

Choosing a Protective Atmosphere for Tool Steel Heat Treatment

Four gas mixtures do the work of protecting tool steel in the furnace, and the alloy content of the grade decides which of them is allowed. The tables below give the composition, dew point, cost, hazard and furnace demands of each atmosphere, what each one is used for, and the chromium and manganese thresholds that pick the atmosphere.

Reference only. This is a reference summary of published practice and it is not a specification of ours. The values are reproduced from the source tables, and what a particular furnace produces depends on the pumping system, the leak rate and the cycle. Final selection is confirmed on the job.

The four principal protective atmospheres

Type and symbol of atmosphere	CO, %	CO ₂ , %	H ₂ , %	N ₂ , %	Dew point, °C
Prepared nitrogen, mono, NX	1 to 5	0.1	1 to 5	remainder	-30
Exo (rich), DX	4 to 12	4 to 8	4 to 15	remainder	-10 to +20
Endo, RX	15 to 25	0.5	30 to 60	remainder	-15 to +5
Dissociated ammonia, AX	0	0	75	25	-30

Composition and dew point of the four principal protective atmospheres. The prepared nitrogen base and dissociated ammonia are the two driest of the four, and endogas carries the most hydrogen and the most carbon monoxide. Dew point is the temperature at which the gas is saturated with water vapour, so a lower figure means a drier gas.

What each atmosphere is used for

Type and symbol	Base fuel	Field of application
Exothermic, DX	propane, butane, oil, natural gas	bright annealing of ferrous metals in the rich grade and of non-ferrous metals in the lean grade; decarburising of dynamo and transformer sheets; brazing; sintering
Endothermic, RX	propane, butane, natural gas	carburising; annealing, hardening, common sintering, and the sintering of hard materials without decarburisation
Prepared nitrogen base, monogas, NX	propane, butane, natural gas, oil	annealing of black-heart malleable cast iron; annealing without decarburisation; low temperature annealing; furnace purging
Ammonia-base, AX	ammonia, cracked in the generator	annealing and brazing of alloy steels that contain chromium, aluminium or silicon

Fields of application of the four principal atmospheres. The list is the source's own and is not restricted to tool steel. Note where the atmosphere is named as suitable for alloy steels containing chromium, aluminium or silicon, and where it is named for carburising.

What each atmosphere costs and what it demands of the furnace

Type of atmosphere	Cost per Nm ³ , GBP
Exo-base	0.0125 to 0.02
Mono-base, prepared nitrogen	0.0275 to 0.0325
Endo-base	0.0375 to 0.0400
Dissociated ammonia	0.125
Purified hydrogen	2.5
Purified nitrogen	0.5 to 0.875
Methanol-base	0.125
Argon	45

Relative costs of producing the atmospheres, in pounds per normal cubic metre. The figures are the source's 1984 cost basis and are reproduced to show the ranking between the gases rather than as current prices.

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Type of atmosphere	Explosion hazard	Toxic effect	Furnace gas tightness required
Exo-base	low	moderate	small
Mono-base, N2	low	small	high
Endo-base	high	high	average
Dissociated ammonia	high	none	average

Main characteristics of the principal atmospheres. Read across a row for one atmosphere and down a column for one property. The nitrogen base atmosphere is the safest of the four to handle and the endothermic atmosphere the most demanding.

Bright, reducing, scale-free and low-scale annealing

Choosing the atmosphere from the composition of the steel

Where this leaves a tool steel order

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, Controlled Atmospheres for Heat Treatment, R. Nemenyi and G. H. J. Bennett, Pergamon Press, 1984.

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