AMETEK®
SPECIALTY METAL PRODUCTS
*Innovative & Advanced Metallurgical Technology*

# TECH BRIEFS

# SEALVAR® (ASTM F-15 Alloy or UNS K94610) Nickel Iron Cobalt Strip

## Description

AMETEK's Nickel-Iron-Cobalt strip, **SEALVAR®**, is a high quality alloy used primarily for making hermetic seals with harder glasses and ceramics. **SEALVAR®** is distinguished from competitive F-15 alloy by its higher purity, more closely controlled chemistry, and very low carbon level.

## Advantages

**Reproducible Low Level Of Reactive Impurity Elements**

- Improved die wear.
- Improved soldering.
- Improved bonding (cladding).
- Predictable oxidation: Rate; Adherence; Uniformity.
- Predictable response to other chemical surface treatment steps.
- Lower work hardening rate.
- Improved metal flow in coining operations.
- Reduced stress on glass or ceramic.

**Low Carbon: 0.01% Max.; 0.004% Nom.**

- Improved die wear.
- Predictable response to bright dip.
- Elimination and/or simplification of decarburization heat treatment.
- Reduced sealing bubbles.
- Retention of fine grain size and resulting improved fatigue life and gold plated surface cosmetics.

**Higher Electrical Conductivity (~10%)**

- Improved current flow.

**Higher Thermal Conductivity (~10%)**

- Improved heat dissipation.

**Lower Softening Point (~150%)**

- Lower annealing temperatures.
- Reduced interdiffusion in clad metal processing.

# SEALVAR® (F-15 Alloy) Nickel Iron Cobalt

## Chemical Composition

| | SEALVAR® | ASTM F-15 |
|---|---|---|
| Ni (nominal) | 31.0 | 29.0* |
| Co(nominal) | 15.0 | 17.0* |
| Mn (max.) | 0.07 | 0.5 |
| Si (max.) | 0.05 | 0.2 |
| C (max.) | 0.01 | 0.04 |
| Al (max.) | 0.001 | 0.1 |
| Mg (max.) | 0.001 | 0.1 |
| Zr (max.) | 0.001 | 0.1 |
| Ti (max.) | 0.001 | 0.1 |
| Cu (max.) | 0.05 | 0.2 |
| Cr. (max.) | 0.05 | 0.2 |
| Mo (max.) | 0.001 | 0.2 |
| Fe (max.) | Bal. | Bal.* |

* The iron, nickel and cobalt requirements listed are nominal. They shall be adjusted by manufacturer so that the alloy meets the requirements for coefficient of thermal expansion.

## Low Temperature Phase Stability

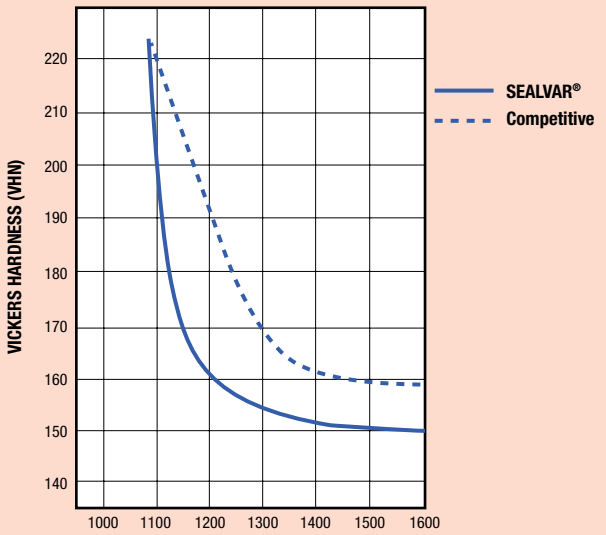
**SEALVAR®** meets and exceeds the ASTM F-15 requirement of no martensitic transformtion upon cooling annealed material to – 78.5°C. Phase stability has also been demonstrated in 30% cold worked material cooled to liquid nitrogen temperature (-196°C). The excellent stability is achieved through the uniform chemistry and the tight control of the effective nickel/iron ratio achievable by the wrought powder metallurgy process. Note the very high purity of **SEALVAR®** in this table.

## Pre-Seal Heat Treatment

The low carbon level of **SEALVAR®** eliminates the need for high temperature wet decarburization heat treatment in glass-to-metal seals made with or without a separate preoxidation step. The lower carbon and lower temperature processing results in reduced frequency of bubbly seals and retention of a fine grain size in the **SEALVAR®** parts. Fine grain size allows smoother finishes on gold plated parts (applicable where ferric chloride etching is performed after high temperature heat treatments) as well as improved fatigue strength.

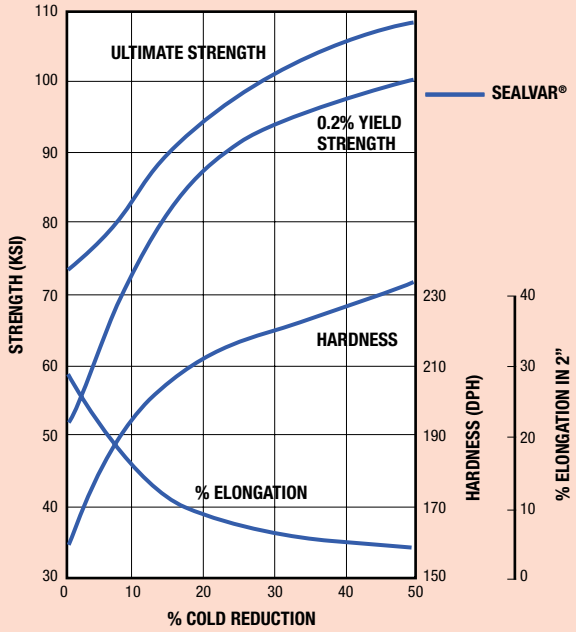
For users preferring a separate heat treatment for removal of residual drawing lubricant or part stress relief anneal, exposures of approximately 15 minutes at 1400-1600°F are recommended as treatments which will not increase grain size above ASTM #8 (0.022 mm). Grain growth response of **SEALVAR®** is comparable to cast F-15 material.

**SOFTENING CURVES 50% COLD ROLLED SEALVAR® AND COMPETITIVE PRODUCT**




**ADVANTAGE: Lower stress relieving temperatures are possible with SEALVAR®**

**SEALVAR® WORK HARDENING CURVES**



# SEALVAR® (F-15 Alloy) Nickel Iron Cobalt

## Specifications

**PROPERTIES OF ANNEALED SEALVAR**

### PHYSICAL PROPERTIES

**MELTING POINT**
1450°C

**CURIE POINT**
435°C

**SPECIFIC HEAT**
cal/gm/°C@0°C: 0.105
cal/gm/°C@430°C: 0.155

**HEAT OF FUSION**
64 cal/gm

**VAPOR PRESSURE**
$10^{-2}$ microns@1000°C

**TRANSFORMATION POINT**
Gamma to Alpha Phase: Below-80°C

**SPECIFIC GRAVITY**
8.20 gm/cm$^3$

**THERMAL CONDUCTIVITY**
148 BTU-in/hr-ft$^2$-°F@100°F

**ELECTRICAL RESISTIVITY**
45.7 $10^6$-ohm-cm@25°C
275-ohm-cm@25°C

### MECHANICAL (TYPICAL)

**ULTIMATE TENSILE STRENGTH**
73,000 psi

**YIELD STRENGTH**
50,000 0.2% offset psi

**ELONGATION**
30-35% in 2”

**MODULUS OF ELASTICITY**
18.0 x $10^6$ psi

**VICKERS HARDNESS**
150-160 VHN

**NOTE**: Values for material annealed to ASTM #8.0-9.5 grain size.

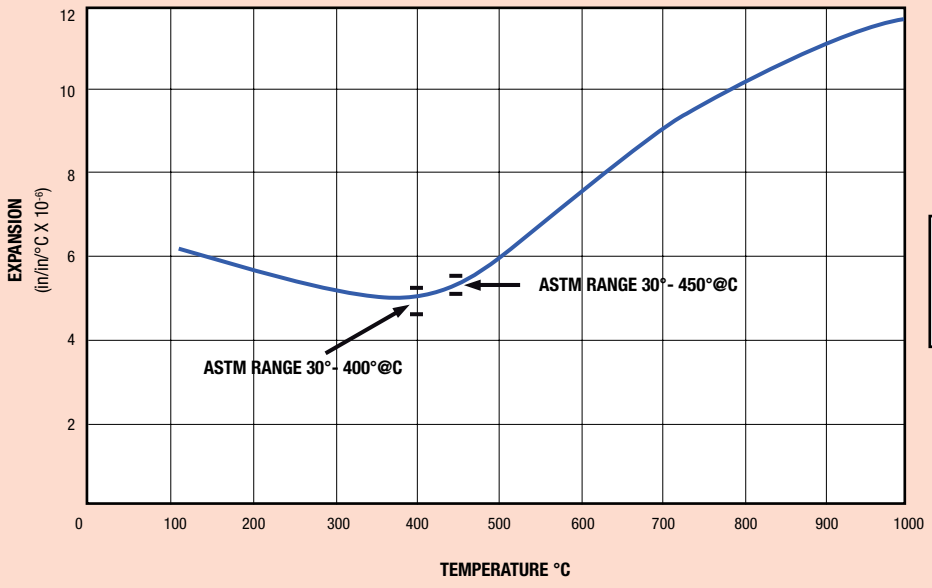
## Thermal Expansion

**SEALVAR® meets specified ASTM F-15 expansion coefficients.**

**THERMAL EXPANSION - ANNEALED SEAVAR®**

| TEMPERATURE RANGE | AVERAGE LINEAR COEFFICIENT THERMAL EXPANSION (in/in/°Cx$10^{-6}$) | in/in/°Fx$10^{-6}$ |
|---|---|---|
| 30-400°C | 4.60-5.20 | 2.6-2.9 |
| 30-450°C | 5.10-5.50 | 2.8-3.1 |

**MEAN EXPANSION COEFFICIENTS VERSUS TEMPERATURE FOR ANNEALED SEAVAR®** 30°C reference temperature




Material given the following pretest anneal:

Heat the specimen in a protective hydrogen atmosphere for one hour at 900°C (1650°F) and then cool it from 900 to 200°C at a rate not exceeding 5°C/minute.

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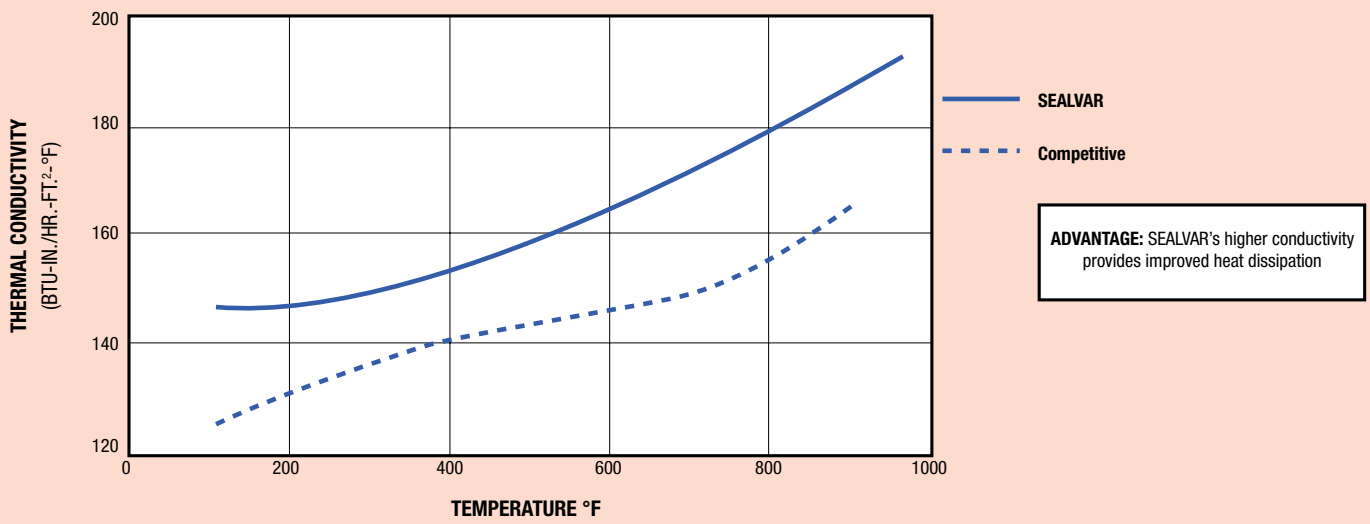
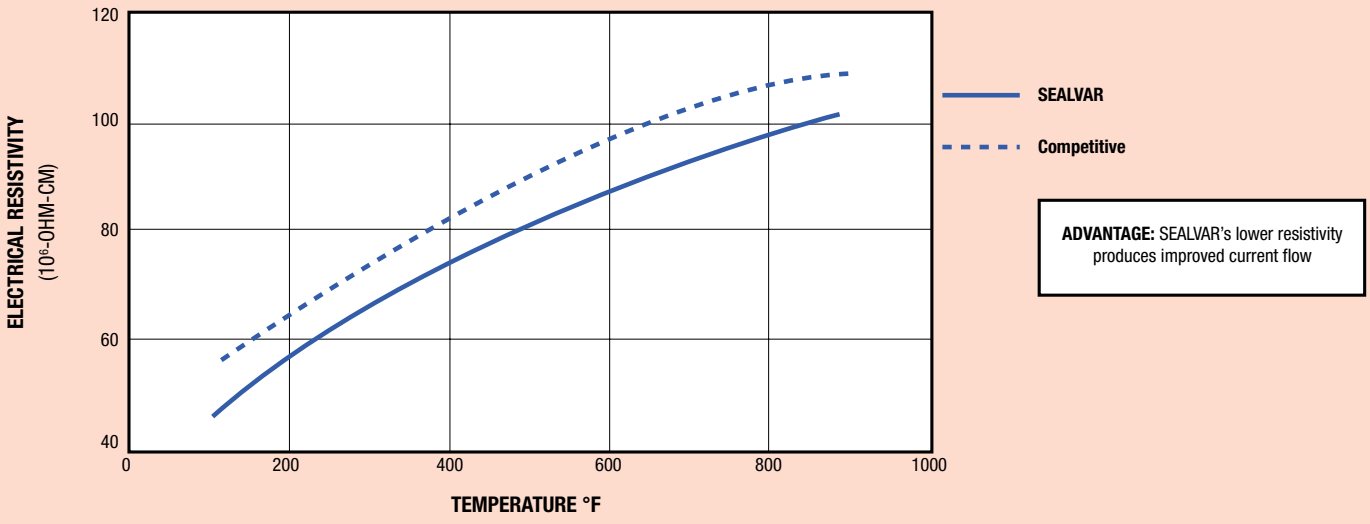
## Thermal Conductivity




## Electrical Resistivity




The higher bulk purity of **SEALVAR®** relative to competitive material results in 10% higher thermal conductivity and 10% lower electrical resistivity

Specifications subject to change without notice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