and chemical industries, the welding products developed for the alloy show a potential for a wide variety of applications which demand hgh strength and toughness at temperatures from the cryogenic range to 2000° F.


*References*

1. Gilliland, R. G., and Slaughter, G. M., "The Welding of New Solution-Strengthened Nickel-Base Alloys," Welding Journal, 45 (7), Research Suppl., 314-s to 320-s (July, 1966).

2. Barker, J. F., Cox, J. D., and Margolin, E., "INCONEL 625—An Alloy for Steam and Gas Turbines," *Metal Progress*, 93 (4), 91-94 (April 1968).

3. "INCOFLUX 5 and 4 Submerged Arc Fluxes," Huntington Alloy Products Division, The International Nickel Company, Inc., Huntington, West Virginia 25720 (1966).

4. "Engineering Properties of INCONEL Alloy 625," Huntington Alloy Products Division, The International Nickel Company, Inc., Huntington, West Virginia 25720 (1966).

5. "Recommended Practices for Detecting Susceptibility to Intergranular Attack in Stainless Steels," Standard A 262-64T, *1966 Book of ASTM Standards*, Part 3, American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

6. "Why Stress Relieve Cryogenic Vessels Made From 9% Nickel Steel?" *Welding Design and Fabrication*, Vol. 33, No. 12, pp. 57-59 (December, 1960).

7. Coutts, D. K., and Whitelaw, R. B., "Low Carbon Nickel Steels for Cryogenic Applications," *Welding Fabrication and Design* (September, 1963).

8. "ASME Boiler and Pressure Vessel Code," Section VIII, Div. 1, Table UHT-23, p. 186. The American Society of Mechanical Engineers, 345 East 47th Street, New York, New York. (1968).


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By Rudolph O. Seitz


*Avtomaticheskaya Svarka* 22, No. 2 (Feb. 1969)

• Sterenborgen, Yu. A. et al.: Kinetics of the formation of chemical heterogencity in the heat-affected zone.—The causes of the formation of chemical heterogencity in the HAZ are discussed. The kinetics of the process was studied with the aid of a mathematical model and a digital computer. It was found that the content of this heterogeneity is greatly affected by boundary migrations during the grain growth in the HAZ (6-10).

• Pokhodnya, I. K. and Yavdoshchin, I.R.: Porosity in welds obtained with rutile-coated electrodes.—The effect of the calcination temperature of the electrodes and of the current level on weld porosity was investigated. It was found that the porosity is caused mainly by hydrogen and that it can be prevented by increasing the partial pressure of hydrogen in the arc atmosphere by the addition of suitable minerals to the coating (mica, kaolin, talc) for the purpose of intensifying hydrogen adsorption and release (11-14).

• Medovar, B. I. and Pavliichuk, G. A.: Effect of boron in the properties and weldability of nickel base alloys. —It has been established that the addition of 0.3-0.5% B increases in cracking resistance. A welding procedure for B-containing stainless nickel alloys has been developed, using a Ni-Cr-Mo electrode with 0.6% B (15-18).

• Rabkin, D. M. et al.: Growth mechanisms of the interlayers in aluminum-copper bimetal.—The mechanisms of the growth of interlayers in the bimetal upon heating have been uncovered by ordinary and by color metallography. The energies of activation have been calculated and the diffusion coefficients have also been determined (19-23).

• Mandel'berg, S. L. et al.; Magnetohydrodynamic phenomena in twin arc welding and how to utilize them.—The problems of interaction of the intrinsic electromagnetic fields and the technological features of different twin arc welding methods are discussed. It is shown that with the most effective method, using a-c, the bead formation is determined largely by the action of the self-generated magnetic field on the pool of liquid weld metal (24-28).

• Makara, A. M. and Nazarchuk, A. T.: How to increase the impact strength of diffusion-welded joints.—The impact strength, orientation and appearance of fracture of diffusion-welded joints in structural alloy steels obtained under widely varying welding conditions were determined. The causes of the lowering if the impact strength were established and recommendations are presented on how to raise the impact strength to the level of the base metal (29-34).

• Kalenski, V. K. and Frumin, I. I.: Determination of residual stresses in hardfaced valves and selection of heat-treating conditions.—The tangential tensile stresses responsible for the formation of radial cracks in type Kh25N40V6 hardfacing metal were determined by measuring the outside diameter of the valve and of the ring of hardfacing metal which was removed from the valve by electromachining. Minimum stress and acceptable hardness of the HAZ is obtained after a two-stage furnace tempering at 740° C of the hardfaced valve made of EI 992 steel (35-38).

• Kazimorov, A. A. et al.: Analytical description of the process of formation of longitudinal weld deformations and stresses.—The initial period in the formation of plastic deformations and stresses in the plate during the welding of a cylinder along the longitudinal seam has been examined. An approximation method of estimating the longitudinal weld deformations and stresses is presented (39-44).

• Chvertko, A. I. et al.: Study of electrode wire feed systems with flexible guide channels.—An efficient design of the flexible guide of wire feed hoses in automatic and semiautomatic welding is described. The authors studied the effect of channel configuration, type of drive rolls and kind of wire used. It was found that molybdenum disulfide greatly reduced wire friction (45-50).

Other articles of interest:

• Nazarenko, O. K. et al.: A new 13.5 kw electron beam welder (51-55).

• Garashchuk, V. P. et al.: Laser welding of electric record player panels (59-60).

• Raevskii, G. V. et al.: Welded tires for rotary furnaces (61-63).

• Belov, Yu, M.: Effect of operating variables on composition of weld deposit in automatic submerged-arc hardfacing with strip electrodes and FR-45 flux (64-68).


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RUDOLPH O. SEITZ is Information Specialist with Air Reduction Co., Murray Hill, N.J.

further cannot be easily admitted that we should have some important chromium depleted zones around the sigma pools. As already mentioned, the transformation rate appears to be too high.

By lowering the heat treatment temperature in order to decrease the transformation rate, it would of course be possible to have long distance diffusion, but this would also result in an homogenization of the austenite around the sigma phase pools. This means that we have not, in fact, a valid method to prove the existence of very small chromium-depleted zones.

#### Conclusions

1. At 850° C the transformation of ferrite to sigma phase occurs very rapidly in the alloys studied. Taking in account both the slow cooling rates during strip welding and the fact that the ferrite pools have smaller dimensions in a weld metal than in the cast or forged steels, it is possible to justify the presence of sigma phase in as deposited weld metal. In order to avoid this type of transformation which is detrimental for the corrosion resistance of the alloys, the welding consumables must be specially designed.

2. The rapid transformation of ferrite to a sigma phase in these low ferrite alloys is characterized by the following particularities:

(a) The transformation occurs *without long distance diffusion*.

(b) It starts at the ferrite-austenite interfaces and progresses very rapidly. The ferrite pools which are first transformed are those where the Mo content is believed to be the highest.

(c) The so called "sigma-phase" is in fact a mixture of very finely dispersed sigma and gamma particles. This means that the specific contact surface between sigma and gamma particles is very high.

(d) The composition of this mixture proved to be the same as that of the original ferrite.

(e) In the present case it is not believed that carbide precipitation interferes with the sigma transformation.

(b) It has not been possible to find chromium depleted zones around the sigma phase pools. If such zones exist, they must be of very small dimensions.

3. The sigma-gamma mixture which is formed in the sites of the original ferrite proved to be very corrosion sensitive. All the etchants are likely to produce very pronounced corrosion effects on those areas. As a result, the higher corrosion rates observed on sigmatised 316L low ferrite alloys can be explained on ground of the following mechanism:

(a) The corrosion does not seem to occur as a result of electrochemical potential differences between the sigma pools on one hand and the austenitic matrix or a chromium depleted austenite around the sigma pools on the other hand.

(b) The corrosion seems to occur as a result of electrochemical potential differences between the sigma and the gamma particles in the transformed areas. The higher the transformation rate of ferrite to sigma, the finer the sigma and gamma particles, the higher the specific surfaces of these particles and the higher the corrosion rate of the alloy.

*References*


1. "Stainless Steel Strip Cladding on Carbon-Ferritic Base Metals," final report, EURATOM—USAEC Contract n° 008-63-12 TEEB.
2. Espy, R. H., "Effect of Composition on the Corrosion Resistance of as Welded 316 L Stainless Steel Weld Deposits," paper presented at the Midwest Welding Conference, Chicago, January 1964.
3. Hall, E. D., and S. H. Algie, "The Sigma Phase," Journal of the Institute of Metals, n°. 4, April 1966.
4. Mommens, Marc, "Metallografische studie van de sigma fase en de delta ferriet fase in Cr-Mn stalen," thesis, 1968, Statts Universiteit Gent.
5. Strickler, R., and Vinckier, A., "La morphologie des carbures de chrome et son influence sur la corrosion inergranulaire d'un acier inoxydable 18/8," Mémoires Scientifiques de la Revue de Métallurgie LX, n° 7-8, 1963.


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- Esibyan, E. M. and Danchenko, M. E.: AVPR-1 equipment for air-plasm-cutting of metals (69-71).

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- Lebedev, B. D.: The problem of carbon equivalent (1-2).
- Nikolaev, G. A. and Kiselev, A. I.: Function of the soft in brazed joints (3-4).

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- Pridantsev, M. V. et al.: Heat-resistant properties of welded joints in austentic chromium-manganese steel with higher aluminum and carbon content (4-5).
- Bakshi, O. A. et al.: Fatigue strength of welded joints in 17 GS steel (6-7).
- Steklov, O. I. and Padaev, A. S.: Effect of nonuniformity of plastic deformation on corrosion cracking of welded joints (7-9).
- Donchenko, E. A. et al.: Effect of heat treatment on the redistribution of chromium, manganese and silicon in the overlay zone (9-11).
- Kuz'min, G. S. and Lazarson, E. V.: Behavior of oxygen, hydrogen and nitrogen in the gas-shielded-arc welding of nickel (11-13).
- Livshits, M. G. et al.: Strength of fillet welds (13-14).
- Lepciko I. P.: Influence of equipment load factor on production cost of welding (15-16).
- Polnarev, A.M.: Economic efficiency of centralized $CO_2$ supply system in the welding shop (16-18).
- Postovalov, Yu, I. et al.: Electroslag welding of circumferential joints at the Urals Machine Works (18-21).
- Rapaport, E. A.: Condensor welding of springs with contacts (21-22).
- Tsygan, B. G. et al.: Characteristics and technology of applying corrosion resistant overlays with vibrating electrodes (22-25.)
- Molchanov, V. D. and Chernykh, N. P.: Effect of hydrogen on the properties of welded joints in high pressure vessels (25-28).
- Astaf'ev, A. S.: Determination of some mechanical properties in the heat-affected zone (28-29).
- Kuznetsov, B. A.: The problem of metal deformation in the HAZ in the welding of type 18-8 steel (29-30).
- Kiselev, S. N. et al.: Residual stresses in welded joints in aluminum pipes (30-31).
- Pastukh, M. N.: and Borovskikh, S. N.: Manual argon arc welding of CAC1 (A1-28Si-6 Ni) alloy (31-32).
- Nazarov, G. V. et al.: Control of contact micro welding, using initial resistance (33-35).
- Volovik, A. Ya. and Kiselev, E. D.: Low-temperature resistance of $CO_2$-welded joints (35-36).
- Tkachev, V. N. and Kagan, A. L.: Longer service life for working parts of earth-moving equipment by resistance-welded alloy strips (37-38).
- Patskevich, I. R. et al.: Vibro-arc application of bronze overlap on steel rods and pistons (38-39).
- Shapiro, I. S. et al.:Plasma arc cutting of thin gage metal (40).