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High Temperature Austenitic Alloys

A new range of wires is now available from I.A.Barnes & Co Ltd:

IABCO 21.33
IABCO 25.35
IABCO 35.45

These are solid wires for welding the alloys: 800H (21.33), HP40Nb (25.35) and 35.45 respectively, which are used in many petrochemical applications. These alloys are currently the most widely used of a range of high temperature cast alloys; the metallurgical and alloying evolution of these alloys is shown in Appendix 1.

Alloy 800 is available in both cast and wrought form but the higher carbon HP40Nb and 35.45 alloys are only available as castings. The castings can be standard static castings but pipe will normally be centrifugally cast.

These alloys are widely used for pyrolysis coils and reformer tubes in the production of ethylene, ammonia, and hydrogen. The furnace temperatures can be up to 1100°C in some sections of the furnace so the alloys that are used need to have a good combination of oxidation resistance, creep strength, carburisation resistance, resistance to embrittlement and thermal shock. In various sections of the furnace the emphasis will be on a different property, so different alloys are often used; three of the most widely used alloys are alloy 800, HP40Nb and 35.45. It is for these applications that I.A.Barnes have introduced the IABCO 21.33, 25.35 and 35.45 wires.

The typical analysis of the wires is given in Table 1. The main alloying of the wires is essentially the same as the respective base materials but, in order to provide the best welding characteristics, some of the other alloying (eg. Mn and Si) may vary from the base material composition. One example is the Mn content of the 21.33 wire, which at ~4.7%, is higher than the matching base materials in order to provide the best resistance to hot cracking. The wires are also micro-alloyed (Ti, Al or Zr) to match the higher creep strength micro-alloyed cast alloys.

The typical room temperature properties produced by the three wires are shown in Table 2, although far more critical are the high temperature strength and creep properties.

Table 1 Typical analysis of welding wires

	C	Mn	Si	P	S	Cr	Ni	Nb	Mo	Other
IABCO 21.33	0.15	4.7	0.2	0.007	0.001	21.5	32.5	1.2	-	Ti, Al
IABCO 25.25	0.43	1.7	1.2	0.010	0.001	26.0	35.0	1.3	0.3	Ti, Zr
IABCO 35.45	0.43	1.0	1.6	0.010	0.001	35.0	45.5	0.8	0.3	Ti, Zr

Alloy 21.33 - Alloy 800

Base material

This alloy has good resistance to thermal fatigue, thermal shock, corrosion and ageing embrittlement at service temperatures up to ~1000°C.

Typical applications can be found in the petrochemical, furnace and nuclear industries where the alloys are used for manifolds, radiant tubes, muffles and heat treatment trays.

Examples of 21.33 base materials include:
ASTM A351: CT15C.
EN: 1.4850, 1.4859, 1.4876, 1.4958, 1.4959.
UNS: N08800, N08810, N08811.
Proprietary alloys include: Centralloy G4859 (Centracero), Incoloy 800/800H/800HT (Special Metals), Manaurite 900 (Manoir), MO-RE 21 (Duraloy), Nicrofer 3220/3220H/3220HP (VDM), RA330 (Rolled Alloys), Sanicro 30 and 31HT (Sandvik), SEL 2032Nb (Cronite Scomark).

Welding wire

IABCO 21.33 is a micro-alloyed 21%Cr-33%Ni-1%Nb wire for welding matching 'alloy 800' heat resistant alloys. The wire can be used for welding any of the standard grades of base material UNS N08800, N08810 and N08811.

The nearly matching 21.33 wire has the additional benefit, compared to nickel base alloys (eg 617 / ERNiCrCoMo-1), of having sulphidation resistance and thermal coefficient of expansion very similar to the base materials.

There is currently no formal standard covering this welding wire but it can be classified in EN ISO 14343 as G/W Z 21 33 Mn Nb.

Alloy 25.35 - HP40Nb

Base material

These alloys have very good creep, oxidation and carburisation resistance in the typical service temperature range of 900-1100°C. Typical applications include ethylene pyrolysis coils, reformer tubes and steam superheaters in the petrochemical industry.

Examples of 25.35 base materials include:
ASTM A297: HP, 'HP40', 'HP40Cb'.
EN: 1.4852, 1.4853, 1.4857.
UNS: J95705.
Proprietary alloys include: Centralloy G4852 (Schmidt+Clemens), E2535Nb (Engemasa), H39W (Doncasters Paralloy), HR33Nb (Cronite Scomark), KHR 35C (Kubota), Manaurite 36X (Manoir), MO-RE 10 and 10MA (Duraloy), SEL 2535Nb (Cronite Scomark).

Welding wire

IABCO 25.35 is a micro-alloyed 25%Cr-35%Ni-1%Nb wire for welding matching high alloy heat resistant castings. The wire includes micro-alloying to match the higher creep performance of the micro-alloyed base material, but the wire is also suitable for the standard HP40Nb alloy and the Nb-free version of this alloy.

There is currently no formal standard covering this welding wire but it can be classified in EN ISO 14343 as G/W Z 25 35.

Alloy 35.45

Base material

This alloy has very good oxidation and carburisation resistance up to service temperatures of ~1150°C. Typical applications include ethylene pyrolysis coils and reformer tubes in the petrochemical industry.

Examples of 35.45 base materials include:
EN: 1.4889, GX40 NiCrNb 45-35.
Proprietary alloys include: Centralloy ET45 Micro (Schmidt+Clemens), E3545Nb-MA (Engemasa), H46M (Doncasters Paralloy), KHR 45A (Kubota), Manaurite XT and XTM (Manoir), MO-RE 40 and 40MA (Duraloy), SEL 3545NbMA (Cronite Scomark).

Welding wire

IABCO 35.45 micro-alloyed 35%Cr-45%Ni-1%Nb wire for welding matching high alloy heat resistant castings. The wire includes micro-alloying to match the higher creep performance of the micro-alloyed base material.

There is currently no formal standard covering this welding wire but it can be classified in EN ISO 18274 as S Ni Z Cr35Fe15Nb.

Table 2 Typical room temperature mechanical properties of TIG/GTAW weld

	0.2% Proof Stress, MPa	Tensile Strength, MPa	Elongation, %
21.33	400	600	25
25.25	450	650	10
35.45	500	600	3

Welding Procedure

Despite being high carbon alloys the welding procedure is generally straightforward. In most cases preheat is not required and an interpass temperature of 250°C should be kept to; for the alloy 800 it is beneficial to maintain an interpass temperature of 150°C. None of these alloys are normally post weld heat treated (PWHT) but for alloy 800 work being carried out to some sections of ASME do require PWHT.

The welding procedure may be complicated if the material being welded has been in service because the ductility of the material can be reduced significantly after prolonged exposure to high temperatures, which will reduce the weldablility of the material. In these circumstances it may be necessary to anneal the material before welding.

Welding Consumables

All of these wires (21.33, 25.35 and 35.45) are available in TIG and MIG form, normally from stock in Stevenage:

TIG	2.4mm	5kg tube
	3.2mm	5kg tube (alloy 800 and 25.35)
MIG	1.2mm	15kg BS300 spool

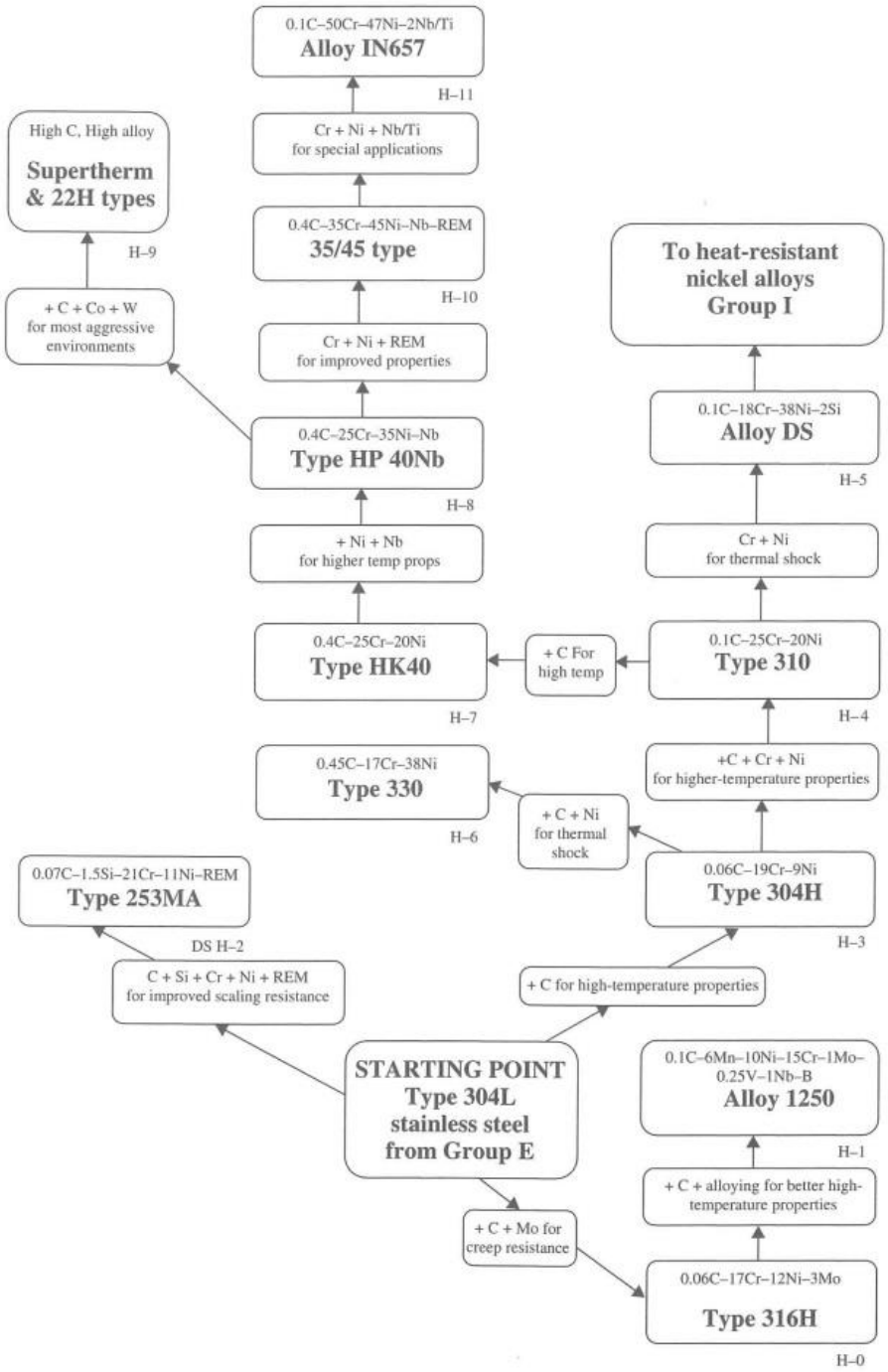
The TIG wires are 1000mm long and are stamped with alloy identification (21.33 / 25.35 / 35.45) and cast number, at both ends.

Other forms and diameters are available to order but normally with a minimum order quantity of 300kg.

Appendix 1

Evolution of the high temperature alloys showing the alloying progression from standard 304L up to nickel base alloys and 50%Cr-50%Ni alloy IN657.

Farrar, J C M 'The Alloy Tree. A guide to low alloy steels, stainless steels and nickel base alloys.' Woodhead Publishing Ltd, Cambridge, 2004.



Group H: Heat-resistant stainless steels.