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Refractory Metal Inserts and Cores for Die Casting

Tungsten base and molybdenum base alloys conduct heat several times faster than steel and expand at about half the rate, which is what gives them their resistance to thermal fatigue, soldering and erosion. The tables below give the composition of both families and how they stand against the H13 hot work steel they replace.

Reference only. This is a reference summary of a published source and it is not a specification of ours. The values are reproduced from the source, which gives them as nominal analyses and property values for named commercial materials. What a particular die or machine reaches depends on the design, the alloy being cast and the cycle. Final specification is confirmed on the job.

Why a refractory metal comes up at all

The tungsten base alloys

Element	Matthey 4000	Matthey 4100
Tungsten	90.0	86.0
Nickel	4.0	6.7
Iron	2.0	3.3
Molybdenum	4.0	4.0

Nominal composition of the two tungsten base high density composites, in weight percent. The lower tungsten content of the 4100 alloy confers additional ductility.

The molybdenum base alloys

Element	TZM	Mo 0.5 Ti
Titanium	0.50	0.50
Carbon	0.015	0.020
Zirconium	0.08	Not specified
Molybdenum	Balance	Balance

Nominal composition of the two molybdenum base alloys, in weight percent. Both contain over 99 percent molybdenum, and in both the balance of the analysis is molybdenum.

The two families against H13

Material	Thermal conductivity	Thermal expansion	Strength at 650 C	Heat treatment	Typical use
Tungsten base alloys, Matthey 4000 and 4100	About four times that of steel	Less than half that of steel	Comparable with H13, and stronger above	None needed	Cores and complete inserts, up to brass and ferrous die casting
Molybdenum alloys, TZM and Mo 0.5 Ti	About eight times that of steel at 650 C and about four times at 1000 C	About half that of H13	Superior to H13	None needed	Cores and inserts for the higher melting point casting alloys
H13 hot work steel	Reference	Reference	Reference	Hardening and tempering	The standard die insert and core material

Refractory metal die materials compared with H13 hot work steel. The conductivity and expansion columns are relative, as published in the source.

What to watch when you fit them

The nickel base family that works elsewhere but not here

Where to go next

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, Die Casting Metallurgy, A. Kaye and A. Street, Butterworths Monographs in Materials, 1982.

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