

H13 Quenching Cooling Rates and Quench Media

Cooling rates measured in H13 blocks and in die casting dies quenched with nitrogen, argon and helium in vacuum furnaces at 2 to 20 bar, set beside the average convective heat transfer coefficient of each quench medium. A reference summary of published practice and not an Aobo Steel specification.

Reference only. The cooling rates, the quench pressures and the heat transfer coefficients are reproduced from the source named at the foot of this sheet. They are a published reference rather than a recommendation of ours, and the sheet carries no tolerances. Read them against the furnace, the gas circuit and the section thickness of your own dies before a heat treatment cycle is set on them.

Average convective heat transfer coefficient by quench procedure

Source, average convective heat transfer coefficient determined for various quench procedures, Table I, printed page 2-4 of the report (PDF page 21).

Quench procedure	Average convective heat transfer coefficient, H (Btu/hr-ft ² -°F)
Vacuum at 100 °F	3.6
Nitrogen at 100 °F, 2 atm. and 3,400 ft/min.	13.9
Helium at 100 °F, 2 atm. and 3,400 ft/min.	19.2
Low speed oil at 100 °F	47.1
Fluidized alumina at 100 °F	61.7
High speed rape/paraffin oil at 100 °F	104.5
Salt at 750 °F	105.9
Salt at 575 °F	122.2
30% UCON A solution at 100 °F	159.2
10% UCON A solution at 100 °F	293.3

H is in Btu per hour per square foot per degree Fahrenheit. The salt entries are quoted at bath temperature and the remainder at 100 °F. The vacuum figure is radiation alone, which is the reason a vacuum furnace needs gas pressure and nozzle velocity before it can approach a salt bath. A coefficient describes the medium and the surface, not the part, so it cannot be read as the cooling rate of a die block. A reference table only, it is not an Aobo Steel recommendation.

Surface and core cooling rates by furnace, pressure and medium

Source, summary of quenching experiments, Table 7.1, printed page 7-36 of the report (PDF page 221).

Part	Heat treater	Furnace	Quench pressure	Quench medium	Surface cooling rate (°F/min)	Core cooling rate (°F/min)
Block #1	Universal HT	Abar-Ipsen	2 bar	Nitrogen	39	30
Die #2	Universal HT	Abar-Ipsen	2 bar	Nitrogen	37	26.2
Die #3	IMP, London	Abar-Ipsen	4 bar	Argon	37.5	28.6
Die #4	FPM, Chicago	Abar-Ipsen	5 bar	Nitrogen	48	36
Die #5	FPM, Chicago	VFS	7.5 bar	Nitrogen	52	40
Block #2	FPM, Chicago	VFS	10 bar	Nitrogen	43	34
Block #3	FPM, Chicago	VFS	10 bar	Nitrogen	42	33
Block #5	Kowalski HT	Seco-Warwick	20 bar	Nitrogen + helium	126	62
Block #6	Euclid HT	Oil	oil	Oil	120	N/A

Cooling rates are in degrees Fahrenheit per minute, at the surface of the part and at its core. Reports of this work average the cooling rate over the 1750 to 550 °F interval, the range in which H13 transforms, and the table above does not repeat that interval. The source prints N/A where no core value was obtained, and the oil quench was run as a baseline for both cooling rate and distortion. A reference table only, it is not an Aobo Steel recommendation.

Aobo Steel, tool steel supplier

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Reference data compiled from Improved Life of Die Casting Dies of H13 Steel by Attaining Improved Mechanical Properties and Distortion Control During Heat Treatment (J. F. Wallace and D. Schwam, US Department of Energy final report DOE/ID/13320-3, October 1998). The quench medium table is printed on page 2-4 and the quenching experiment table on page 7-36 of that report. Both were read from the page images and not from an automatic text layer.

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