A. Finkl & Sons Co.

DC-Xtra

H13 Premium Quality for Die Casting Service

Vacuum Arc Remelted (VAR)

Nominal DC-Xtra Alloy Composition (Wt. %)

0.40%	CARBON
0.35%	MANGANESE
1.00%	SILICON
5.25%	CHROMIUM
1.50%	MOLYBDENUM
1.00%	VANADIUM

DC-Xtra (H13 Premium Quality)

Approximate chemistry equivalents: EN 1.2344, DIN X40CrMoV5-1, SKD 61, US AISI/SAE H13

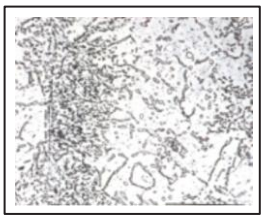
Chemistry

Successfully employed in a wide range of tooling applications, H13 was developed primarily as hot-working die steel for the forging industry. The high content of Chromium, Molybdenum and Vanadium provides a carbide-dense microstructure with exceptional resistance to abrasive wear.

These same alloys also provide strong temper resistance during the brief but frequent high temperature excursions common to either forging or die casting service.

Metallurgy

The high carbide content of H13 alloy is prone to developing a coarse network of carbides that can adversely affect the fracture toughness of the steel.



This tendency can be largely overcome by employing special metallurgical procedures during forging and heat treating.

Finkl Metallurgical Control

Standards developed by the die casting industry have identified key components required for high-quality steel optimized for die-casting service.

- **Excellent Microcleanliness:** The Finkl patented Double-Vacuum Process combines VAD and VAR steelmaking to meet NADCA Superior Grade quality requirement.
- **Superior Microstructure:** Powerful 8,000 ton forging press optimizes forged integrity and fine-grain microstructure.
- **Alloy Uniformity:** Double vacuum processing combined with effective forging and micro-processor controlled annealing produces a die-steel with minimum alloy segregation and preferred carbide distribution necessary for demanding applications.

Die Casting Application

DC-Xtra is capable of achieving high hardness, typically 42 to 52 HRC with standard hardening procedures employed by most vacuum heat treating operations. Usually sold in the annealed condition (nominally 24 HRC max), and heat-treated to service hardness by vacuum furnace practice after machining the die cavity.

Melting

Electric Arc Furnace (EAF) coupled with an Argon stirred **Ladle Metallurgy Furnace (LMF)** offers precise control of chemistry and critical melting temperatures.

Following the LMF, the argon stirred **Vacuum Argon Degassing (VAD)** system effectively removes dissolved gases and fine impurities that are deleterious to die properties.

Bottom Pouring is used to protect the degassed melt during the ingot casting process. Nitrogen, Oxygen and Hydrogen (from dissociation of atmospheric humidity) are prevented by this process from being re-introduced into the refined molten steel. This provides the best possible ingots for electrodes prior to the VAR process.

Vacuum Arc Refining (VAR) individual ingots (aka,electrodes) are progressively remelted over the course of more than a day through an ultra-deep vacuum (<0.001 torr) analogous to a large welding rod. Inside the VAR, droplets of molten steel fall through the high vacuum region and are rapidly re-solidified against a water-cooled copper crucible to assure the finest, most uniform as-solidified structure.

The Finkl Double-Vacuum Process (VAD-VAR) provides improved alloy distribution, minimizes "banding" segregation, and refines grain size. All of which are significant contributors to improved fracture toughness and thermal fatigue resistance.

Heat Treating

DC-Xtra (EAF+LMF+VAD + VAR) is typically used at high service hardness (42–52 HRC) posing a challenge for conventional die sinking or general machining operations at that hardness. For this reason, these grades are generally purchased in the annealed condition (max 24 HRC), and hard-ened after most, or all, machining is completed.

The suggested heat treating procedure for vacuum or protected atmosphere furnaces is detailed in a published industry practice available from the **North American Die Casting Association (NADCA).**

Key parameters of the NADCA recommended procedure for hardening dies for die casting service are:

- Austenitizing: 1885˚F ±10°F (1030°C ±5°C)
- Rapid quench to 300˚F (150˚C)
- Temper: Double Temper required, 1050°F (565°C) minimum

Tempering response, i.e., hardness after tempering, is influenced by a number of variables in addition to actual quenching procedure.

Machinability

Machinability Index of annealed DC and DC-Xtra is 0.50, i.e., 50% of annealed tool steel grade W1.

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