

Thermal Fatigue Cracking in Die Casting Dies

Thermal fatigue cracking is the most common way an aluminium die casting die ends its life. The tables below give the temperature, the cracking and the hardness measured at four melt contact times in premium grade H13, which is the data behind the heat checking a production die develops.

Reference only. This is a reference summary of a published study and it is not a specification of ours. The values are reproduced from the source, which tested one grade, one specimen shape and one set of casting conditions. What a particular die reaches depends on the die design, the alloy, the cycle and the cooling circuit. Final design is confirmed on the job.

The four ways a die fails

How the stress is built and released in each cycle

Longer contact with the melt raises the temperature and the damage

Item	5 sec	7 sec	9 sec	12 sec
Maximum temperature, F	926	991	1087	1147
Minimum temperature, F	322	346	399	460
Total crack area, x 10 ⁶ µm ² , after 15,000 cycles	1.97	5.9	108.56	167.72
Average maximum crack length, x 100 µm, after 15,000 cycles	2.25	3	12.5	15.25
Hardness at the average maximum crack length, HRC	36.9	33.8	31.6	29.2

The effect of immersion time on the temperature at the corner of a premium H13 specimen and on the cracking measured after 15,000 cycles. Immersion time is the only variable, and the cooling line was 1.5 in in every case.

Hardness falls from the corner inward

Distance from the corner, in	5 sec	7 sec	9 sec	12 sec
0.01	36.9	33.8	24.5	24.3
0.02	39.4	36.5	27.4	25.1
0.04	42.4	39.1	31.2	27.7
0.06	43.3	42.4	32.3	29.2
0.08	44.1	44.2	34.5	29.2
0.1	44.3	44.3	36.2	30
0.2	44.4	44.5	40.9	34.1

Hardness in HRC measured from the corner inward on the four specimens after 15,000 cycles. The greater the immersion time, the deeper and softer the softened band.

Estimating the stress at the corner

What this means on the job

Aobo Steel, tool steel supplier

Aobo Steel supplies tool steel to distributors and mold, tool and die shops, including D2, D3, DC53, A2, O1, H13, H11, H10, H21, S7, M2, M42, L6, P20 and 420 and 440C stainless. Forged or hot rolled, annealed or pre-hardened, cut to your sizes, with test certificates.

Source, Effect of Design Factors on Thermal Fatigue Cracking of Die Casting Dies, D. Schwam, J. F. Wallace and S. Birceanu, Case Western Reserve University, final technical report to the U.S. Department of Energy, Award No. DE-FC07-00ID138486, October 2004.

CONTACT

EMAIL

sales@aobosteel.com

WHATSAPP

+86 180 6294 5370

WEB

aobosteel.com



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