 20

## Physical properties

Temperature	20°C	400°C	600°C
Volumic mass kg/m <sup>3</sup>	7800	7700	7620
Young Modulus N/mm <sup>2</sup>	210000	180000	145000
Thermal conductivity W/m.K	31	31	32
Coefficient of linear expansion 10 <sup>-6</sup> /K	11.4	12.7	13.3

## Heat treatment

### SOFT ANNEALING

**Temperature:** 800 - 860°C, duration 1h + 1h for 25 mm thickness. slow cooling in the furnace (10 to 20°C/h) down to 500°C. 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 600 - 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 2 steps.

- **1st preheating step:**  
temperature: 550°C time: 30 s/mm of thickness
- **2nd preheating step:**  
temperature: 750°C time: 30 s/mm of thickness

**Recommended austenitizing temperature:** 1000 - 1050°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.

## SUB ZERO TREATMENT

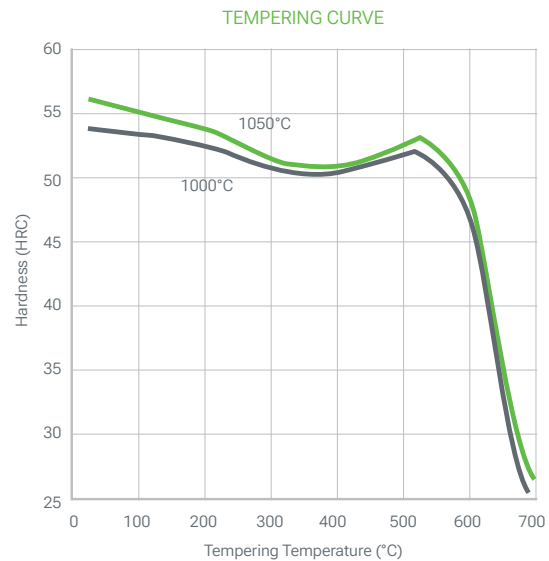
For parts used in cold work applications that need to have high dimensional stability and to increase wear resistance without reducing toughness, it is recommended to perform a subzero treatment at a temperature between -70°C and -190°C for 1 hour for 25mm of thickness of the part.

The temperature range from -70°C up to -120°C (named cold treatment of steel) leads to the complete transformation of austenite into martensite and as a consequence to better stability associated with improved hardness and better wear resistance and the temperature range from -135°C down to -190°C (named cryotreatment of steel) leads also to the complete transformation of austenite and also the precipitation of ultrafine carbides improving a lot the wear resistance without modification of the toughness. This treatment is optional for common applications.

## 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



## Surface treatment

### NITRIDING

TGE21 COBIA ESR 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

TGE21 COBIA ESR 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

TGE21 COBIA ESR is suitable for polishing in the heat treated condition and it can be used for applications requiring a mirror polished level ( $Rt \leq 0.25 \mu\text{m}$ , 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

TGE21 COBIA ESR 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.

### TURNING

	Carbide tool		HSS tool
	Rough machining	Finishing	Finishing
Cutting speed m/min	130 - 170	170 - 220	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	210 - 280
Feed mm/r	0.4	0.35 - 0.25	0.10 - 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 - 16	0.05 - 0.15
5 - 10	14 - 16	0.15 - 0.20
10 - 15	14 - 16	0.20 - 0.25
15 - 20	14 - 16	0.25 - 0.30

### DRILLING: CARBIDE DRILL

	Carbide type		
	Indexable insert	Solid carbide	Carbide tip
Cutting speed m/min	160 - 180	100 - 130	55 - 80
Feed mm/t	0.05 - 0.10	0.10 - 0.25	0.15 - 0.25

### FINE GRINDING

General indications for grinding wheels to be used on TGE21 COBIA ESR 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

TGE21 COBIA ESR 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 TGE21 COBIA ESR 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 heat treated state:** tempering at 600°C 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 25mm of thickness. slow cooling in the furnace (*10 to 20°C/h*).



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