



**NICKEL ALLOYS**  
for Special Applications



**ACCIAIERIE VALBRUNA**

High quality is our standard

OUR PRODUCTS CHANGE WITH YOU

## NICKEL ALLOYS FOR SPECIAL APPLICATIONS



Vicenza plant, Italy



Bolzano plant, Italy



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Valbruna, founded in 1925 and leader in the production of Stainless Steels, Nickel Alloys and Titanium long products, is underpinned by long experience and a highly qualified customer service. Since the seventies, Valbruna has concentrated part of its production on Super-Austenitic Stainless Steels and Nickel Alloys. Today a wide range of Nickel Alloys is produced in billets, bars, wire rod and wire, making Valbruna an ideal partner for all those manufacturing companies involved in oil, chemical, petrochemical, marine, automotive, energy and power generation sectors.



### VALBRUNA... SUCH A GREAT REALITY!

Our extensive and strategic distribution network is our corner stone in a global market, granting a worldwide commercial presence with the opportunity for continuous feedback from our customers.



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| <b>ITALY:</b> | Vicenza        | <b>AMERICA</b>        | Canada        |
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## Nickel Alloys for Special Applications

The development of new technologies and industries often demands materials with enhanced performance and resistance to aggressive environments. These demands have driven the development of highly alloyed iron, nickel and cobalt based. By varying the combination of different chemical elements a wide range of useful properties can be achieved. These include exceptional mechanical properties, high creep and rupture strength, enhanced toughness, better metallurgical stability, improved fatigue and thermal shock properties, superior corrosion resistance across a broad spectrum of temperatures while maintaining good fabricability. Nickel alloys can be easily cold worked to enhance mechanical properties. Heat treatments can also raise mechanical properties in some nickel alloys and can be used to improve corrosion resistance.

Typical heat treatment of these alloys are:

- Solution treating
- Annealing
- Stress Relieving
- Age Hardening

The heat treatment (temperature, soaking and cooling practice) depends on chemistry, profiles & dimensions, manufacturing process, and final application.



### Classification

Nickel Alloys could be classified according to their chemistry or properties:

#### CHEMICAL CLASSIFICATION:

- Ni Alloys
- Ni-Cu Alloys
- Ni-Si Alloys
- Ni-Cr-Fe Alloys
- Ni-Cr-Mo Alloys
- Ni-Cr-Fe-Mo-Cu Alloys
- Cu-Ni Alloys

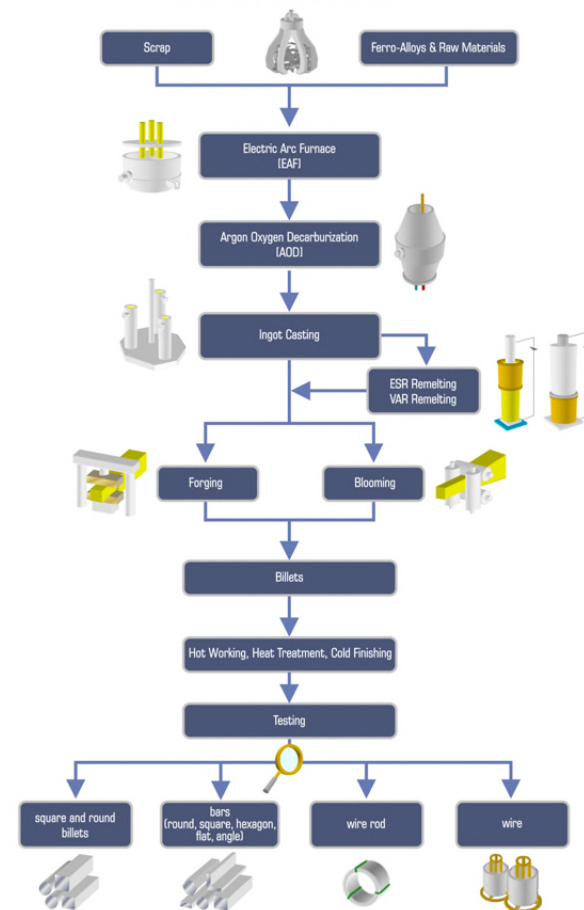
#### PROPERTIES CLASSIFICATION:

- Corrosion Resistance
- Heat Resistance

Based on aforesaid assumptions, special alloys could be used for:

- Thermal Processing
- Automotive Industry
- Chemical/Petrochemical Industry
- Power Generation
- Marine Engineering
- Oil & Gas Extraction
- Aerospace Engineering
- Pollution Control & Waste Processing
- Electrical Resistance
- Welding
- Electronic

### NICKEL ALLOYS PRODUCTION FLOW CHART



## OUR NICKEL ALLOYS

| VALBRUNA GRADE       | COMMERCIAL NAME                        | UNS                        | W.N.     | BS              | INTERNATIONAL DESIGNATION             | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | MELTING PRACTICES |     |     |
|----------------------|----------------------------------------|----------------------------|----------|-----------------|---------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-----|-----|
|                      |                                        |                            |          |                 |                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ADD               | ESR | VAR |
| AN1                  | Alloy 800<br>Alloy 800H<br>Alloy 800HT | N08800<br>N08810<br>N08811 | 1.4876   | NA15<br>NA15(H) | X10NiCrAlTi32-21;<br>X10NiCrAlTi32-20 | <p><b>Alloy 800</b> is an austenitic Fe-Ni-Cr alloy with controlled Al, Ti, Si and Mn additions. It is characterized by high strength for service temperatures up to 540° C, very good resistance to oxidation and to carburization up to 1093° C and corrosion resistance in many corrosive and aqueous media.</p> <p><b>Alloy 800H</b> is a high Carbon version of alloy 800 which guarantees higher creep and rupture resistance for temperature above 600° C. These properties are also due a higher heat treatment temperature than alloy 800's one that provides an average grain size 5 or coarser. Alloy 800H is preferred for prolonged exposure at high temperatures.</p> <p><b>Alloy 800HT</b> is a modified chemistry of alloy 800H which guarantees a higher creep and stress rupture for service temperatures above 700° C because of controlled C, Al and Ti additions (C=0.06-0.10%, Al+Ti=0.85-1.20%) and a higher solution annealing temperature grain size 5 or coarser is requested. 800HT is used specially at temperature above 800° C.</p> | ✓                 |     |     |
|                      |                                        |                            |          |                 |                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |     |     |
| AN2                  | Alloy 825<br>Alloy 65                  | N08825<br>N08065           | (2.4858) | NA16<br>NA41    | NiCr21Mo<br>NiFe30Cr21Mo3             | <b>Alloy 825</b> is a Ti-stabilized fully austenitic Ni-Fe-Cr alloy with Mo and Cu additions. It is characterized by excellent resistance to stress-corrosion cracking, good resistance to pitting, crevice corrosion and to oxidizing and reducing acids. Its mechanical properties are good from cryogenic to moderately high temperature, but at temperature above 540° C this alloy shows a lower ductility and impact strength. It is not recommended for high-temp. services where creep-rupture resistance is requested.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ✓                 |     |     |
| AN3                  | Alloy DS                               | -                          | (1.4862) | NA17            | XBNiCrSi38-18                         | <b>Alloy DS</b> is a Ni-Fe-Cr alloy. It is considered a variation of alloy 330 with improved carburization resistance. This grade is characterized by good mechanical properties at high temperature and good resistance to oxidation (up to 1000° C) and to carburization. Its chemical analysis hinders sigma-phase precipitation in the 600-900° C range. Alloy DS is also used for heating elements in industrial furnace up to 1150° C.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | ✓                 |     |     |
| AN3CB                | Alloy 330Cb                            | -                          | -        | -               | -                                     | <b>Alloy 330Cb</b> is an austenitic Fe-Ni-Cr alloy with controlled Nb (and/or Cb) additions. The presence of Nb greatly increases the creep rupture resistance at high temperature. This alloy exhibits a resistance to carburization thanks to the poor tendency to form Cr-carbides.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | ✓                 |     |     |
| AN3US                | Alloy 330                              | N08330                     | -        | -               | -                                     | <b>Alloy 330</b> is a Fe-Ni-Cr alloy with Si and Mn additions. This alloy is characterized by good corrosion resistance in a wide range of media, to carburization, to nitridation and by good mechanical properties at high temperature. It is not recommended for application where high creep-rupture strength is requested.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ✓                 |     |     |
| AN4                  | Alloy 904L                             | N08904                     | 1.4539   | -               | X1NiCrMoCu25-20-5                     | <b>Alloy 904L</b> is a superaustenitic Stainless Steel with high Mo, Cu additions and extremely low carbon content. This alloy provides high resistance to pitting, crevice corrosion, stress-corrosion cracking and inter-crystalline corrosion, excellent resistance to moderately aggressive reducing acids such as sulphuric and phosphoric acids, as well as to many chloride-containing media. It has vastly superior properties to those of conventional acid-resistant SS.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | ✓                 |     |     |
| AN5                  | Alloy 660<br>Alloy A286                | S66286                     | 1.4980   | -               | X6NiCrTiMoVB25-15-2                   | <b>Alloy 660/A286</b> is a precipitation hardenable superalloy. It is a Fe-Ni-Cr alloy with additions of Mo and Ti. In aged condition this alloy shows high mechanical properties and good creep-rupture, corrosion resistance to oxidation at temperatures up to 700° C. In accordance to different solution treat. temperatures and the quenching, Alloy 660/A286 could be classified in different types or classes provided by the specifications; for instance: solution treatment at 980° C gives the highest creep-rupture strength in precipitation-hardened material, solution treatment at 900° C instead results in improved ductility and room-temperature tensile strength.                                                                                                                                                                                                                                                                                                                                                                           | ✓                 | ✓   |     |
| AV20                 | Alloy 20                               | N08020                     | 2.4660   | -               | NiCr20CuMo                            | <b>Alloy 20</b> is a low carbon, Nb stabilized austenitic Ni-Fe-Cr alloy with addition of Cu and Mo. It is characterized by an excellent resistance to acid and other aggressive media, to pitting, to crevice corrosion, to intergranular corrosion and to stress corrosion.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | ✓                 |     |     |
| AVC276               | Alloy C276                             | N10276                     | 2.4819   | -               | NiMo16Cr15W                           | <b>Alloy C276</b> is a Ni-Cr-Mo alloy with low Carbon, W and Si. This alloy is characterized by high corrosion resistance in a wide range of media, by resistance to pitting, crevice corrosion and stress-corrosion cracking.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | ✓                 | ✓   |     |
| AV718CRV<br>AV718HTV | Alloy 718                              | N07718                     | 2.4668   | NA51            | NiCr19Fe19Nb5Mo3;<br>NiCr19NbMo       | <b>Alloy 718</b> is a precipitation-hardening austenitic Ni-base superalloy. High strength and corrosion resistance (at high and low temperature) are its stand out features. It is also characterized by good oxidation resistance up to 1000° C, good mechanical properties at temperature below 0° C and good resistance to stress-corrosion cracking and pitting.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ✓                 |     | ✓   |
| AV925                | Alloy 925                              | N09925                     | -        | -               | -                                     | <b>Alloy 925</b> is an age-hardenable Ni-Fe-Cr alloy with Mo, Cu, Ti and Al additions, characterized by high strength (up to 540° C) and corrosion resistance to pitting, crevice corrosion and stress-corrosion cracking.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | ✓                 | ✓   |     |
| EG1                  | Alloy 400                              | N04400                     | (2.4360) | NA13            | NiCu30Fe                              | <b>Alloy 400</b> is a Ni-Cu alloy characterized by corrosion resistance in marine and chemical applications (hydrofluoric acid, non-oxidizing dilute acids, alkalis and salt solutions, organic acids, dry gases such as chlorine and to hydrogen chloride), high strength and toughness from temperatures below 0° up to 550° C. The mechanical properties can be improved only by cold working.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ✓                 |     |     |
| EG2                  | Alloy K-500                            | N05500                     | (2.4375) | NA18            | NiCu30Al                              | <b>Alloy K-500</b> is a precipitation hardening alloy with Al and Ti additions. This alloy is characterized by the same excellent corrosion resistance as alloy 400 but with higher mechanical properties that are maintained for a wide range of temperature (from -200° C up to 650° C). It has a greater tendency toward stress-corrosion cracking in some environments than alloy 400 and in the aged condition it has low magnetic permeability to temperature below to -120° C.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ✓                 |     |     |



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| VALBRUNA GRADE | COMMERCIAL NAME        | UNS              | W.N.     | BS           | INTERNATIONAL DESIGNATION          | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | MELTING PRACTICES |     |     |
|----------------|------------------------|------------------|----------|--------------|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-----|-----|
|                |                        |                  |          |              |                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ADD               | ESR | VAR |
| EG3            | Alloy 60               | N04060           | 2.4377   | NA33         | SG-NiCu 30 MnTi<br>UP-NiCu 30 MnTi | <b>Alloy 60</b> is used for MIG and TIG techniques. It is used for welding alloys such as 400 and K-500. Its properties - as welded - are similar to base alloy. Nevertheless this alloy is not precipitation hardenable.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | ✓                 |     |     |
| EG4            | Alloy 401              | N04401           | 2.0842   | -            | -                                  | <b>Alloy 401</b> is a Cu-Ni alloy. It is used for electrical and electronic applications and for welding.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | ✓                 |     |     |
| GL1            | Alloy 600              | N06600           | 2.4816   | NA14         | NiCr15Fe                           | <b>Alloy 600</b> is a Ni-Cr-Fe alloy with excellent corrosion resistance to oxidation up to 980° C, to carburization and to stress corrosion cracking at elevated temperatures. It also provides corrosion resistance by many organic and inorganic compounds. This alloy is characterized also by good mechanical properties from temperature below-zero up to 700° C, high creep-rupture properties and by good workability. This set of properties suggests the use of alloy 600 for services from cryogenic to high temperatures (above to 1090° C).                                                                                                                                                                                                          | ✓                 |     |     |
| GL2            | Alloy 80A              | N07080           | 2.4952   | NA20         | NiCr20TiAl                         | <b>Alloy 80A</b> is a Ni-Cr precipitation hardenable alloy. It is characterized by good mechanical properties and resistance to creep at high temperature. Alloy 80A exhibits also good corrosion and oxidation resistance and high fatigue resistance in several conditions. This alloy is used for services up to 815° C.                                                                                                                                                                                                                                                                                                                                                                                                                                       | ✓                 | ✓   |     |
| GL3            | Alloy 625              | N06625           | 2.4856   | NA21         | NiCr22Mo9Nb                        | <b>Alloy 625</b> is a low-carbon Ni-Cr-Mo alloy with Nb addition. This alloy is characterized by good mechanical properties (due to effect of Mo and Nb in the matrix structure), excellent resistance to pitting and crevice corrosion, high resistance to stress-corrosion. Also it resists in a wide range of organic and mineral acids and at high temperature as well to oxidation and to carburization. In accordance to heat treat. temperatures it is classified as grade 1 (annealed) or grade 2 (solution ann.). Grade 2 is recommended for applications where good resistance to creep or rupture up to 1000° C is requested. Grade 1 is recommended for applications up to 840° C when finer grain size and high mechanical properties are requested. | ✓                 | ✓   | ✓   |
| GL3/EL         | Alloy 625              | N06625           | 2.4831   | NA43         | SG-NiCr21Mo9Nb<br>UP-NiCr21Mo9Nb   | <b>Alloy 625</b> components for welding is a Ni-Cr-Mo alloy with low C & Fe contents. It is used for welding alloy 625 components or other grades such as alloy 825, 926 and 20.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | ✓                 |     |     |
| GL4            | Alloy 82               | N06082           | 2.4806   | NA35         | SG-NiCr20Nb<br>UP-NiCr20Nb         | <b>Alloy 82</b> is a Ni-Cr-Fe filler metal used for MIG, TIG. It is used for welding alloys such as 600, 601, 800/H/H/T, and 330. It exhibits high strength and good corrosion resistance also at high temperature.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ✓                 |     |     |
| GL5            | Alloy 601              | N06601           | 2.4851   | NA49         | NiCr23Fe                           | <b>Alloy 601</b> is a Ni-Cr-Fe alloy with high resistance to corrosion and to high temperature oxidation. Generally it is used for thermal and chemical processing, pollution control, aerospace and power generation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | ✓                 |     |     |
| SG1            | Alloy 200<br>Alloy 201 | N02200<br>N02201 | 2.4068   | NA11<br>NA12 | LC-Ni99.0                          | <b>Alloy 200</b> is basically a commercially-pure Ni grade that shows excellent corrosion resistance to many corrosive media (especially to caustic alkalis, halides and a large number of organic compounds). It also provides a good combination of mechanical, magnetic properties and low electrical resistivity.<br><b>Alloy 201</b> is a low carbon version (C max 0.02%) preferred for applications at temperatures above 315° C in order to avoid graphite precipitation.                                                                                                                                                                                                                                                                                 | ✓                 |     |     |
| SG2            | Alloy 55               | W82002           | (2.4560) | NA47         | S-NiFe 40                          | <b>Alloy 55</b> is used for welding cast-irons to various materials (mild steels, stainless steels, wrought alloys or high-Ni alloys). Weld deposits are machineable.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ✓                 |     |     |
| SG3            | Alloy 55 Ti            | -                | -        | -            | -                                  | <b>Alloy 55 Ti</b> is a variation of alloy 55 with addition of Ti.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | ✓                 |     |     |
| SG4            | Alloy 212              | N02212           | 2.4110   | -            | NiMn 2                             | <b>Alloy 212</b> is a very high-Ni alloy with addition of Mn. It is used for electrical and electronic applications                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ✓                 |     |     |
| SG5            | Alloy 36               | K93601           | 1.3912   | -            | Ni36                               | <b>Alloy 36</b> is a binary Ni-Fe alloy. Due to its low coefficient of expansion it maintains a constant dimension for a wide range of temperature (from -250° C to 200° C). It also exhibits good mechanical properties at temperature below 0° C. At temperature above 280° C it is non-magnetic. This alloy is ductile and it shows enough corrosion resistance in dry air.                                                                                                                                                                                                                                                                                                                                                                                    | ✓                 |     |     |
| SG6            | Alloy 61               | N02061           | 2.4155   | NA32         | SG-NiTi 4                          | <b>Alloy 61</b> is a high-Ni filler metal used for MIG, TIG or PAW welding. It is used for welding of alloys such as 200 & 201 to themselves or to stainless steels, alloy 600, 400, and Cu-Ni alloys.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | ✓                 |     |     |
| VAL40          | Alloy 40               | -                | 1.4860   | -            | NiCr 30 20<br>(X16NiCr30-20)       | <b>Alloy 40</b> is a Ni-Cr alloy with high resistivity and good oxidation resistance. It is used at temperature up to 1100° C.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | ✓                 |     |     |
| VAL60          | Alloy 60/40            | N06004           | 2.4867   | -            | NiCr6015                           | <b>Alloy 60/40</b> is a Ni-Cr electrical resistance alloy. It is used in service up to 1100° C.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ✓                 |     |     |
| VAL80          | Alloy 80/20            | N06003           | 2.4869   | -            | NiCr80-20                          | <b>Alloy 80/20</b> is a Ni-Cr resistance alloy. It is used for service up to 1200° C because of its properties of resistance to oxidation and thermal fatigue.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | ✓                 |     |     |
| VAL4529        | Alloy 926              | N08926           | 1.4529   | -            | X1NiCrMoCuNi25-20-7                | <b>Alloy 926</b> is a superaustenitic stainless steel with increased Mo and N contents compared to 904L. This alloy exhibits exceptional resistance to pitting, crevice corrosion and to stress-corrosion cracking in aggressive media.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | ✓                 |     |     |
|                | Alloy 367              | N08367           | -        | -            | -                                  | <b>Alloy 367</b> is a corrosion resistant iron-base austenitic stainless steel. It is chemically balanced in order to provide thermal stability and resistance to stress corrosion cracking.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | ✓                 |     |     |

## CORROSION RESISTANT ALLOYS

In several environments (wide spectrum of acids, alkalis and salts) where the corrosion resistance is the most important criteria for material selection that has to be considered, the choice of the nickel alloys is recommended. These alloys exhibit also good mechanical properties. The corrosion resistance is proved in terms of limited metal loss and in the ability to better withstand localized attack, notably pitting/crevice corrosion, intergranular attack and stress corrosion cracking.

### CORROSION RESISTANT ALLOYS - Designations

| VALBRUNA GRADE | COMMERCIAL NAME         | UNS              | W.N.     | BS           | INTERNATIONAL DESIGNATION       | ASTM                         | ASME           | AMS                          | EN               | DIN                | BS           | Other            |
|----------------|-------------------------|------------------|----------|--------------|---------------------------------|------------------------------|----------------|------------------------------|------------------|--------------------|--------------|------------------|
| SG1            | Alloy 200<br>Alloy 201  | N02200<br>N02201 | 2.4068   | NA11<br>NA12 | LC-Ni99.0                       | B160<br>B564                 | SB160<br>SB564 | -                            | -                | 17740              | 3076         | -                |
| AN2            | Alloy 825<br>Alloy 65   | N08825<br>N08065 | (2.4858) | NA16<br>NA41 | NiCr21Mo<br>NiFe30Cr21Mo3       | B425<br>B564                 | SB425<br>SB564 | -                            | -                | 17744<br>1736      | 3076<br>2901 | A5.14 ERNiFeCr-1 |
| AV925          | Alloy 925               | N09925           | -        | -            | -                               | -                            | -              | -                            | -                | -                  | -            | NACE MR0175      |
| AN4            | Alloy 904L              | N08904           | 1.4539   | -            | X1NiCrMoCu25-20-5               | A182<br>A479                 | SB649          | -                            | 10088-3<br>10272 | -                  | -            | -                |
| VAL4529        | Alloy 926               | N08926           | 1.4529   | -            | X1NiCrMoCuN25-20-7              | B472<br>B649                 | SB649          | -                            | 10088-3          | -                  | -            | SEW 400          |
|                | Alloy 367               | N08367           | -        | -            | -                               | A182<br>B472<br>B564<br>B691 | SB564          | -                            | -                | -                  | -            | -                |
| AN5            | Alloy 660<br>Alloy A286 | S66286           | 1.4980   | -            | X6NiCrTiMoVB25-15-2             | A638<br>A453                 | -              | 5731<br>5732<br>5734<br>5737 | 10269<br>10302   | -                  | -            | -                |
| AV20           | Alloy 20                | N08020           | 2.4660   | -            | NiCr20CuMo                      | B473<br>B472                 | SB473          | -                            | -                | -                  | -            | -                |
| EG1            | Alloy 400               | N04400           | (2.4360) | NA13         | NiCu30Fe                        | B164<br>B564                 | SB164<br>SB564 | 4674                         | -                | (17743)<br>(17752) | 3076         | QQ-N-281 D/2     |
| EG2            | Alloy K-500             | N05500           | (2.4375) | NA18         | NiCu30Al                        | B865                         | -              | 4676                         | -                | (17743)<br>(17752) | 3076         | QQ-N-286 E/2     |
| GL3            | Alloy 625               | N06625           | 2.4856   | NA21         | NiCr22Mo9Nb                     | B446<br>B564                 | SB446<br>SB564 | 5666                         | 17744            | -                  | 3076         | -                |
| AVC276         | Alloy C276              | N10276           | 2.4819   | -            | NiMo16Cr15W                     | B564<br>B574                 | SB564          | -                            | -                | -                  | -            | -                |
| AV718CRV       | Alloy 718               | N07718           | 2.4668   | NA51         | NiCr19Fe19Nb5Mo3;<br>NiCr19NbMo | B637*                        | SB637*         | -                            | -                | -                  | -            | API6A718         |
| AV718HTV       | Alloy 718               | N07718           | 2.4668   | NA51         | NiCr19Fe19Nb5Mo3;<br>NiCr19NbMo | B637                         | SB637          | 5662<br>5663                 | -                | -                  | -            | -                |

\* Only for chemistry



## Nickel Alloys for Special Applications

### CORROSION RESISTANT ALLOYS - Mechanical properties

| VALBRUNA GRADE | COMMERCIAL NAME         | Condition                                    | Mechanical Properties at room Temperature requested by standard specifications |                |             |             |
|----------------|-------------------------|----------------------------------------------|--------------------------------------------------------------------------------|----------------|-------------|-------------|
|                |                         |                                              | Y.S. min (MPa)                                                                 | Y.S. min (MPa) | E4d min (%) | HB          |
| SG1            | Alloy 200               | Cold Drawn - As Hot Worked                   | 510-550                                                                        | 345-415        | 10-15       | min 112     |
|                |                         | Hot Worked - As Hot Worked                   | 415                                                                            | 105            | 35          | min 112     |
|                |                         | Cold Drawn - Annealed                        | 380                                                                            | 105            | 40          | min 112     |
|                | Alloy 201               | Hot Worked - Annealed                        | 380                                                                            | 105            | 40          | min 112     |
|                |                         | Hot Worked - As Hot Worked                   | 345                                                                            | 70             | 35          | min 112     |
|                |                         | Cold Drawn - Annealed                        | 345                                                                            | 70             | 35          | min 112     |
| AN2            | Alloy 825               | Hot Worked - Annealed                        | 345                                                                            | 70             | 40          | min 112     |
|                |                         | Cold Drawn - Sol Annealed                    | 586                                                                            | 241            | 30          | 176-325     |
|                |                         | Hot Worked - Sol Annealed                    | 586                                                                            | 241            | 30          | 176-325     |
| AV925          | Alloy 925               | Hot Worked - Sol Annealed                    | 517                                                                            | 240            | 56          | -           |
|                |                         | Cold Drawn - Sol Annealed - Aged             | 965                                                                            | 724            | 25          | max 341     |
|                |                         | Hot Worked - Sol Annealed - Aged             | 965                                                                            | 758            | 25          | max 341     |
| AN4            | Alloy 904L              | Cold Drawn - Sol Annealed                    | 965                                                                            | 758            | 25          | max 341     |
|                |                         | Hot Worked - Sol Annealed                    | 600                                                                            | 400            | 20          | max 330     |
|                |                         | Cold Drawn - Sol Annealed                    | 530                                                                            | 230            | 35          | max 230     |
| VAL 4529       | Alloy 926               | Hot Worked - Sol Annealed                    | 650                                                                            | 295            | 35          | 194-316     |
|                |                         | Cold Drawn - Sol Annealed                    | 490                                                                            | 220            | 35          | max 250     |
|                |                         | Hot Worked - Sol Annealed                    | 650                                                                            | 295            | 35          | 194-316     |
|                | Alloy 367               | Cold Drawn - Sol Annealed                    | 490                                                                            | 220            | 35          | max 250     |
|                |                         | Hot Worked - Sol Annealed                    | 490                                                                            | 220            | 35          | max 250     |
|                |                         | Hot Worked - Sol Annealed (class A)          | 580                                                                            | 260            | 40          | -           |
| AN5            | Alloy 660<br>Alloy A286 | Hot Worked - Sol Annealed and Aged (class A) | 895                                                                            | 585            | 15          | 248-341     |
|                |                         | Hot Worked - Sol Annealed (class B)          | 580                                                                            | 260            | 40          | -           |
|                |                         | Hot Worked - Sol Annealed and Aged (class B) | 895                                                                            | 585            | 15          | 248-341     |
|                |                         | Hot Worked - Sol Annealed (class D)          | 580                                                                            | 260            | 40          | -           |
|                |                         | Hot Worked - Sol Annealed and Aged (class D) | 895                                                                            | 725            | 15          | 248-325     |
|                |                         | Cold Drawn - Sol Annealed                    | 551                                                                            | 241            | 30          | min 165     |
| AV20           | Alloy 20                | Hot Worked - Sol Annealed                    | 551                                                                            | 241            | 30          | 164-300     |
|                |                         | Cold Drawn - As Hot Worked                   | 760                                                                            | 585            | 8           | -           |
|                |                         | Cold Drawn - Stress Relieved                 | 580-600                                                                        | 345-415        | 10-20       | max 320     |
|                |                         | Hot Worked - Sol Annealed                    | 515-550                                                                        | 276            | 30          | max 320     |
|                |                         | Cold Drawn - Sol Annealed                    | 480                                                                            | 170            | 35          | max 320     |
|                |                         | Hot Worked - Sol Annealed                    | 480                                                                            | 170            | 35          | 145-325     |
| EG1            | Alloy 400               | Hot Worked - High Tensile (Stress Relieved)  | 580-680                                                                        | 415-480        | 20-25       | -           |
|                |                         | Hot Worked - As Hot Worked                   | 620                                                                            | 300            | 40          | max 245     |
|                |                         | Cold Drawn - As Hot Worked                   | 830                                                                            | 600            | 15          | max 280     |
|                |                         | Cold Drawn - Sol Annealed                    | 600                                                                            | 210            | 20          | max 185     |
|                |                         | Hot Worked - Sol Annealed                    | 580                                                                            | 200            | 40          | max 185     |
|                |                         | Cold Drawn - Aged                            | 930-1000                                                                       | 655-760        | 15-20       | 255-300 min |
| EG2            | Alloy K-500             | Hot Worked - Aged                            | 965                                                                            | 689            | 20          | 265 min     |
|                |                         | Cold Drawn - Sol Annealed - Aged             | 896                                                                            | 586-655        | 20          | max 250     |
|                |                         | Hot Worked - Sol Annealed - Aged             | 896                                                                            | 586-655        | 20          | max 250     |
|                |                         | Hot Worked - Annealed (grade1)               | 760-830                                                                        | 345-415        | 25-30       | max 325     |
|                |                         | Cold Drawn - Sol Annealed (grade1)           | 760-830                                                                        | 345-415        | 25-30       | max 325     |
|                |                         | Hot Worked - Sol Annealed (grade2)           | 690                                                                            | 276            | 30          | max 325     |
| GL3            | Alloy 625               | Cold Worked - Sol Annealed (grade2)          | 690                                                                            | 276            | 30          | max 325     |
|                |                         | Hot Worked - Sol Annealed                    | 690                                                                            | 283            | 40          | -           |
|                |                         | Hot Worked - Sol Annealed                    | -                                                                              | -              | -           | max 277     |
| AV718HTV       | Alloy 718               | Hot Worked - Sol Annealed - Aged             | 1275                                                                           | 1035           | 12          | 331 min     |
| AV718CRV       | Alloy 718               | Hot Worked - Sol Annealed - Aged             | 1034                                                                           | 827-1000       | ≥ 20        | 300 - 363   |

| VALBRUNA GRADE        | COMMERCIAL NAME         | C (%)    | Mn (%)   | Si (%)   | S (%)     | P (%)     | Ni (%)     | Cr (%)      | Fe (%)   | Mo (%)   | Cu (%)   | Ti (%)    | Al (%)    | Co (%)   | Others (%)                                                                                   |
|-----------------------|-------------------------|----------|----------|----------|-----------|-----------|------------|-------------|----------|----------|----------|-----------|-----------|----------|----------------------------------------------------------------------------------------------|
| SG1                   | Alloy 200<br>Alloy 201  | max 0,02 | max 0,35 | max 0,35 | max 0,010 | -         | min 99     | -           | max 0,40 | -        | max 0,25 | max 0,10  | -         | max 2,00 | Mg max 0,20                                                                                  |
| AN2                   | Alloy 825<br>Alloy 65   | max 0,05 | max 1,00 | max 0,50 | max 0,030 | max 0,030 | 38-46      | 19,50-23,50 | min 22   | 2,5-3,5  | 1,5-3,0  | 0,6-1,2   | max 0,20  | max 2,00 | -                                                                                            |
| AV925                 | Alloy 925               | max 0,03 | max 1,00 | max 0,50 | max 0,030 | -         | 42-46      | 19,50-22,50 | min 22   | 2,5-3,5  | 1,5-3,0  | 1,9-2,4   | 0,10-0,50 | -        | Nb 0,5 max                                                                                   |
| AN4                   | Alloy 904L              | max 0,02 | max 2,00 | max 0,70 | max 0,010 | max 0,030 | 24-26      | 19-21       | min 49   | 4,0-5,0  | 1,20-2,0 | -         | -         | -        | N max 0,15                                                                                   |
| VAL4529               | Alloy 926               | max 0,02 | max 2,00 | max 0,50 | max 0,010 | max 0,030 | 24-26      | 19-21       | min 47   | 6,0-7,0  | 0,5-1,5  | -         | -         | -        | N 0,15-0,25                                                                                  |
|                       | Alloy 367               | max 0,03 | max 2,00 | max 1,00 | max 0,030 | max 0,040 | 23,5-25,50 | 20-22       | min 47   | 6,0-7,0  | max 0,75 | -         | -         | -        | N 0,18-0,25                                                                                  |
| AN5                   | Alloy 660<br>Alloy A286 | max 0,08 | max 2,00 | max 1,00 | max 0,025 | max 0,025 | 24-27      | 13,5-16     | balance  | 1,0-1,50 | max 0,50 | 1,9-2,30  | max 0,35  | max 1,00 | V 0,10-0,50<br>B 0,003-0,010                                                                 |
| AV20                  | Alloy 20                | max 0,07 | max 2,00 | max 1,00 | max 0,035 | max 0,045 | 32-38      | 19-21       | -        | 2-3      | 3-4      | -         | -         | -        | Nb+Ta max 1,0                                                                                |
| EG1                   | Alloy 400               | max 0,20 | max 2,00 | max 0,50 | max 0,015 | max 0,020 | min 63     | -           | max 2,5  | -        | 28-34    | -         | max 0,50  | max 2,00 | Pb max 0,006<br>Sn max 0,006<br>Zn max 0,02                                                  |
| EG2                   | Alloy K-500             | max 0,25 | max 1,50 | max 0,50 | max 0,010 | -         | min 63     | -           | max 2,0  | -        | 27-33    | 0,35-0,85 | 2,3-3,15  | max 2,00 | -                                                                                            |
| GL3                   | Alloy 625               | max 0,10 | max 0,50 | max 0,50 | max 0,015 | max 0,015 | min 58     | 20-23       | max 5,0  | 8,0-10   | max 0,50 | max 0,40  | max 0,40  | max 1,00 | Nb+Ta 3,15-4,15<br>Ta max 0,50<br>Nb 3,15-4,15                                               |
| AVC276                | Alloy C276              | max 0,01 | max 1,00 | max 0,08 | max 0,030 | max 0,040 | balance    | 14,5-16,5   | 4-7      | 15-17    | -        | -         | -         | max 2,50 | W 3,0-4,50<br>V max 0,35                                                                     |
| AV718CRV/<br>AV718HTV | Alloy 718               | max 0,08 | max 0,35 | max 0,35 | max 0,015 | max 0,015 | 50-55      | 17-21       | 15-21    | 2,8-3,3  | max 0,30 | 0,65-1,15 | 0,20-0,80 | max 1,00 | Nb 4,75-5,50<br>Ta max 0,05<br>B max 0,006<br>Pb max 5 ppm<br>Se max 3 ppm<br>Bi max 0,3 ppm |



Selection Criteria of Nickel Alloys for Corrosion Environments at High Temperature

|                      | CORROSION MEDIA               | Ni | Ni-Cu | Ni-Fe-Cr | Ni-Cr-Mo |
|----------------------|-------------------------------|----|-------|----------|----------|
| Low Concentration    | Pure Sulfuric Acid            |    | x     | x        | x        |
|                      | Pure Hydrochloric Acid        |    |       |          |          |
|                      | Pure Hydrofluoric Acid        |    |       |          |          |
|                      | Pure Phosphoric Acid          |    |       | x        | x        |
|                      | Pure Nitric Acid              |    |       | x        | x        |
| Medium Concentration | Caustic Soda & Caustic Potash | x  | x     |          | x        |
|                      | Pure Sulfuric Acid            |    |       |          |          |
|                      | Pure Hydrochloric Acid        |    |       |          |          |
|                      | Pure Hydrofluoric Acid        |    |       |          |          |
|                      | Pure Phosphoric Acid          |    |       | x        | x        |
| High Concentration   | Pure Nitric Acid              |    |       | x        |          |
|                      | Pure Sulfuric Acid            |    |       |          | x        |
|                      | Pure Hydrochloric Acid        |    |       |          |          |
|                      | Pure Hydrofluoric Acid        |    |       |          |          |
|                      | Pure Phosphoric Acid          |    |       | x        | x        |
|                      | Pure Nitric Acid              |    |       | x        |          |
|                      | Caustic Soda & Caustic Potash | x  |       |          |          |

High Temperature (from 79°C up to boiling)

Selection Criteria of Nickel Alloys for Corrosion Environments at Medium Temperature

|                      | CORROSION MEDIA               | Ni | Ni-Cu | Ni-Fe-Cr | Ni-Cr-Mo |
|----------------------|-------------------------------|----|-------|----------|----------|
| Low Concentration    | Pure Sulfuric Acid            |    | x     | x        | x        |
|                      | Pure Hydrochloric Acid        |    |       |          | x        |
|                      | Pure Hydrofluoric Acid        |    | x     |          | x        |
|                      | Pure Phosphoric Acid          |    | x     | x        | x        |
|                      | Pure Nitric Acid              |    |       | x        | x        |
| Medium Concentration | Caustic Soda & Caustic Potash | x  | x     | x        | x        |
|                      | Pure Sulfuric Acid            |    | x     | x        | x        |
|                      | Pure Hydrochloric Acid        |    |       |          |          |
|                      | Pure Hydrofluoric Acid        |    | x     |          | x        |
|                      | Pure Phosphoric Acid          |    | x     | x        | x        |
| High Concentration   | Pure Nitric Acid              |    |       | x        | x        |
|                      | Pure Sulfuric Acid            |    |       |          | x        |
|                      | Pure Hydrochloric Acid        |    |       |          |          |
|                      | Pure Hydrofluoric Acid        |    | x     | x        | x        |
|                      | Pure Phosphoric Acid          |    |       | x        | x        |
|                      | Pure Nitric Acid              |    |       | x        |          |
|                      | Caustic Soda & Caustic Potash | x  | x     |          |          |

Medium Temperature (from 52°C up to 79°C)

Selection Criteria of Nickel Alloys for Corrosion Environments at Low Temperature

|                      | CORROSION MEDIA               | Ni | Ni-Cu | Ni-Fe-Cr | Ni-Cr-Mo |
|----------------------|-------------------------------|----|-------|----------|----------|
| Low Concentration    | Pure Sulfuric Acid            |    | x     | x        | x        |
|                      | Pure Hydrochloric Acid        |    | x     | x        | x        |
|                      | Pure Hydrofluoric Acid        |    |       | x        | x        |
|                      | Pure Phosphoric Acid          |    | x     | x        | x        |
|                      | Pure Nitric Acid              |    |       | x        | x        |
| Medium Concentration | Caustic Soda & Caustic Potash | x  | x     |          | x        |
|                      | Pure Sulfuric Acid            |    | x     | x        | x        |
|                      | Pure Hydrochloric Acid        |    |       |          | x        |
|                      | Pure Hydrofluoric Acid        |    | x     |          | x        |
|                      | Pure Phosphoric Acid          |    | x     | x        | x        |
| High Concentration   | Pure Nitric Acid              |    |       | x        | x        |
|                      | Pure Sulfuric Acid            |    |       | x        | x        |
|                      | Pure Hydrochloric Acid        |    |       |          | x        |
|                      | Pure Hydrofluoric Acid        |    | x     |          | x        |
|                      | Pure Phosphoric Acid          |    |       | x        | x        |
|                      | Pure Nitric Acid              |    |       | x        |          |
|                      | Caustic Soda & Caustic Potash | x  | x     |          |          |

Low Temperature (from room temp. up to 52°C)

| LEGEND          | VALBRUNA GRADE                                |
|-----------------|-----------------------------------------------|
| Ni Alloys       | SG1                                           |
| Ni-Cu Alloys    | EG1; EG2                                      |
| Ni-Fe-Cr Alloys | AV20; AN5; AV925; AV718CRV; AN2; AN4; VAL4529 |
| Ni-Cr-Mo Alloys | AVC276; GL3                                   |

There are some applications at elevated temperatures (such as aircraft components, chemical plant and petrochemical equipment) where a good combination of high strength and corrosion resistance is requested.

For these kinds of applications Nickel alloys could provide the most suitable properties such as:

Good resistance to corrosion, creep, fatigue, thermal fatigue, thermal shock, impact, cavitation and erosion, good fracture properties, forming characteristics and weldability.



## HIGH TEMPERATURE ALLOYS - Designations

| VALBRUNA GRADE | COMMERCIAL NAME                        | UNS                        | W.N.     | BS              | INTERNATIONAL DESIGNATION            | ASTM         | ASME           | AMS  | EN                      | DIN                     | BS     | Other   |
|----------------|----------------------------------------|----------------------------|----------|-----------------|--------------------------------------|--------------|----------------|------|-------------------------|-------------------------|--------|---------|
| AN1            | Alloy 800<br>Alloy 800H<br>Alloy 800HT | N08800<br>N08810<br>N08811 | 1.4876   | NA15<br>NA15(H) | X10NiCrAlTi32-21<br>X10NiCrAlTi32-20 | B408<br>B564 | SB408<br>SB564 | 5766 | 10095                   | -                       | 3076   | SEW 470 |
| AN3            | Alloy DS                               | -                          | (1.4862) | NA17            | X8NiCrSi38-18                        | -            | -              | -    | 10095                   | -                       | 3076   | -       |
| AN3US          | Alloy 330                              | N08330                     | -        | -               | -                                    | B511         | -              | 5716 | -                       | -                       | -      | -       |
| AN3CB          | Alloy 330Cb                            | -                          | -        | -               | -                                    | -            | -              | -    | -                       | -                       | -      | -       |
| GL1            | Alloy 600                              | N06600                     | 2.4816   | NA14            | NiCr15Fe                             | B166<br>B564 | SB166<br>SB564 | 5665 | 10095                   | 17742<br>17752          | 3076   | -       |
| GL2            | Alloy 80A                              | N07080                     | 2.4952   | NA20            | NiCr20TiAl                           | B637         | SB637          | -    | 10302<br>10269<br>10090 | 17480<br>17240<br>17742 | 3076   | -       |
| GL5            | Alloy 601                              | N06601                     | 2.4851   | NA49            | NiCr23Fe                             | B166<br>B564 | SB166<br>SB564 | 5715 | 10095                   | 17742<br>17752<br>1736  | 2901-5 | -       |



## HIGH TEMPERATURE ALLOYS



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### HIGH TEMPERATURE ALLOYS - Chemical Composition

| VALBRUNA GRADE | COMMERCIAL NAME                        | C [%]     | Mn [%]    | Si [%]    | S [%]     | P [%]     | Ni [%]  | Cr [%] | Fe [%]    | Mo [%] | Cu [%]   | Ti [%]    | Al [%]    | Co [%]   | Others [%]                    |
|----------------|----------------------------------------|-----------|-----------|-----------|-----------|-----------|---------|--------|-----------|--------|----------|-----------|-----------|----------|-------------------------------|
| AN1            | Alloy 800<br>Alloy 800H<br>Alloy 800HT | 0,06-0,10 | max 1,50  | max 1,00  | max 0,015 | max 0,030 | 30-34   | 19-23  | min 39,50 | -      | max 0,75 | 0,15-0,60 | 0,15-0,60 | -        | -                             |
| AN3            | Alloy DS                               | max 0,10  | 0,80-1,50 | 1,90-2,60 | max 0,030 | -         | 34,5-41 | 17-19  | min 41    | -      | max 0,50 | max 0,20  | -         | -        | -                             |
| AN3US          | Alloy 330                              | max 0,80  | max 2,00  | 0,75-1,50 | max 0,030 | max 0,030 | 34-37   | 17-20  | min 41    | -      | max 1,0  | -         | -         | -        | Sn max 0,025<br>Pb max 0,0050 |
| AN3CB          | Alloy 330Cb                            | max 0,15  | max 2,00  | 1,00-2,00 | max 0,015 | max 0,030 | 33-37   | 20-23  | min 41    | -      | -        | -         | -         | -        | Nb 1,0-2,0                    |
| GL1            | Alloy 600                              | max 0,15  | max 1,00  | max 0,50  | max 0,015 | max 0,020 | min 72  | 14-17  | 6,0-10,0  | -      | max 0,50 | max 0,30  | max 0,30  | max 1,00 | -                             |
| GL2            | Alloy 80A                              | 0,04-0,10 | max 1,00  | max 1,00  | max 0,015 | max 0,020 | min 65  | 18-21  | max 3,0   | -      | max 0,20 | 1,8-2,70  | 1,00-1,80 | max 1,00 | B max 0,008                   |
| GL5            | Alloy 601                              | 0,03-0,10 | max 1,00  | max 0,50  | max 0,015 | max 0,020 | 58-63   | 21-25  | max 18    | -      | max 0,50 | max 0,50  | 1,00-1,70 | max 1,50 | B max 0,006                   |



### HIGH TEMPERATURE ALLOYS - Mechanical properties

| VALBRUNA GRADE | COMMERCIAL NAME | Condition                                  | Mechanical Properties at room Temperature requested by standard specifications |                |             |         |
|----------------|-----------------|--------------------------------------------|--------------------------------------------------------------------------------|----------------|-------------|---------|
|                |                 |                                            | T.S. min [MPa]                                                                 | Y.S. min [MPa] | E4d min [%] | HB      |
| AN1            | Alloy 800       | Hot Worked - As Hot Worked                 | 550                                                                            | 240            | 25          | -       |
|                |                 | Hot Worked - Sol Annealed                  | 515                                                                            | 205            | 30          | -       |
|                |                 | Cold Worked - Sol Annealed                 | 515                                                                            | 205            | 30          | 155-268 |
|                | Alloy 800H      | Cold Worked - Sol Annealed                 | 450                                                                            | 170            | 30          | 155-268 |
|                |                 | Hot Worked - Sol Annealed                  | 450                                                                            | 170            | 30          | 155-192 |
|                |                 | Cold Worked - Sol Annealed                 | 450                                                                            | 170            | 30          | 155-268 |
| AN3            | Alloy DS        | Hot Worked - Sol Annealed                  | 450                                                                            | 170            | 30          | 155-192 |
|                |                 | Hot Worked - As Hot Worked                 | 600                                                                            | 250            | 30          | -       |
|                |                 | Hot Worked - Sol Annealed                  | 600                                                                            | 250            | 30          | -       |
|                |                 | Cold Worked - Sol Annealed                 | 600                                                                            | 250            | 30          | -       |
| AN3US          | Alloy 330       | Hot Worked - Sol Annealed                  | 483                                                                            | 207            | 30          | -       |
| AN3CB          | Alloy 330Cb     | Hot Worked - Sol Annealed                  | 500                                                                            | 100            | 40          | -       |
| GL1            | Alloy 600       | Cold Worked - As Hot Worked                | 725-825                                                                        | 550-620        | 7-12        | -       |
|                |                 | Hot Worked - As Hot Worked                 | 585-655                                                                        | 240-310        | 20-30       | -       |
|                |                 | Hot Worked - Sol Annealed                  | 550                                                                            | 240            | 30          | -       |
|                |                 | Cold Worked - Sol Annealed                 | 550                                                                            | 240            | 30          | -       |
|                |                 | Hot Worked - Sol Annealed                  | 1000                                                                           | 620            | 18          | -       |
| GL2            | Alloy 80A       | Hot Worked - Sol Annealed-Aged             | 1180                                                                           | 760            | 18          | -       |
|                |                 | Hot Worked - Sol Annealed-Stabilized-Aged  | 1150                                                                           | 710            | 12          | -       |
|                |                 | Cold Worked - Sol Annealed                 | 1000                                                                           | 620            | 12          | -       |
|                |                 | Cold Worked - Sol Annealed-Stabilized-Aged | 1000                                                                           | 620            | 12          | -       |
| GL5            | Alloy 601       | Hot Worked - Sol Annealed                  | 550                                                                            | 205            | 30          | -       |
|                |                 | Cold Worked - Sol Annealed                 | 550                                                                            | 205            | 30          | -       |



### HIGH TEMPERATURE ALLOYS - Service temperature

| VALBRUNA GRADE | Service temperature |         | Description                                                    |
|----------------|---------------------|---------|----------------------------------------------------------------|
|                | Min                 | Max     |                                                                |
| AN1 (800)      | cryogenic           | 600° C  | good corrosion, heat resistance and mechanical properties      |
| AN1 (800H)     | 600°                | 816° C  | good creep-rupture properties at T> 700° C                     |
| AN1 (800HT)    | 700°                | 1000° C | excellent creep strength (but reduced ductility) at T> 700° C  |
| AN3            | -                   | 1000° C | good oxidation resistance                                      |
| AN3US          | -                   | 1150° C | good oxidation resistance also at reducing atmospheres         |
| AN3CB          | -                   | 1150° C | better creep rupture resistance                                |
| GL1            | cryogenic           | 1093° C | high resistance to oxidation atmospheres                       |
| GL2            | -                   | 815° C  | good mechanical properties and outstanding resistance to creep |
| GL5            | 540°                | 1150° C | good corrosion resistance                                      |

## WELDING ALLOYS

Alloys with special chemical balance for welding



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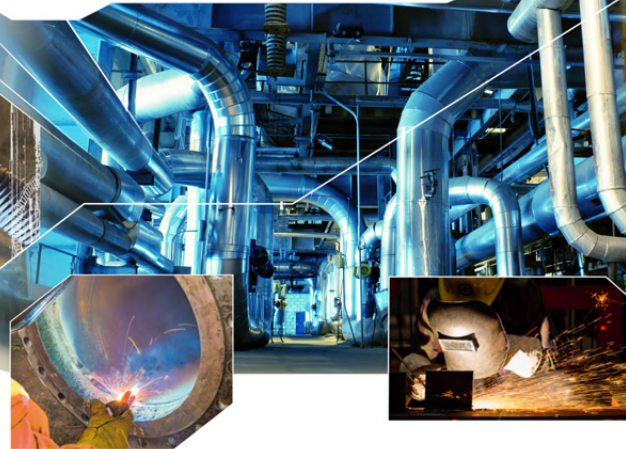
## Nickel Alloys for Special Applications

### WELDING ALLOYS - Designations

| VALBRUNA GRADE | COMMERCIAL NAME       | UNS              | W.N.     | BS   | INTERNATIONAL DESIGNATION          | ASTM | ASME | AMS | EN   | DIN  | BS     | Other                               |
|----------------|-----------------------|------------------|----------|------|------------------------------------|------|------|-----|------|------|--------|-------------------------------------|
| GL3/EL         | Alloy 625             | N06625           | 2.4831   | NA43 | SG-NiCr21Mo9Nb<br>UP-NiCr21Mo9Nb   | B446 | -    | -   | 1736 | -    | 2901   | A5.14 ERNiCrMo-3                    |
| AN2            | Alloy 825<br>Alloy 65 | N08825<br>N08065 | (2.4858) | NA41 | SG-NiCr27Mo                        | F45  | -    | -   | -    | -    | 2901   | A5.14 ERNiFeCr-1                    |
| GL4            | Alloy 82              | N06082           | 2.4806   | NA35 | SG-NiCr20Nb<br>UP-NiCr20Nb         | -    | -    | -   | 1736 | -    | 2901   | A5.14 ERNiCr-3                      |
| GL5            | Alloy 601             | N06601           | 2.4826   | NA49 | -                                  | B166 | -    | -   | -    | 1736 | 2901-5 | -                                   |
| EG3            | Alloy 60              | N04060           | 2.4377   | NA33 | SG-NiCu 30 MnTi<br>UP-NiCu 30 MnTi | -    | -    | -   | 1736 | -    | 2901   | A5.14 ERNiCu-7                      |
| SG2            | Alloy 55              | W82002           | (2.4560) | NA47 | S-NiFe 40                          | -    | -    | -   | 1736 | -    | 2901-5 | A 5.15 ERNiFe-CL<br>A 5.15 ENiFe-CL |
| SG3            | Alloy 55 Ti           | -                | -        | -    | -                                  | -    | -    | -   | -    | -    | -      | -                                   |
| SG6            | Alloy 61              | N02061           | 2.4155   | NA32 | SG-NiTi 4                          | -    | -    | -   | 1736 | -    | 2901   | A5.14 ERNi-1                        |

### WELDING ALLOYS - Mechanical properties

| VALBRUNA GRADE | COMMERCIAL NAME | Condition                 | Mechanical Properties at room Temperature requested by standard specifications |                |             |    |
|----------------|-----------------|---------------------------|--------------------------------------------------------------------------------|----------------|-------------|----|
|                |                 |                           | T.S. min [MPa]                                                                 | Y.S. min [MPa] | E4d min [%] | HB |
| GL3/EL         | Alloy 625       | Hot Worked - Sol Annealed | 720                                                                            | 276            | 30          | -  |
| AN2            | Alloy 65        | Hot Worked - Sol Annealed | 552                                                                            | 230            | 25          | -  |
| GL4            | Alloy 82        | Hot Worked - Sol Annealed | 650                                                                            | 320            | 25          | -  |
| GL5            | Alloy 601       | Hot Worked - Sol Annealed | 650                                                                            | 320            | 25          | -  |
| EG3            | Alloy 60        | Hot Worked - Sol Annealed | 700                                                                            | 450            | 30          | -  |
| SG2            | Alloy 55        | Hot Worked - Sol Annealed | 350                                                                            | -              | 6           | -  |
| SG3            | Alloy 55Ti      | Hot Worked - Sol Annealed | -                                                                              | -              | -           | -  |
| SG6            | Alloy 61        | Hot Worked - Sol Annealed | 400                                                                            | -              | 18          | -  |



### WELDING ALLOYS - Chemical Composition

| VALBRUNA GRADE | COMMERCIAL NAME | C [%]     | Mn [%]    | Si [%]    | S [%]     | P [%]     | Ni [%] | Cr [%]      | Fe [%]   | Mo [%]  | Cu [%]   | Ti [%]    | Al [%]    | Co [%]   | Others [%]                    |
|----------------|-----------------|-----------|-----------|-----------|-----------|-----------|--------|-------------|----------|---------|----------|-----------|-----------|----------|-------------------------------|
| GL3/EL         | Alloy 625       | max 0,06  | max 0,25  | max 0,20  | max 0,015 | max 0,010 | min 58 | 21-22,5     | max 0,40 | 8,5-10  | max 0,30 | 0,10-0,30 | max 0,40  | max 0,50 | Nb+Ta 3,4-3,8<br>Pb max 0,005 |
| AN2            | Alloy 65        | max 0,05  | max 1,00  | max 0,50  | max 0,030 | -         | 38-46  | 19,50-23,50 | min 22   | 2,5-3,5 | 1,5-3,0  | 0,6-1,2   | max 0,20  | max 2,00 | -                             |
| GL4            | Alloy 82        | max 0,10  | 2,50-3,50 | max 0,50  | max 0,015 | max 0,030 | min 67 | 18-22       | max 3,0  | -       | max 0,50 | max 0,75  | -         | -        | Nb+Ta 2,0-3,0                 |
| GL5            | Alloy 601       | 0,03-0,10 | max 1,00  | max 0,50  | max 0,015 | max 0,020 | 58-63  | 21-25       | max 18   | -       | max 0,50 | max 0,50  | 1,00-1,70 | max 1,50 | B max 0,006                   |
| EG3            | Alloy 60        | max 0,15  | max 4,0   | max 0,015 | max 0,020 | max 0,020 | 62-69  | -           | max 2,5  | -       | balance  | 1,50-3,00 | max 1,25  | -        | -                             |
| SG2            | Alloy 55        | max 0,03  | 0,60-0,80 | max 0,15  | max 0,010 | max 0,015 | 54-55  | -           | 43-45    | -       | -        | -         | -         | -        | -                             |
| SG3            | Alloy 55 Ti     | max 0,03  | 0,60-0,80 | max 0,15  | max 0,015 | max 0,015 | 52-55  | -           | 42-47    | -       | -        | 0,05-0,25 | -         | -        | -                             |
| SG6            | Alloy 61        | max 0,05  | max 0,80  | max 0,75  | max 0,010 | max 0,030 | min 93 | -           | max 0,70 | -       | max 0,05 | 2,0-3,5   | max 1,00  | -        | -                             |

### WELDING PROCESS

|     | Very Good                 | Good                      | Satisfactory |
|-----|---------------------------|---------------------------|--------------|
| TIG | GL3EL, GL4, GL5, EG3, SG6 |                           | AN2          |
| MIG |                           | GL3EL, GL4, EG3, AN2, SG6 |              |
| PAW | GL3EL, GL4, GL5, EG3, SG6 |                           |              |



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High quality is our standard

## ELECTRICAL RESISTANCE AND ELECTRONIC INSTRUMENT ALLOYS

These alloys are mostly used for the manufacture of heating elements for industrial furnaces and domestic devices.

Alloys with special physical properties, such as a low coefficient of expansion, are requested for applications that include precision components in magnetic shields, integrated circuits, and glass-to-metal seals.



### ELECTRICAL RESISTANCE AND ELECTRONIC INSTRUMENT ALLOYS - Designations

| VALBRUNA GRADE     | COMMERCIAL NAME | UNS    | W.N.   | BS | INTERNATIONAL DESIGNATION | ASTM | ASME | AMS | EN    | DIN   | BS | Other   |
|--------------------|-----------------|--------|--------|----|---------------------------|------|------|-----|-------|-------|----|---------|
| SG4                | Alloy 212       | N02212 | 2.4110 | -  | NiMn 2                    | -    | -    | -   | -     | 17741 | -  | -       |
| EG4                | Alloy 401       | N04401 | 2.0842 | -  | -                         | F30  | -    | -   | 17644 | -     | -  | -       |
| SG5                | Alloy 36        | K93601 | 1.3912 | -  | Ni 36                     | -    | -    | -   | -     | 17745 | -  | SEW 385 |
| VAL40              | Alloy 40        | -      | 1.4860 | -  | NiCr 30 20 (X16NiCr30-20) | -    | -    | -   | -     | 17470 | -  | -       |
| VAL60              | Alloy 60/40     | N06004 | 2.4867 | -  | NiCr6015                  | B344 | -    | -   | -     | 17742 | -  | -       |
| VAL80              | Alloy 80/20     | N06003 | 2.4869 | -  | NiCr60-20                 | B344 | -    | -   | -     | 17742 | -  | -       |
| X21AL <sup>®</sup> | CrAl20-5        | -      | 1.4767 | -  | -                         | B603 | -    | -   | 17470 | -     | -  | -       |
| X22AL <sup>®</sup> | CrAl25-5        | -      | 1.4765 | -  | -                         | B603 | -    | -   | 17470 | -     | -  | -       |

<sup>®</sup>Cr-Al Alloys

### ELECTRICAL RESISTANCE AND ELECTRONIC INSTRUMENT ALLOYS - Chemical Composition

| VALBRUNA GRADE     | COMMERCIAL NAME | C (%)    | Mn (%)    | Si (%)    | S (%)     | P (%)     | Ni (%)   | Cr (%) | Fe (%)   | Mo (%) | Cu (%)   | Ti (%) | Al (%)    | Co (%)   | Others (%)                  |
|--------------------|-----------------|----------|-----------|-----------|-----------|-----------|----------|--------|----------|--------|----------|--------|-----------|----------|-----------------------------|
| SG4                | Alloy 212       | max 0,50 | 1,50-2,50 | max 0,20  | max 0,010 | -         | min 97   | -      | max 0,30 | -      | max 0,20 | -      | -         | -        | Ni+Co min 97<br>Mg max 0,15 |
| EG4                | Alloy 401       | max 0,10 | 0,50-2,00 | max 0,30  | max 0,020 | -         | 40-45    | -      | max 0,50 | -      | min 58   | -      | -         | max 0,50 | Zn max 0,20<br>Pb max 0,010 |
| SG5                | Alloy 36        | max 0,10 | max 0,60  | max 0,50  | -         | -         | 35-37    | -      | balance  | -      | -        | -      | -         | -        | -                           |
| VAL40              | Alloy 40        | max 0,15 | max 1,00  | 1,00-3,00 | max 0,010 | -         | 34-37    | 18-21  | balance  | -      | -        | -      | -         | max 1,00 | Ni+Co 34-37                 |
| VAL60              | Alloy 60/40     | max 0,15 | max 1,00  | 0,75-1,75 | max 0,010 | -         | min 57   | 14-18  | min 20   | -      | -        | -      | -         | max 1,00 | Ni+Co min 57                |
| VAL80              | Alloy 80/20     | max 0,15 | max 1,00  | 0,75-1,75 | max 0,010 | -         | 76-80    | 19-21  | max 1,0  | -      | -        | -      | -         | max 1,00 | -                           |
| X21AL <sup>®</sup> | CrAl20-5        | max 0,10 | max 1,00  | max 1,00  | max 0,030 | max 0,045 | max 0,20 | 19-22  | balance  | -      | -        | -      | 4,00-5,00 | -        | -                           |
| X22AL <sup>®</sup> | CrAl25-5        | max 0,10 | max 0,06  | max 1,00  | max 0,030 | max 0,045 | max 0,20 | 22-25  | balance  | -      | -        | -      | 4,50-6,00 | -        | -                           |

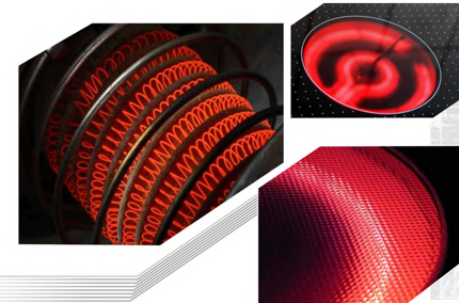
<sup>®</sup>Cr-Al Alloys

## Nickel Alloys for Special Applications

### ELECTRICAL RESISTANCE AND ELECTRONIC INSTRUMENT ALLOYS - Mechanical properties

| VALBRUNA GRADE     | COMMERCIAL NAME | Condition                 | Mechanical Properties at room Temperature requested by standard specifications |                |             |         |
|--------------------|-----------------|---------------------------|--------------------------------------------------------------------------------|----------------|-------------|---------|
|                    |                 |                           | T.S. min (MPa)                                                                 | Y.S. min (MPa) | E4d min (%) | HB      |
| SG4                | Alloy 212       | Hot Worked - Sol Annealed | -                                                                              | -              | -           | -       |
| EG4                | Alloy 401       | Hot Worked - Sol Annealed | 420                                                                            | 130            | 48          | -       |
| SG5                | Alloy 36        | Hot Worked - Sol Annealed | 450                                                                            | 200            | 30          | max 220 |
| VAL40              | Alloy 40        | Hot Worked - Sol Annealed | 700                                                                            | 350            | 35          | -       |
| VAL60              | Alloy 60/40     | Hot Worked - Sol Annealed | -                                                                              | -              | -           | -       |
| VAL80              | Alloy 80/20     | Hot Worked - Sol Annealed | 650                                                                            | 280            | 30          | -       |
| X21AL <sup>®</sup> | CrAl20-5        | Hot Worked - Sol Annealed | -                                                                              | -              | -           | -       |
| X22AL <sup>®</sup> | CrAl25-5        | Hot Worked - Sol Annealed | -                                                                              | -              | -           | -       |

<sup>®</sup>Cr-Al Alloys



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