

# Thermodur 2329

46CrSiMoV7

C 0.45 Si 0.70 Mn 0.80 Cr 1.80 Mo 0.30 Ni 0.60 V 0.20

## Steel properties

Excellent tempering resistance, high-temperature strength, full quenching and tempering properties, outstanding weldability, nitridable, PVD and CVD coatable, good machinability.

## Applications

Hot-work tool steel for forging dies, pressure disks for extrusion, mould press dies, and many other applications.

## Heat treatment

### Soft annealing °C

780 – 800

### Cooling

Furnace or air

### Hardness HB

max. 230

### Hardening °C

880 – 920

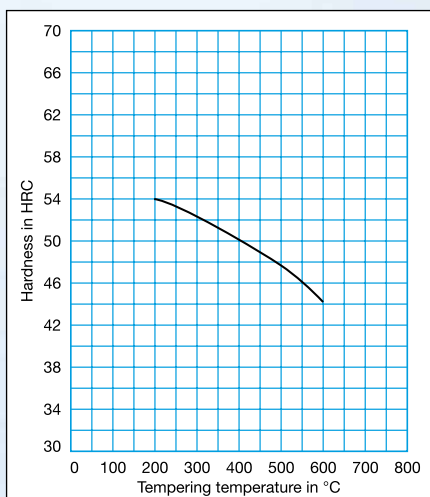
### Quenching

Air, oil or hot bath, 200 – 250 °C

### Hardness after quenching HRC

53 – 55

## Tempering diagram



# Thermodur

# 2342 EFS

X35CrMoV5-1-1

C 0.35 Si 0.80 Cr 5.00 Mo 1.00 V 0.85

### Steel properties

Excellent high-temperature toughness, thermal conductivity, low susceptibility to hot cracking, may be water-cooled to a limited extent.

### Physical properties

#### Coefficient of thermal expansion

at °C	20 – 100	20 – 200	20 – 300	20 – 400	20 – 500	20 – 600	20 – 700
$10^{-6} \text{ m}/(\text{m} \cdot \text{K})$	10.9	11.9	12.3	12.7	13.0	13.3	13.5

#### Thermal conductivity

at °C			
$\text{W}/(\text{m} \cdot \text{K})$	20	350	700
	24.5	26.8	28.8

### Applications

Mandrel bars, pressure casting dies, and extrusion tools.

### Heat treatment

**Soft annealing °C**  
750 – 800

**Cooling**  
Furnace

**Hardness HB**  
max. 230

**Hardening °C**  
1000 – 1040

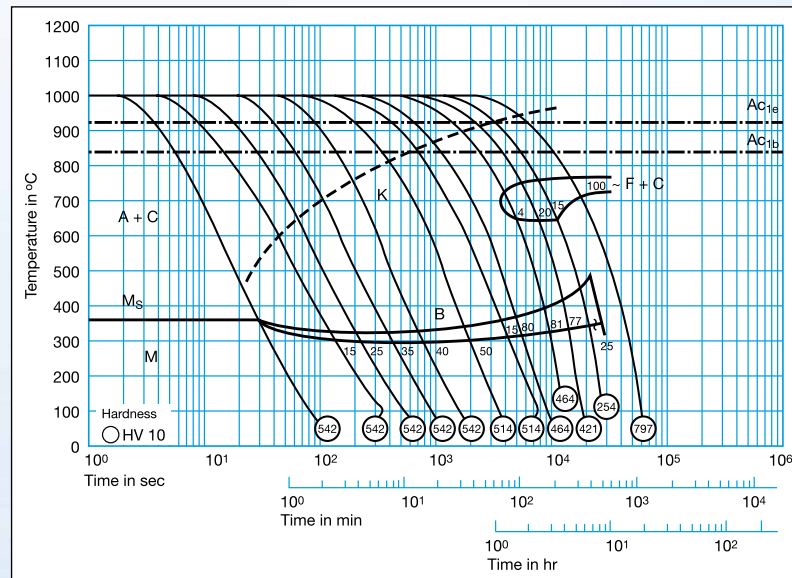
**Quenching**  
Air, oil or  
hot bath, 500 – 550 °C

**Hardness after quenching HRC**  
53

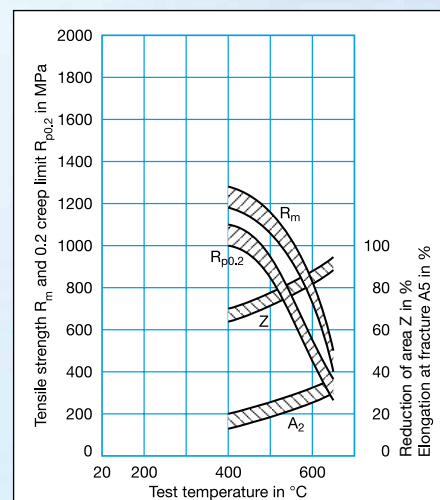
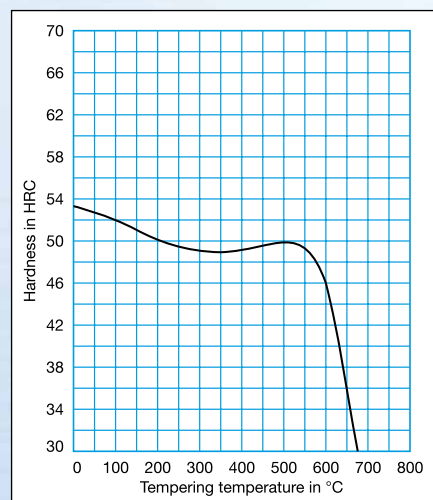
**Tempering °C**  
**HRC**

100	200	300	400	500	550	600	650	700
52	50	49	49	50	49	46	36	26

### Time-temperature-transformation diagram



### Tempering diagram/High-temperature strength diagram



# Thermodur 2343 EFS / 2343 EFS Superclean

X37CrMoV5-1

C 0.38 Si 1.00 Cr 5.30 Mo 1.30 V 0.40

## Steel properties

Outstanding high-temperature strength and toughness. Excellent thermal conductivity and low susceptibility to hot cracking. May be water-cooled to a limited extent.

## Standards

AISI H11 AFNOR Z38CDV5

## Physical properties

**Coefficient of thermal expansion at °C**

20 – 100	20 – 200	20 – 300	20 – 400	20 – 500	20 – 600	20 – 700
10 <sup>-6</sup> m/(m • K)	11.8	12.4	12.6	12.7	12.8	12.9

**Thermal conductivity at °C**

W/(m • K) Annealed	20	350	700
W/(m • K) Quenched and tempered	29.8	30.0	33.4
	26.8	27.3	30.3

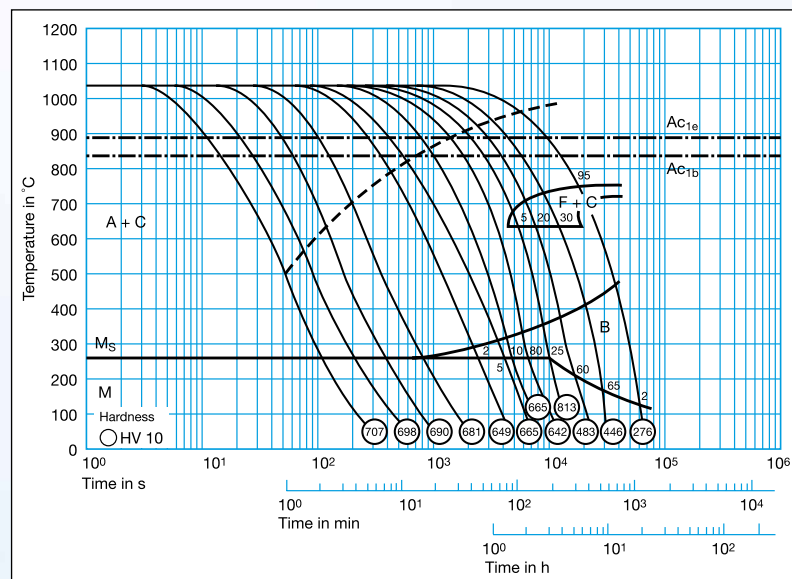
## Applications

Hot-work tool steel for universal use. Mandrel bars, pressure casting dies, and extrusion tools. Pressure casting dies and extrusion tools for light metal processing, forging dies, mandrels, shrink rings, hot-shear blades. **For your most challenging requirements, we recommend Thermodur 2343 EFS Superclean (ESR).**

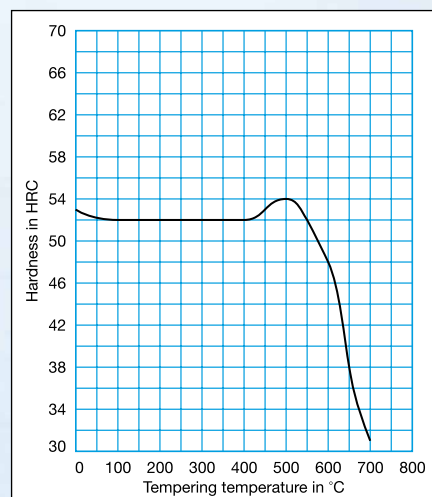
## Heat treatment

<b>Soft annealing °C</b> 750 – 800	<b>Cooling</b> Furnace	<b>Hardness HB</b> max. 230
<b>Hardening °C</b> 1000 – 1030	<b>Quenching</b> Air, oil or hot bath, 500 – 550 °C	<b>Hardness after quenching HRC</b> 54
<b>Tempering °C</b> <b>HRC</b>	100    200    300    400    500    550    600    650    700	52    52    52    52    54    52    48    38    31

## Time-temperature-transformation diagram



## Tempering diagram



# Thermodur 2344 EFS / 2344 EFS Superclean

X40CrMoV5-1

C 0.40 Si 1.00 Cr 5.30 Mo 1.40 V 1.00

## Steel properties

High hot-wear resistance, high hot tensile strength and toughness. Good thermal conductivity and insusceptibility to hot cracking. Can be water-cooled to a limited extent.

## Standards

AISI H13 AFNOR Z40CDV5

## Physical properties

### Coefficient of thermal expansion

at °C	20 – 100	20 – 200	20 – 300	20 – 400	20 – 500	20 – 600	20 – 700
$10^{-6} \text{ m}/(\text{m} \cdot \text{K})$	10.9	11.9	12.3	12.7	13.0	13.3	13.5

### Thermal conductivity

at °C		20	350	700
$\text{W}/(\text{m} \cdot \text{K})$ Annealed		27.2	30.5	33.4
$\text{W}/(\text{m} \cdot \text{K})$ Quenched and tempered		25.5	27.6	30.3

## Applications

Hot-work steel for universal use. Pressure casting moulds and metal extrusion tools for processing light metals, forging moulds, moulds, screws and barrels for plastic processing, nitrided ejectors and hot-shear blades.

**We recommend the use of Thermodur 2344 EFS Superclean (ESR) for the highest demands.**

## Heat treatment

### Soft annealing °C

750 – 800

### Cooling

Furnace

### Hardness HB

max. 230

### Hardening °C

1010 – 1030

### Quenching

Air, oil or saltbath, 500 – 550 °C

### Hardness after quenching HRC

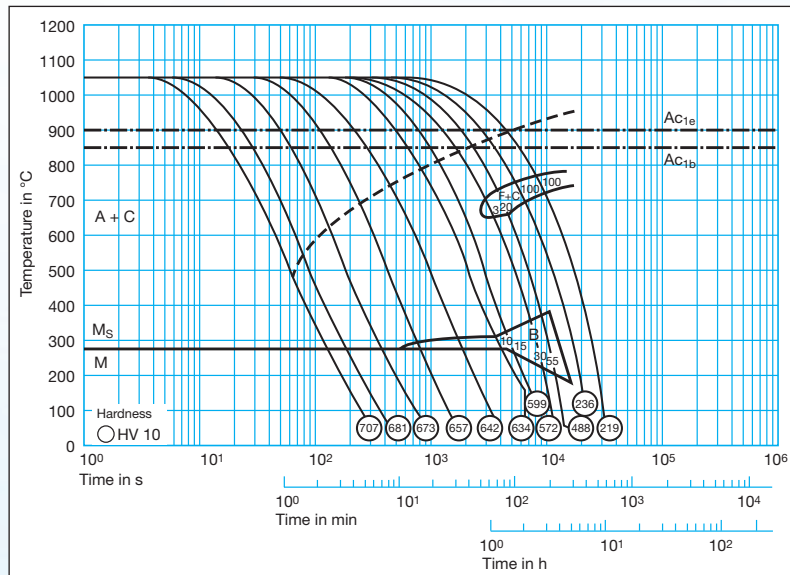
54

### Tempering °C

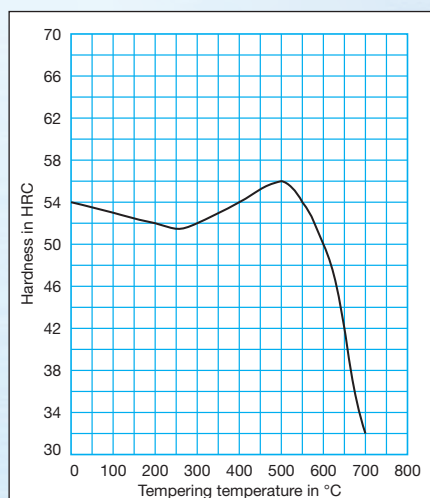
HRC

100	200	300	400	500	550	600	650	700
53	52	52	54	56	54	50	42	32

## Time-temperature-transformation diagram



## Tempering diagram



# Thermodur 2365 EFS / 2365 EFS Superclean

32CrMoV12-28

C 0.32 Cr 3.00 Mo 2.80 V 0.50

## Steel properties

Excellent high-temperature strength and tempering resistance, thermal conductivity, low susceptibility to hot cracking. May be water-cooled to a limited extent. Suitable for cold hobbing.

## Standards

AISI H10 AFNOR 32CDV12-28

## Physical properties

Coefficient of thermal expansion							
at °C	20 – 100	20 – 200	20 – 300	20 – 400	20 – 500	20 – 600	20 – 700
10 <sup>-6</sup> m/(m • K)	11.8	12.5	12.7	13.1	13.5	13.6	13.8

## Thermal conductivity

at °C	20	350	700
W/(m • K) Annealed	32.8	34.5	32.2
W/(m • K) Quenched and tempered	31.4	32.0	29.3

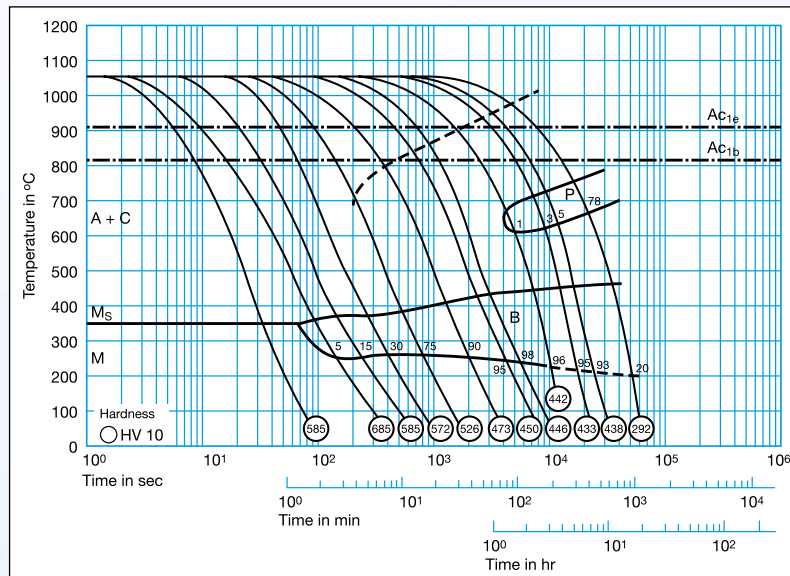
## Applications

Press and piercing mandrels, die inserts, heavy metal die casting tools.  
**For your most challenging requirements, we recommend Thermodur 2365 EFS Superclean (ESR).**

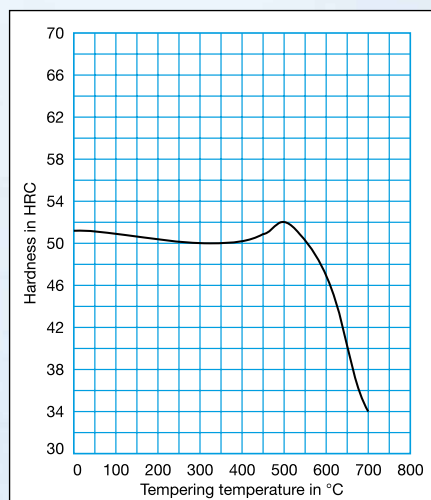
## Heat treatment

Soft annealing °C	Cooling	Hardness HB
750 – 800	Furnace	max. 185
Hardening °C	Quenching	Hardness after quenching HRC
1030 – 1050	Oil or hot bath, 500 – 550 °C	52
Tempering °C		
HRC	100 200 300 400 500 550 600 650 700	51 50 50 50 52 50 47 40 34

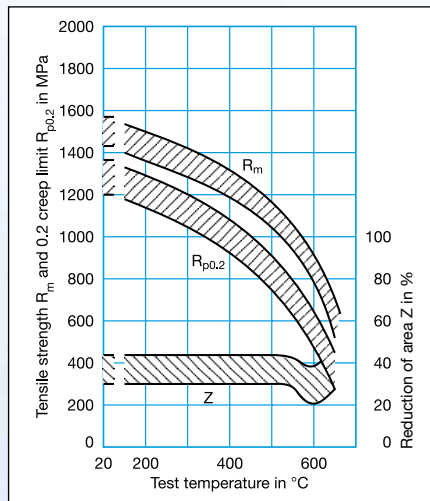
## Time-temperature-transformation diagram



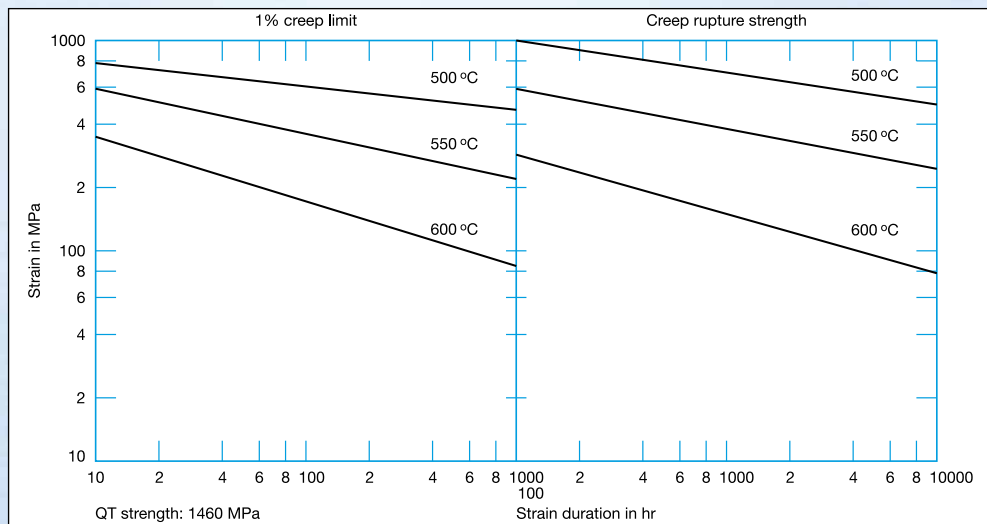
## Tempering diagram



High-temperature strength diagram



Creep behavior



# Thermodur 2367 EFS / 2367 EFS Superclean

~X38CrMoV5-3

C 0.37 Cr 5.00 Mo 3.00 V 0.60

## Steel properties

Excellent high-temperature strength and tempering resistance, good hardenability, minimal warpage.

## Physical properties

### Coefficient of thermal expansion

at °C	20 – 100	20 – 200	20 – 300	20 – 400	20 – 500	20 – 600	20 – 700
$10^{-6} \text{ m}/(\text{m} \cdot \text{K})$	11.9	12.5	12.6	12.8	13.1	13.3	13.5

### Thermal conductivity

at °C	20	350	700
$\text{W}/(\text{m} \cdot \text{K})$ Annealed	30.8	33.5	35.1
$\text{W}/(\text{m} \cdot \text{K})$ Quenched and tempered	29.8	33.9	35.3

## Applications

Forging dies, die casting dies, die holders, extrusion dies for heavy metals, inner liner for light metals, profiling dies, and mandrels.

**For your most challenging requirements, we recommend Thermodur 2367 EFS Superclean (ESR).**

## Heat treatment

**Soft annealing °C**  
730 – 780

**Cooling**  
Furnace

**Hardness HB**  
max. 235

**Hardening °C**  
1020 – 1050

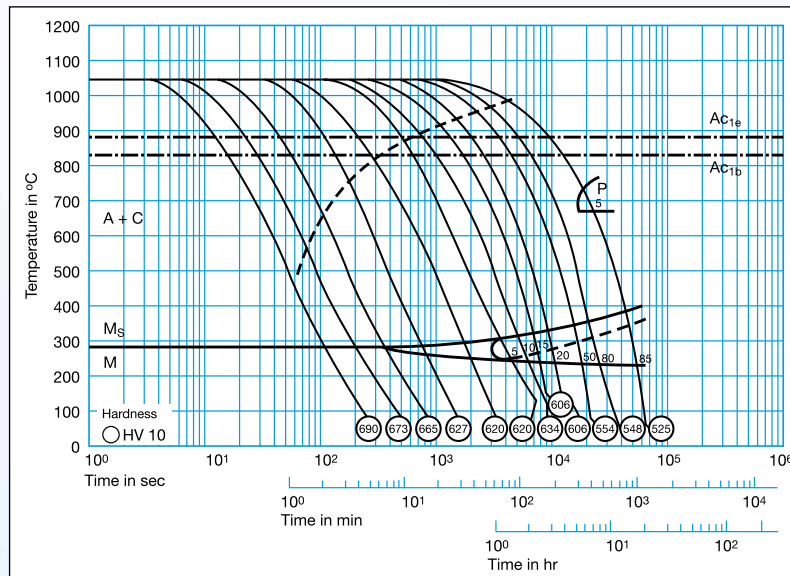
**Quenching**  
Air, oil or  
hot bath, 500 – 550 °C

**Hardness after quenching HRC**  
57

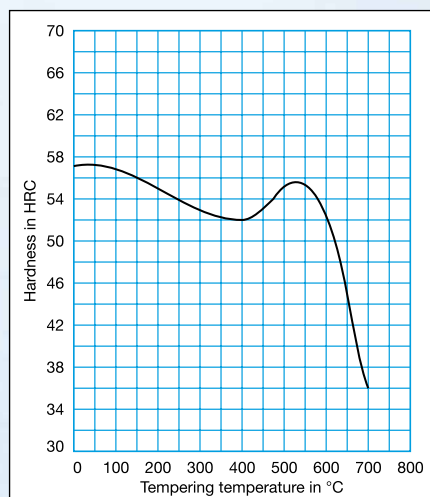
**Tempering °C**  
**HRC**

100	200	300	400	500	550	600	650	700
57	55	53	52	55	55	52	45	36

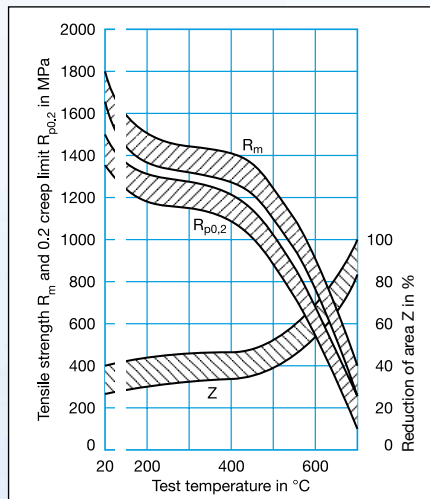
## Time-temperature-transformation diagram



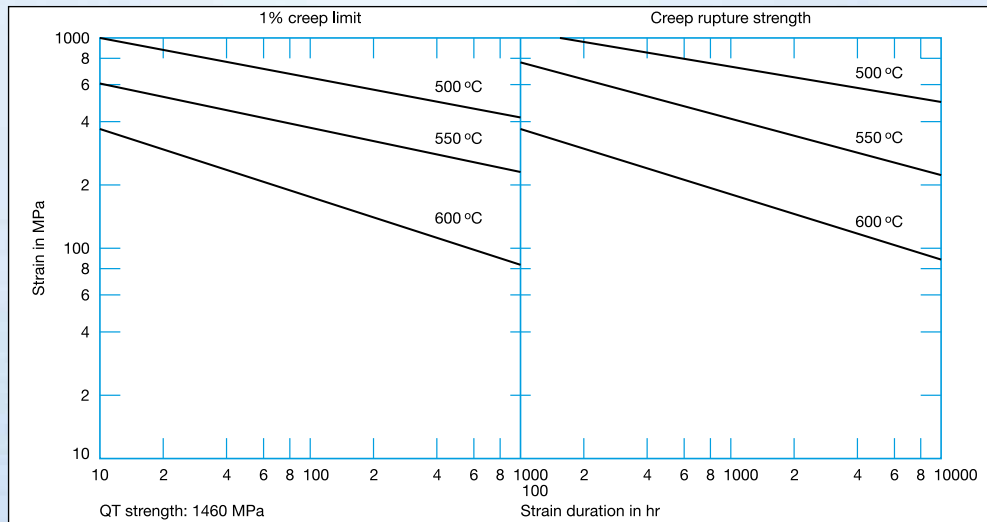
## Tempering diagram



High-temperature strength diagram



Creep behavior



# Thermodur 2714

55NiCrMoV7

C 0.56 Cr 1.10 Mo 0.50 Ni 1.70 V 0.10

## Steel properties

Tough die steel with high tempering resistance and good through-hardening properties. This grade is usually supplied in annealed condition or quenched and tempered to a working hardness of 370 to 410 HB (round) or 355 to 400 HB (square, flat).

## Standards

AISI ~L6 AFNOR 55NCDW7

## Physical properties

**Coefficient of thermal expansion at °C**  
 $10^{-6} \text{ m}/(\text{m} \cdot \text{K})$

20 – 100	20 – 200	20 – 300	20 – 400	20 – 500	20 – 600
12.2	13.0	13.3	13.7	14.2	14.4

**Thermal conductivity at °C**  
 $\text{W}/(\text{m} \cdot \text{K})$

20	350	700
36.0	38.0	35.0

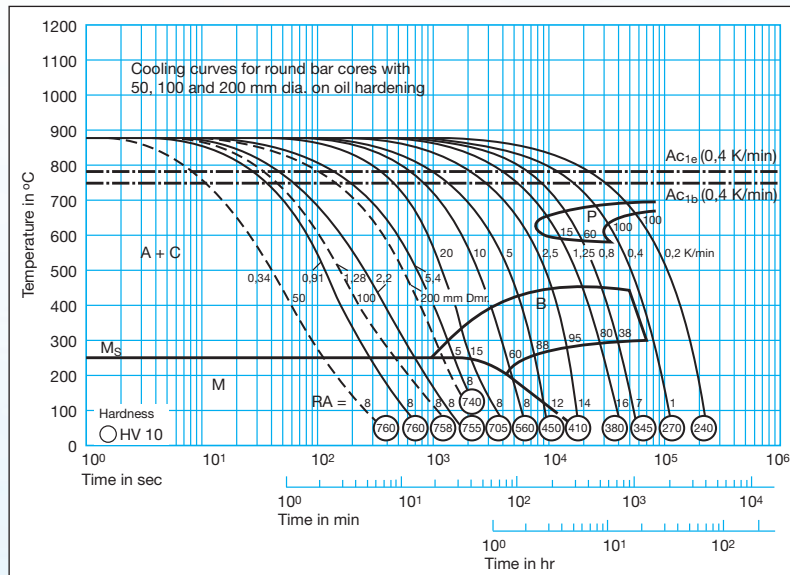
## Applications

Standard steel for forging dies of all types, press dies, extrusion dies, retainer plates, armoured trim dies, hot-shear blades and tool holders.

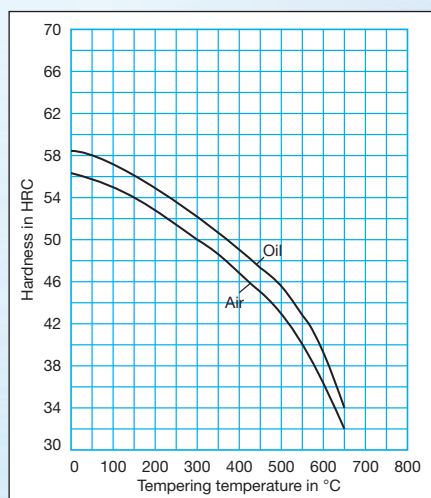
## Heat treatment

Soft annealing °C	Cooling	Hardness HB
650 – 700	Furnace	max. 250
Hardening °C	Quenching	Hardness after quenching HRC
830 – 870	Oil	58
860 – 900	Air	56
Tempering °C after quenching		
<b>in Oil – HRC</b>	100 200 300 400 450 500 550 600 650	
<b>in Air – HRC</b>	57 54 52 49 47 46 43 38 34	
	55 52 50 47 45 43 40 36 32	

## Time-temperature-transformation diagram



## Tempering diagram



# Thermodur 2740

28NiCrMoV10

C 0.28 Cr 0.70 Mo 0.60 Ni 2.50 V 0.30

## Steel properties

Air-hardening special steel for hot working. Outstanding high-temperature toughness and thermal shock resistance.

## Applications

Special steel for mandrels and pilger mandrels. We generally supply the rough-machined or fully machined tools in tempered condition.

## Heat treatment

### Soft annealing °C

670 – 700

### Cooling

Furnace

### Hardness HB

max. 240

### Hardening °C

840 – 870

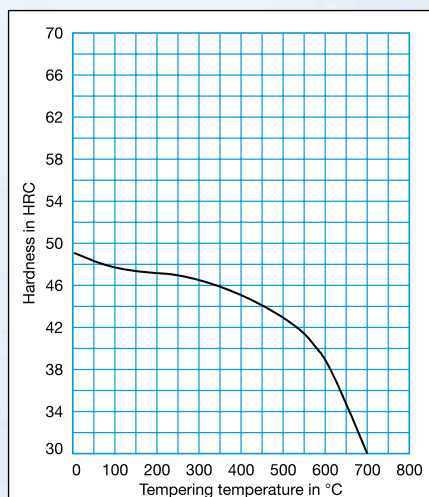
### Quenching

Air or oil

### Hardness after quenching HRC

49

## Tempering diagram



## Thermodur 2782 Superclean

X16CrNiSi25-20

C 0.15 Si 2.00 Mn 0.80 Cr 25.00 Ni 20.00

### Steel properties

Non-scaling, austenitic hot-work tool steel, which is resistant to oxidizing environments and displays good cold workability. Resistant to scaling in air up to approx. 1150 °C. Delivered in precipitation hardened condition 650 – 800 MPa.

### Physical properties

#### Coefficient of thermal expansion

at °C	20 – 200	20 – 400	20 – 600
$10^{-6} \text{ m}/(\text{m} \cdot \text{K})$	16.5	17.0	17.5

#### Thermal conductivity

at °C	20	700
$\text{W}/(\text{m} \cdot \text{K})$	13.0	19.0

### Applications

Tools for glass product manufacturing, such as punches, couplers, blowing iron heads and mandrels, orifices, blowpipes, and gathering irons.

### Heat treatment

**Soft annealing °C**  
1000 – 1100

**Quenching**  
Air or water

**Hardness after quenching MPa**  
495 – 705

# Thermodur 2787 / 2787 Superclean

X23CrNi17

C 0.22 Si 0.40 Mn 0.50 Cr 16.50 Ni 1.70

## Steel properties

Corrosion and scaling resistant hot-work tool steel, which can easily be tempered.

## Physical properties

### Coefficient of thermal expansion

at °C	20 – 100	20 – 200	20 – 300	20 – 400	20 – 500
$10^{-6} \text{ m}/(\text{m} \cdot \text{K})$	10.0	10.5	11.0	11.0	11.0

### Thermal conductivity

at °C	20
$\text{W}/(\text{m} \cdot \text{K})$	25.0

## Applications

Tools for glass product manufacturing

**For your most challenging requirements, we recommend Thermodur 2787 Superclean.**

## Heat treatment

### Soft annealing °C

710 – 750

### Cooling

Ofen

### Hardness HB

max. 245

### Hardening °C

990 – 1020

### Quenching

Oil or  
hot bath, 200 °C

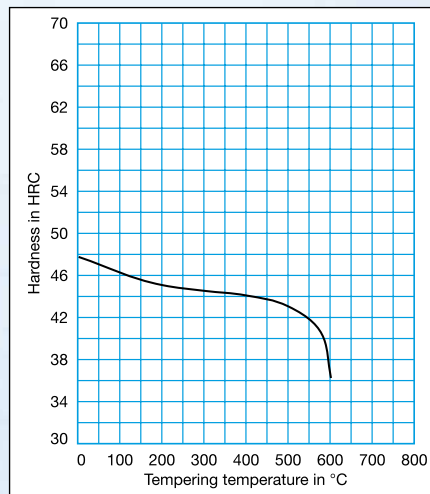
### Hardness after quenching HRC

47

### Tempering °C after quenching in oil – HRC

100	200	300	400	500	600
46	45	45	44	43	36

## Tempering diagram



# Thermodur

# 2999 EFS Superclean

X45MoCrV5-3-1

C 0.45 Si 0.30 Mn 0.30 Cr 3.00 Mo 5.00 V 1.00

### Steel properties

Maximum high-temperature strength, good high-temperature wear resistance, excellent thermal shock resistance and thermal conductivity across the entire range of service temperatures.

### Physical properties

#### Coefficient of thermal expansion

at °C	20 – 100	20 – 200	20 – 300	20 – 400	20 – 500	20 – 600	20 – 700
$10^{-6} \text{ m/(m} \cdot \text{K)}$	11.3	11.9	12.2	12.6	13.0	13.3	13.5

#### Thermal conductivity

at °C	20	350	700
$\text{W/(m} \cdot \text{K)}$ Annealed	37.8	39.5	39.5
$\text{W/(m} \cdot \text{K)}$ Quenched and tempered	31.4	35.2	36.2

### Applications

Die inserts and high-speed forging tools exposed to severe wear stresses, heavy metal die casting, hot-work tool steels for use at highest temperatures.

### Heat treatment

**Soft annealing °C**  
750 – 800

**Cooling**  
Furnace

**Hardness HB**  
max. 230

**Hardening °C**  
1070 – 1100

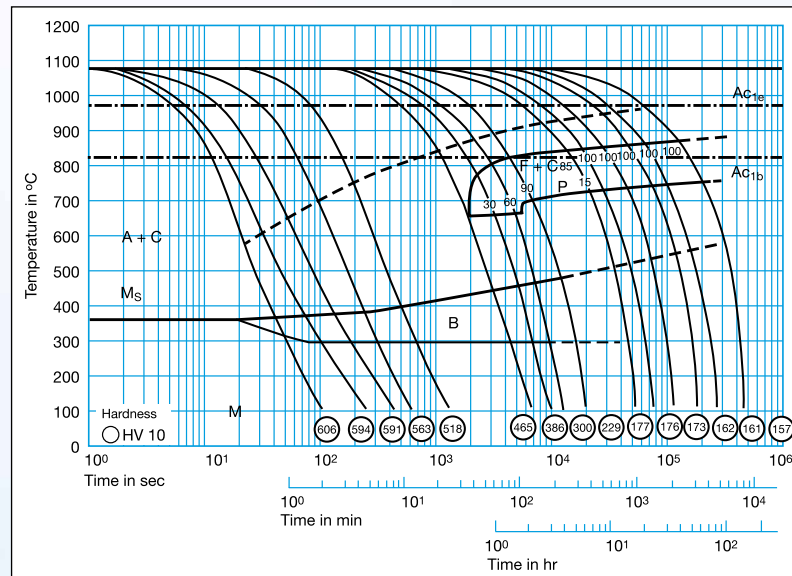
**Quenching**  
Oil or  
hot bath, 500 – 550 °C

**Hardness after quenching HRC**  
57

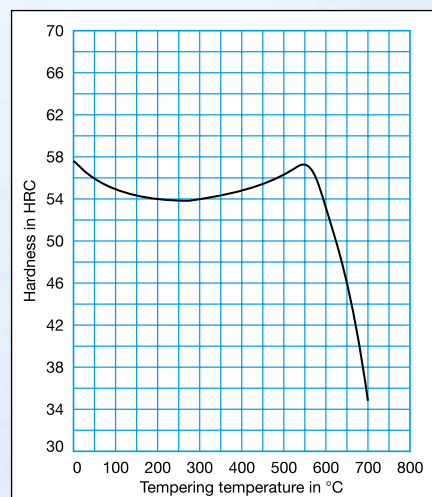
**Tempering °C**  
**HRC**

100	200	300	400	500	550	600	650
55	54	54	55	56	57	53	46

### Time-temperature-transformation diagram



### Tempering diagram



# Thermodur

# E 38 K

approx. X35CrMoV5-1

C 0.35 Si 0.30 Mn 0.30 S < 0.003 Cr 5.00 Mo 1.35 V 0.45

### Steel properties

Outstanding high-temperature strength and improved toughness. Excellent thermal conductivity and low susceptibility to hot cracking. May be water-cooled to a limited extent.

### Physical properties

#### Coefficient of thermal expansion

at °C	20 – 100	20 – 200	20 – 300	20 – 400	20 – 500	20 – 600	20 – 700
$10^{-6} \text{ m/(m} \cdot \text{K)}$	11.8	12,4	12,6	12,7	12,8	12,9	12,9

#### Thermal conductivity

at °C	20	350	700
$\text{W/(m} \cdot \text{K)}$ Annealed	29.8	30.0	33.4
$\text{W/(m} \cdot \text{K)}$ Quenched and tempered	26.8	27.3	30.3

### Applications

Hot-work tool steel for universal use, which is particularly suitable for applications involving high flexural stresses due to its outstanding toughness.

- Extrusion tools for light metal processing
- Die casting tools for light metal processing

### Heat treatment

#### Soft annealing °C

740 – 780

#### Cooling

Furnace

#### Hardness HB

max. 200

#### Hardening °C

1000 – 1030

#### Quenching

Oil or  
hot bath, 500 – 550 °C

#### Hardness after quenching HRC

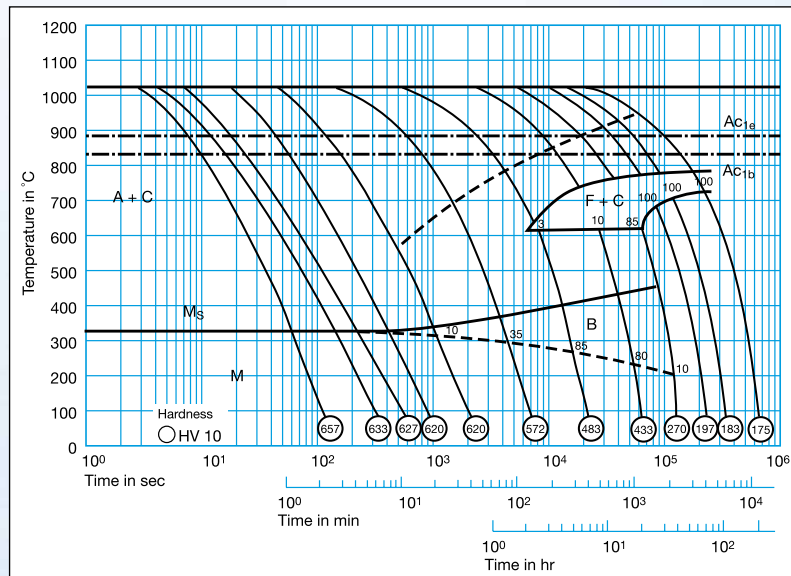
53

#### Tempering °C

HRC

100	200	300	400	500	550	600	650
51	51	51	51	52	50	47	34

### Time-temperature-transformation diagram



### Tempering diagram

