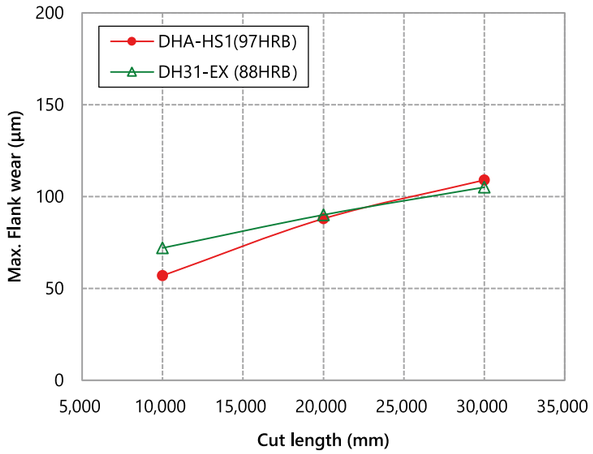
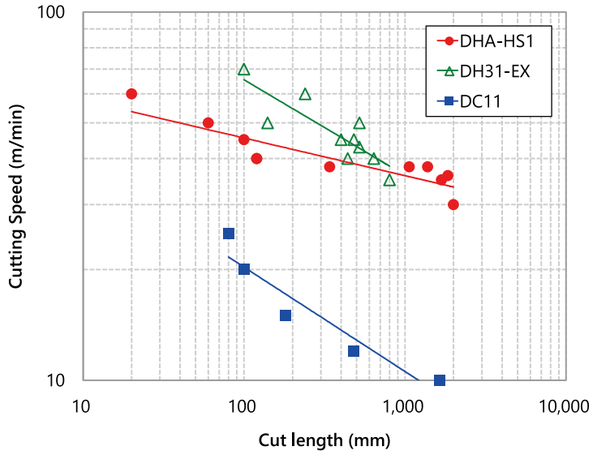
Machinability (Endmilling)

Tool : VP15TF (TiAlN coating)
Speed : 100m/min
Feed : 0.2mm/rev
Depth of cut : 1×4mm
Cooling : Air blow
Milling : Down cut



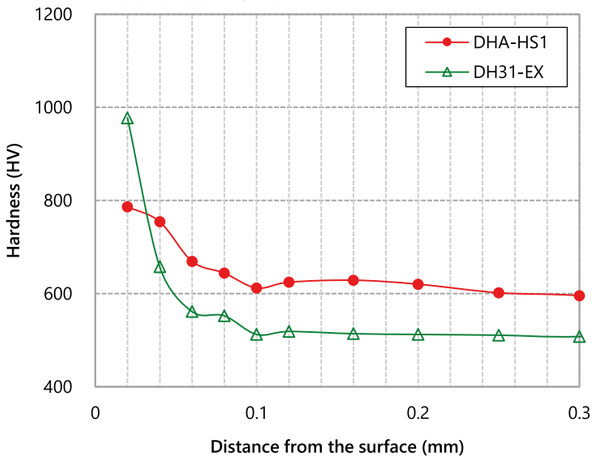
Machinability (drilling)

Tool : SKH51
Shape : Φ5, Straight shank drill
Feed : 0.15mm/rev
Depth of hole : 20mm
Lubricant : Yushiroken EZ30 (5% Soln.)
Criteria : Breakage or corrosion



Nitriding characteristics

Specimen : 10×15×20mm
Quenching : 1030°C×1h, Gas cooling
Tempering : DHA-HS1 560°C×1h, Twice
DH31-EX 600°C×1h, Twice
Nitriding : Daido Die & Mold Steel Solutions Co., Ltd.
Radical nitriding



Physical properties

Quenching : 1030°C×1h, Gas cooling (6bar)
Tempering : 560°C×1h, Twice
Tempered to the hardness : 53HRC

◆Thermal expansion rate

Temp.	20～100°C	20～200°C	20～300°C	20～400°C	20～500°C	20～600°C
×10^{-6}/K	10.8	11.9	12.6	13.2	13.7	14.2

◆Thermal conductivity

Temp.	25°C	100°C	200°C	300°C	400°C	500°C	600°C
W/m・K	36.3	40.5	40.6	39.0	38.6	36.1	35.1

※Accuracy of repeated measurements is about ±10%.

◆Specific heat

Temp.	25°C	100°C	200°C	300°C	400°C	500°C	600°C
J/kg・K	495	561	599	626	692	757	854

◆Young's modulus / Rigidity modulus / Poisson's ratio (25°C)

Young's modulus	Rigidity modulus	Poisson's ratio
208 Gpa	82 GPa	0.27

DAIDO STEEL

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www.daido.co.jp

No.SC2002a 22.02.0,0(DDD)

Daido's Hot Work Die Steel Series

DHA-HS1™

High thermal conductivity, High softening resistance Hot Stamping Die Steel

Features

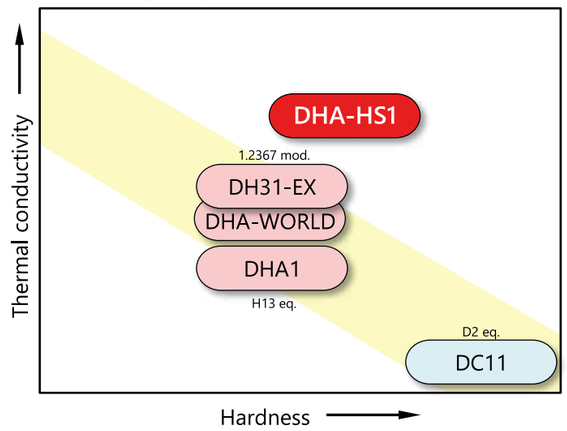
DHA-HS1 is "Hot stamping die steel", which offers high thermal conductivity as well as excellent abrasion resistance at high temperatures. It contributes to increasing productivity and improving die life.

◆**High thermal conductivity** : With high thermal conductivity of approx. **36(W/m·K)** at room temperature, DHA-HS1 helps reducing cooling time of dies and steel sheets.

◆**High hardness** : Practical hardness of up to **54 HRC** can be obtained at a wide range of tempering temperatures. Surface treatment can also be applied.

◆**High softening resistance** : DHA-HS1 retains high hardness at elevated temperatures when in contact with hot steel sheets.

Positioning diagram



Heat treatment

Re-forging Temperature (°C)	Heat treatment (°C)			Hardness		Transformation Temp. (°C)	
	Annealing	Quenching	Tempering	Annealed	Quenched & Tempered	Ac	Ms
900～1200	820～870 Slow cooling + 650～700 Air cooling	1000～1030 **Vacuum (≧6bar)**	**550～670** Air cooling	≦235HBW	45～54 HRC	725～790	230 (Austenitized at 1030°C)

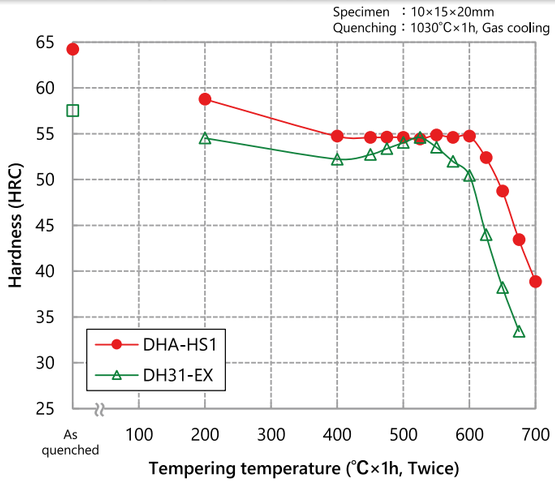
◇Notice ・Please be careful of quenching crack on the cooling.
・Due to a limitation in hardenability, DHA-HS1 is best suited for rough machined dies lighter than 80 kg. Please ask for our advice if you plan to heat treat dies heavier than 80 kg in order to avoid unexpected trouble.

DAIDO STEEL

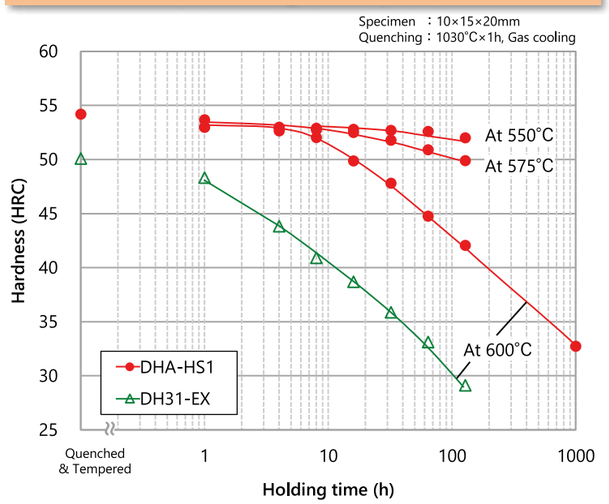
Properties

Material size : 320mm×490mm

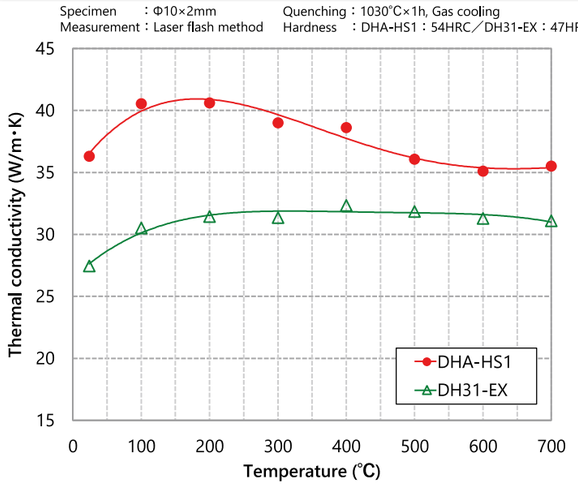
Tempering hardness curves



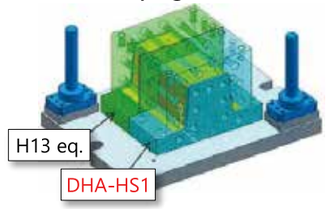
Softening resistance



Thermal conductivity and Hot stamping test results

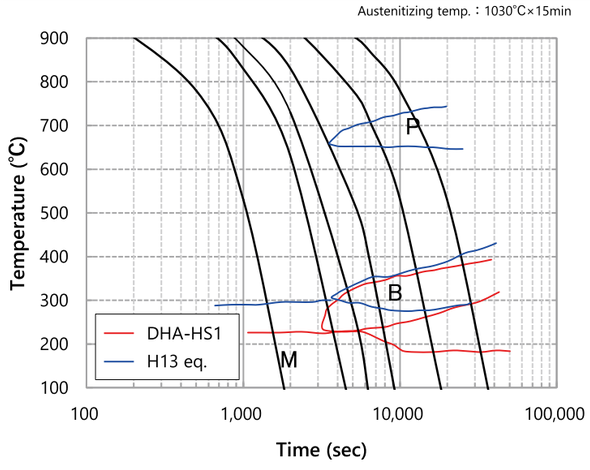


◆Test die and Hot stamping test method

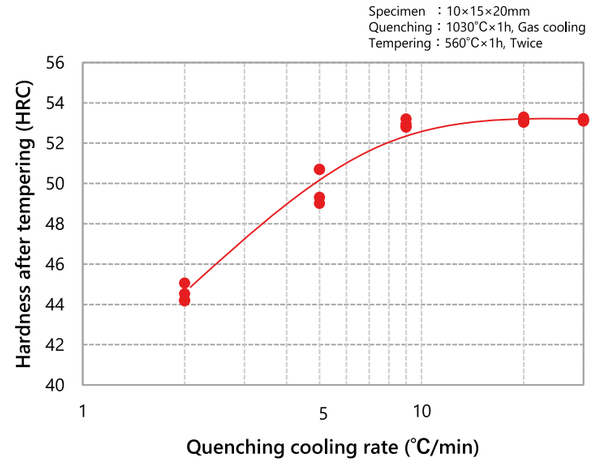


Press conditions	Cycle time	3.0spm
	Holding time at the bottom dead center	6.0sec
Steel sheet temperature at the start of pressing		approx. 850℃
Cooling conditions	Coolant temperature	approx. 18℃
	Location of water line	approx. 10mm from the die surface
Evaluation	Thermocouple position	lower die : approx. 5mm from the die surface

CCT diagram

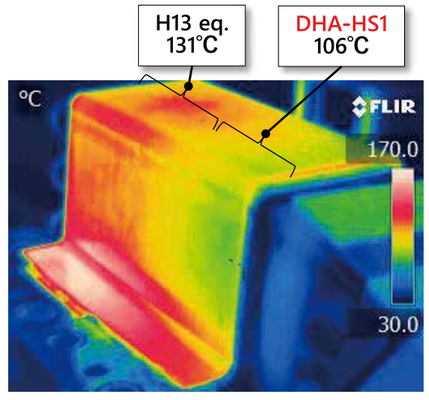


Relation between Quenching cooling rate and Hardness after tempering



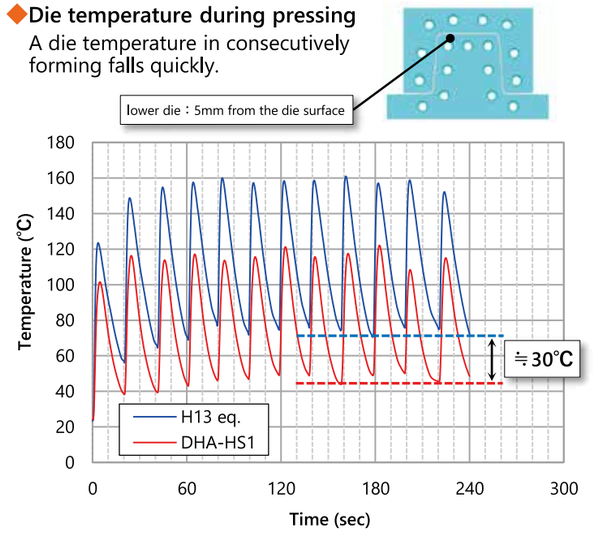
◆Sheet surface temperature immediately after opening die

A steel sheet cooling rates increase in quenching.



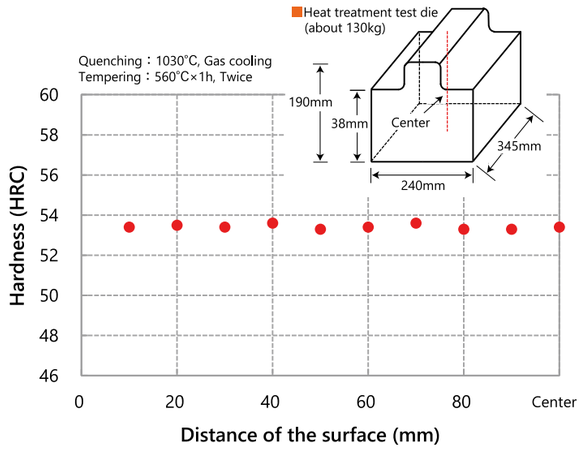
◆Die temperature during pressing

A die temperature in consecutively forming falls quickly.

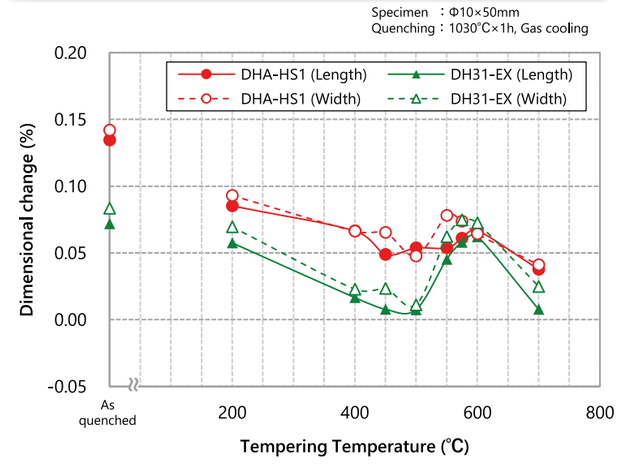


Hardness distribution

Hardness can be secured up to the center.



Dimensional change



Mechanical properties at R.T.

Quenching：1030℃×1h, Gas cooling
Tempering：560℃×1h, Twice

Hardness (HRC)	53
Tensile strength (MPa) Specimen：Φ8×90mm	1,973
0.2% Yield strength (MPa)	1,787
Charpy Impact values (J/cm^2) Specimen：10×10×55mm, 2mmU Notched	17
Fracture toughness (MPa･m$^{1/2}$) Specimen：2×2×0.5 in, Length of Notch=22.8mm	35

Fatigue properties

Parallel parts：Φ5 circular taper
Method ：Tensile pulsating load
Stress mode ：Sine wave
Frequency ：5Hz
Stress ratio ：0.1
Temperature：RT
Specimen ：Φ18×90mm
Quenching：1030℃, Gas cooling