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EN36A Case Hardening Steel

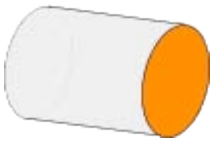
EN36A is a 3.2% nickel - chromium high hardenability, case hardening (carburizing) steel, generally supplied in the annealed condition with a maximum brinell hardness of 255 (Rc26).

Characterised by high core strength, excellent toughness and fatigue resistance in relatively large sections with case hardness up to Rc62 when carburized, hardened and tempered.

EN36A can also be used (uncarburised) as a high tensile steel, which when suitably hardened and tempered can be utilized for various applications requiring good tensile strength and excellent toughness.

Pre hardened and tempered (uncarburized) EN36A can be further surface hardened by nitriding but will not respond satisfactorily to flame or induction hardening due to its low carbon content.

EN36A (carburized) is used extensively by all industry sectors for components and shafts requiring high surface wear resistance, high core strength and impact properties. Typical uses are: Heavy Duty Bushings, Collets, Conveyor Pins, Heavy Duty Gears, King Pins, Ring Gears, Sprockets, Shafts etc..

Colour Code  Orange (Bar end)	Stocked Sizes	Rounds	14mm to 610 mm Diameter
	Bar Finish	Peeled, Turned	

Related Specifications		
	Australia	AS 1444-1996-X3312/X3312H
	Germany	W.Nr 1.5752 DIN 14NiCr14
	Great Britain	BS970: PART 3: 1991 655 M13 BS970: 1955 - EN36A
	Japan	JISG 4052 SNC815H JISG 4102 SNC815
	U.S.A.	SAE 3310 9310 AISI E3310 E9310 UNS G33106/G93106

Chemical Composition	Min. %	Max. %
Carbon	0.10	0.16
Silicon	0.10	0.40
Manganese	0.35	0.60
Nickel	3.00	3.75
Chromium	0.70	1.00
Phosphorous	0	0.04
Sulphur	0	0.04

Mechanical Property Requirements - As Supplied to AS1444-1996 X3312

Annealed Condition - Brinell Hardness 255 Maximum

Mechanical Property Requirements - As Supplied to BS 970 Part 3-1991 655M13

Test Bar Diameter mm	Tensile Strength Mpa		Elongation on $5.65\sqrt{S_0}$ * %	Izod Impact J	Charpy Impact J	*Annealed Brinell Hardness
	Min		Min.	Min.	Min.	Max
19	1000		9	40	35	255

Note: Mechanical tests are in the blank carburised condition
Hardening Temperature 800 °C - 820 °C
*Hardness figures are in the condition stated.

Typical Mechanical Properties - Annealed

Tensile Strength Mpa	Yield Strength Mpa	Elongation on $5.65\sqrt{S_o}$* %	Hardness	
			HB	Rc
700/770	540	25	212	17

Typical Mechanical Properties For Core - Carburised and Oil Quenched at 830 °C.

Section Size mm	Tensile Strength Mpa		Yield Strength Mpa Min	Elongation on $5.65\sqrt{S_o}$* % Min	Charpy Impact J Min	Hardness			
						HB		Rc	
	Min	Max				Min	Max	Min	Max
11	1030	1320	835	9	55	300	385	33	42
30	930	1230	785	10	55	275	360	29	40
63	880	1180	735	10		260	350	27	39

Typical Mechanical Properties - Oil Quenched at 830 °C and Tempered as Indicated *

Tempering Temperature °C	Tensile Strength Mpa	Yield Strength Mpa	Elongation on $5.65\sqrt{S_o}$* %	Izod Impact J	Hardness	
					HB	Rc
200	1140	896	20	95	340	37
430	1080	865	20	95	320	35
650	726	540	25	135	212	17

*Section Size 50 mm

Can be used in the Hardened and Tempered (uncarburised) condition for heavy duty shock resisting shafts and parts with tensile strengths over 1000 Mpa, plus excellent toughness possible in sections up to 200 mm.

EN36A is however generally used in the carburised condition with heat treatment details as follows.

Forging

Heat to 1150 °C and hold until temperature is uniform throughout the section. Soaking time at forging temperature should be as short as possible to avoid heavy scaling and excessive grain growth. This will vary depending on furnace conditions but 15 minutes per 25 mm of section may be used as a guide.

Do not forge below 850 °C.

Following completion of forging operation, work piece should be cooled as slowly as possible in sand or dry lime etc.

Note: Case hardening steels due to their low carbon content are less susceptable to cracking than medium or high carbon steels, and may therefore be heated and cooled more rapidly.

Heat Treatment

Annealing

Heat to 830 °C - 850 °C, hold until temperature is uniform throughout the section and cool in furnace.

Carburizing

Pack, salt or gas carburize at 900 °C - 950 °C, holding for sufficient time to develop the required case depth and carbon content, followed by a suitable hardening and tempering cycle to optimise case and core properties.

Hardening

Refer Refining & Hardening.

Nitriding

EN36A suitably hardened and tempered (uncarburised) will respond to nitriding giving a surface hardness up to Rc 60.

Nitriding is carried out at 490 °C - 530 °C followed by slow cooling (no quench), reducing the problem of distortion.

N.B. The fairly high nickel content in EN36A will result in a lower case hardness, or a longer nitriding cycle than with other alloy grades containing less nickel.

Normalizing - For Improved Machinability

Heat to 880 °C - 920 °C, hold until temperature is uniform throughout the section. Soak for 10 - 15 minutes and cool in still air.

Temper immediately at 650 °C - 660 °C and air cool.

Refining & Hardening

Core Refine

Slow cool from carburizing temperature and re-heat to 830 °C - 880 °C, hold until temperature is uniform throughout the section, quench as required in water, oil or air cool. Alternatively quench in salt bath held at 150 °C - 250 °C, followed by air cool.

Case Hardening

Following core refining, re-heat to 760 °C - 800 °C, hold until temperature is uniform throughout the section, and quench in oil.

Temper immediately while still hand warm.

Single Refine*

Direct Quench: Cool from carburizing temperature to 810 °C - 830 °C, hold until temperature is uniform throughout the section. Quench as required in water, oil or air cool. Alternatively quench in salt bath held at 150 °C - 250 °C, followed by air cool and temper immediately.

OR: Cool from carburizing temperature to room temperature, re-heat to 810 °C - 830 °C and hold until temperature is uniform throughout the section and quench or air cool as previous. Temper immediately.

Note: When air cooling large sections a uniform fan cooling is recommended, especially when direct cooling from carburizing temperature.

*Suitable for fine grained steels only.

Stress Relieving

Heat to 600 °C - 650 °C, hold until temperature is uniform throughout the section, soak for 1 hour per 25 mm section, and cool in still air.

Tempering

Heat to 150 °C - 200 °C as required, hold until temperature is uniform throughout the section, soak for 1 - 2 hours per 25 mm of section, and cool in still air.

N.B.Tempering will improve the toughness of both case and core, with only a slight reduction in core strength and case hardness. It will also reduce the susceptibility of the case to grinding cracks.

Notes on Heat Treatment

Heating temperatures, rate of heating, cooling and soaking times will vary due to factors such as work piece size/shape also furnace type employed, quenching medium and work piece transfer facilities etc..

Please consult your heat treater for best results.

Machining

EN36A in the annealed as supplied condition has very good machinability and all operations such as turning, drilling,milling and tapping etc. can be carried out satisfactorily as per machine manufacturers recommendations for suitable tool type - feeds and speeds.

Welding

EN36A is readily weldable in the annealed as supplied condition. Following welding, the work piece immediately upon cooling to hand warm should be stress relieved at 600 °C - 650 °C if possible.

N.B. Welding in the carburized and heat treated condition is not recommended.

Welding Procedure

Welding of EN36A should always be carried out using low hydrogen electrodes - please consult your welding consumables supplier.

Suggested pre-heat temperature

Section	°C
25 mm	250
50 mm	300
75 mm	350
150 mm	400

Post Welding

Maximum cooling rate 100 °C per hour down to 100 °C, followed by cooling in still air.

It is recommended that the work piece if possible is buried in sand or dry lime etc..

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