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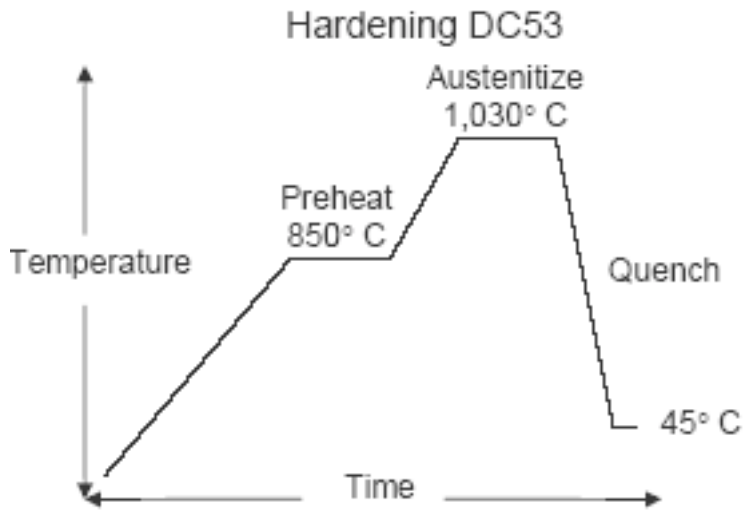
DC53® Advanced Cold Work Die Steel Heat Treatment Recommendations

Heat Treat:

DC53 Heat Treat – DC53 is only as good as the heat treatment it receives. The heat treat process can be broken down into two segments, Hardening & Tempering. DC53 is typically air hardened using a vacuum furnace however it can also be processed by using a gas or electric furnace with or without a controlled atmosphere when wrapped in stainless foil or salt bath hardened by immersing the part in high temperature salts.



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Air Hardening – Air hardening DC53 is best accomplished under vacuum. First, preheat and hold at 800° C (1,475° F) to 850° C (1,560° F) until the part is uniformly heated and then increase the heat to 1,030° C (1,885° F) to Austenitize, otherwise known as soaking the tool. Austenitize 25 to 30 minutes per inch at temperature (to be safe, minimum austenitize time for smaller parts under 1 inch can be up to 1 hour) up to 4 inches thick in cross section and 10 to 25 minutes per inch for thickness over 4 inches before inert gas pressure quenching (Generally in nitrogen), to rapid cool with 2 times atmosphere pressure (2 bar) or high velocity equivalent. To be safe, longer times are acceptable while shorter times are not.

Quench rates using 3 bar pressure or higher are not recommended due to the potential for distorting and the higher stress involved. The quenching phase converts the majority of the tool steel from the austenitic state to an un-tempered martensite condition. The part should then be immediately tempered once it has reached 45° C (120° F). Be sure to check hardness at this point to assure that the part has reached the desirable hardness if at least 64 HRC.

Thickness Inch (mm)	Austenitize Time (Minutes)
Up to 1" (25 mm)	45 minutes minimum time
1" to 4" (25 mm to 100 mm)	25 minutes/inch thickness minimum time
4" to 6" (100 mm to 150 mm)	20 minutes/inch thickness minimum time
6" to 8" (150 mm to 200 mm)	15 minutes/inch thickness minimum time
Over 8" (200 mm)	10 minutes/inch thickness minimum time

Note: Smaller parts require a longer the soak time per inch than large parts.

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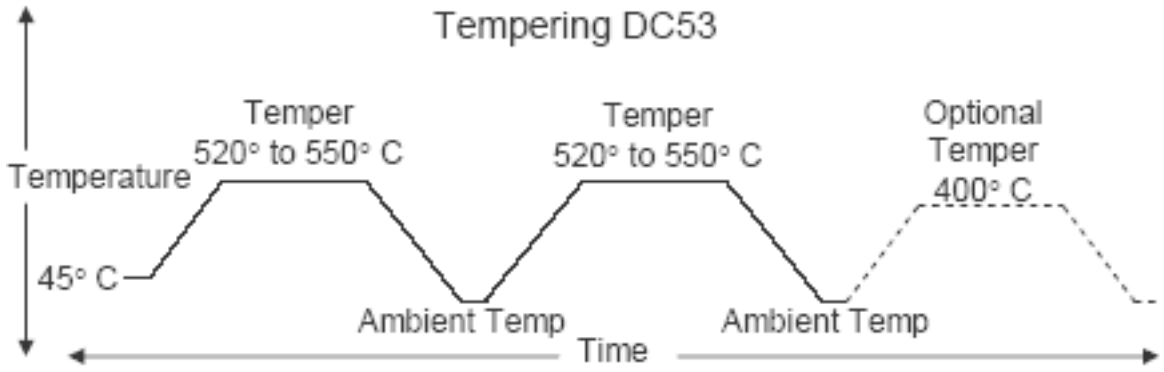
Austenitize	Double High Temperature Draw	
1,030° C 1,885° F	520° C 968° F	HRC 62/64
	540° C 1,004° F	HRC 60/62
	550° C 1,022 F	HRC 58/60



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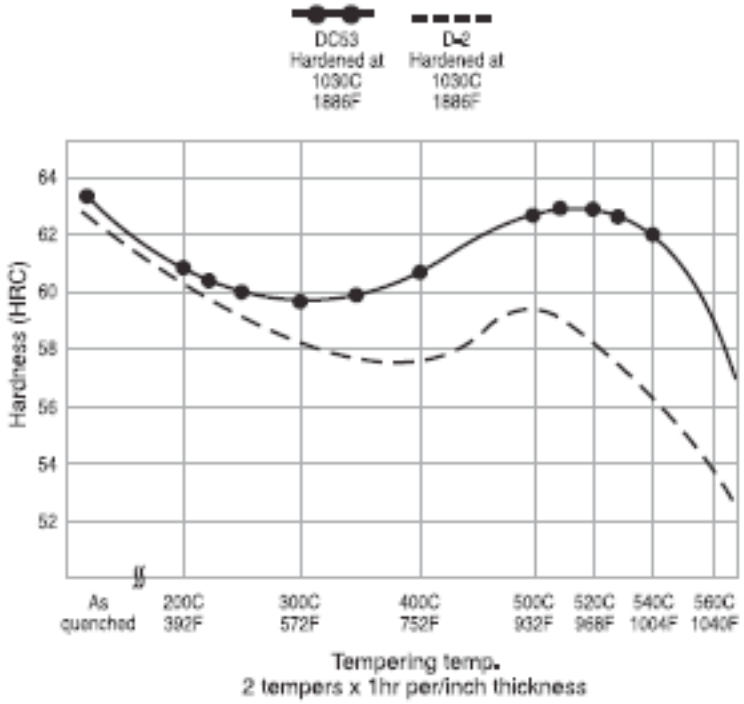
Tempering Hardness Curve



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Material growth .10% to .15% (.001” to .0015” per inch).
An optional third temper recommended for intricate high precision components requiring EDM work or PVD coatings.

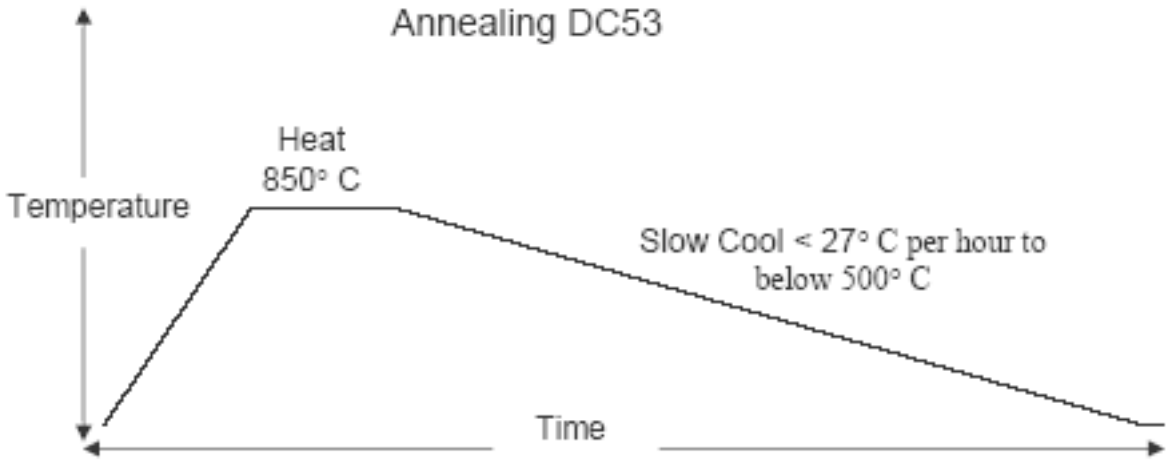
Tempering – Tempering is commonly performed in a non-atmosphere controlled convection furnace. The first temper should be conducted as soon as the part can be handled at about 45° C (120° F) to 65° C to (150° F). The part should be allowed to cool to ambient temperature between subsequent tempers.

To achieve HRC 60-62, temper DC53 twice at 540° C (1,005° F) for 60 to 90 minutes per inch in thickness in cross section. The minimum tempering time is 90 minutes. Temper twice at 520° C (970° F) for the same amount of time to achieve HRC 62-64. A hardness les than HRC 60 is not generally recommended for most punch and die components due to insufficient compressive strength typically needed for stamping applications. Applications requiring additional toughness can be double tempered at 550° C (1,020° F) to achieve HRC 58-60.

If size change or distortion of hardened DC53 due machining, grinding, applying surface treatments or wire EDM work is a concern in high precision applications, an optional third temper of 400° C (750° F) can be applied to the initial heat treat process. This final tempering temperature is high enough to temper the remaining un-tempered martensite, but not high enough to convert additional retained austenite resulting in a more stable

structure. The third temper is typically not necessary if the tool has been hardened using the salt bath process.

Inspection - Conducting a hardness test after the heat treat process is complete is just one method used to measure the quality of heat treat. For additional quality assurance, it is also recommended that a precise dimensional measurement be taken from a given feature both before and after the entire heat treat



process to assure that the proper amount of growth has taken place. Properly heat treated DC53 can be expected to grow approximately .1% to .1 ½% (.001" to .0015" per inch) of its original size before hardening. Shrinkage of the tooling can be a sign of problems in the hardening and or tempering process and is generally attributed to excessive amounts of retained austenite.

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Vacuum Tempering – As when tempering most tool steels, vacuum tempering is a more difficult process to control than convection tempering and fluctuations in hardness results are to be expected. It should only be used when absolutely necessary and ideally be limited to smaller parts with a simple geometry.

Cryogenics - Freezing at 185° C (-300° F) between the first and second temper may also be beneficial to toughness however, specific data is not readily available. It is important to note that cryogenics should always be followed by a temper.

Forging – For special applications, DC53 can also be forged into many shapes. The temperature for forging is between 900° C (1,650° F) and 1,100° C (2,010° F). Annealing after forging in highly recommended to minimize stress in the part and assuring optimum heat treat response.

Annealing - DC53 can be annealed by uniformly heating the part to 800° C (1,475° F) to 850° C (1,550° F), and holding for 2 hours followed by a slow cooling at no more than 27° C (50° F) degrees per hour to until the it has dropped below 500° C (930° F). The part can then be removed from the furnace and allowed to continue to cool in still air to room temperature. If decarburization is a concern, annealing vacuum is recommended. In order to minimize size change, the pre-coating and post heat treat will need to be as similar as possible.

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