A Survey of the effects of Delta Ferrite in Austenitic Steel Weldments

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1.0 Introduction

Delta ferrite in the austenitic stainless steel weld plays a dual role. On the one hand it affects the corrosion resistance and on the other helps in reducing the susceptibility of the weld to hot cracking. So controlling delta ferrite in austenitic stainless steel weldments has become one of the tricky problems faced both by the consumable manufacturers as well as fabricators. This is more so in the case of equipments subjected to severe corrosive service conditions like urea service where the presence of ferrite in excess of 2% leads to corrosive attack. In such cases special techniques and consumables are required to produce sound joints for satisfactory service performance.

A better understanding of the various aspects of ferrite with regard to its formation, variation, measurement, effect on cracking and corrosion etc. is essential for a better approach to the problem. This paper presents a survey of the developments in these areas.

2.0 Occurrence of Ferrite

The austenitic stainless steels contain in addition to chromium some minimum percentage of Nickel which ensures the room temperature structure to be austenitic. Fig. 1 shows a typical section of the Fe-Cr-Ni diagram at 18%Cr. From the diagram one can visualize that a minimum of 8%Ni is required to render the structure fully austenitic at room temperature. But this seldom occurs during welding. The weldmetals of 18/8 type do retain some amount of delta ferrite formed at higher temperatures. This is attributed to the following reasons.

(i) the transformation of ferrite to austenite—a diffusion based phenomenon—which takes place at higher temperatures is suppressed due to the fast cooling rates experienced by the weldments.

(ii) the segregation that accompanies the weldmetal solidification also favours the ferrite phase to be stable at the dendritic axes which are impoverished in nickel.

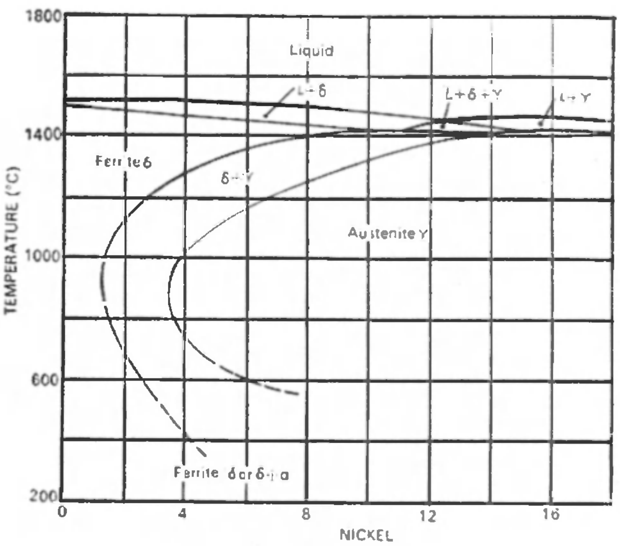

Fig 1 Vertical Section of very low carbon Fe-Cr-Ni Alloys at 18% Cr. (Ref. 20)

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The occurrence of delta ferrite in austenitic stainless steel weldments is therefore dependent on two major factors, the composition of the weldmetal and the welding conditions. Both these factors not only affect the total percentage of delta ferrite in the weld deposit but also its size, morphology and distribution. All these factors and their influences will be discussed in the following paragraphs.

2.1 Effect of Composition

The effect of composition has been vividly brought out by Schaeffler in his diagram (Fig. 2A). This diagram is widely used not only to determine the structure of the weldmetal of a given composition but also to select a suitable filler material for a known composition of the base material. The various elements and their relative effectiveness in stabilizing a ferritic or austenitic structure is shown in the diagram. The diagram gives the percentage of a delta ferrite that can be expected in the weldmetal of a given composition cooled under normal conditions. However it should be remembered that this diagram is based on metallographic studies of several samples.

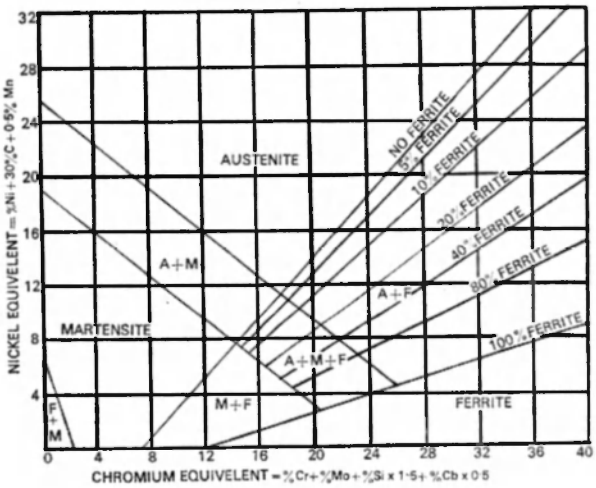


Fig 2A. Schaeffler Diagram

An important aspect, apart from the change in the total amount of ferrite, is the change in morphology of the ferrite network with the composition. J C Lippold and N F Savage[1] in their recent work have clearly brought out the changes occurring in the morphology of the ferrite with the changes in Cr eq/Ni eq ratio. According to them the morphology varies with the composition and also with the nature of solid state transformation. They have observed that when the liquid metal solidifies as primary delta ferrite the room temperature structure exhibits delta ferrite in the subgrain cores and when the liquid metal solidifies as primary austenite the room temperature structure exhibits delta ferrite in subgrain boundaries. The authors have also predicted the ferrite morphologies for various regions of the pseudo-binary diagram (Fig. 3).

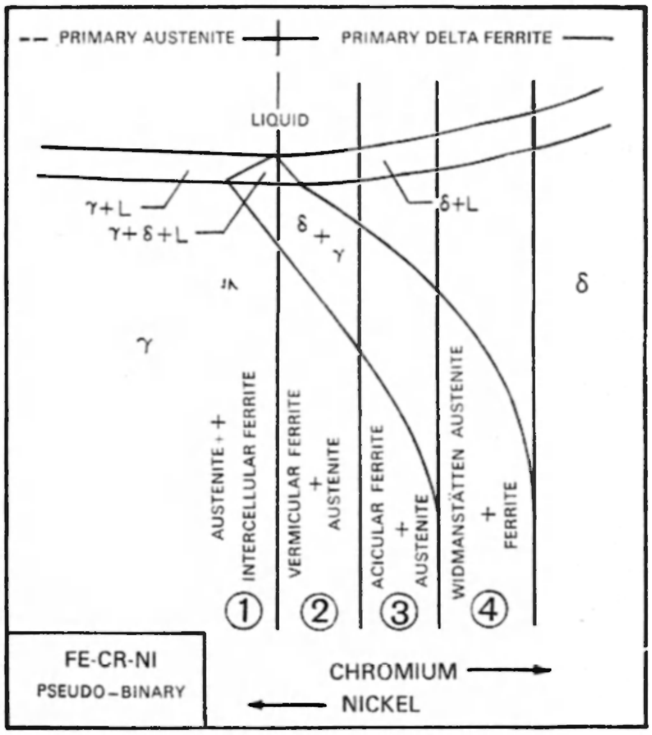


Fig 3 Schematic Pseudo-Binary Diagram of the Fe-Cr-Ni Ternary System (Ref. 1)

2.2 Effect of Welding conditions

The retention of ferrite occurs mainly because of the non-equilibrium cooling experienced by the weldments. Therefore welding conditions do affect the morphology and also the percentage of delta ferrite in the weldmetal.

2.2.1 *Cooling Rate*

The rate at which the weldmetal cools determines the time available for the delta ferrite to transform to austenite. In general if the cooling rate is faster higher amounts of delta ferrite is retained in the weldmetal. This leads to the conclusion, that at higher heat inputs the delta ferrite retained is lesser. With the changes in cooling rate the delta ferrite morphology also varies. When the cooling rate is slow the ferrite tends to coarsen and distribute over a more widely spaced network. Studies at RPI[2] have shown that in autogenous welds of type 304 the normal vermicular morphology of ferrite can be replaced by acicular morphology with a greater than normal ferrite content by rapid quenching. Investigators like Matsude[3] and Fredrikson[4] have also observed that in 18-8 type stainless steel weldmetals the vermicular morphology can be replaced by a lathy morphology by rapid quenching. Thus it is apparent that the weldmetal cooling rate has considerable influence on the ferrite morphology.

2.2.2 *Welding process and Welding conditions*

It can be immediately concluded from the above discussion that the welding process affects the cooling rate and hence the ferrite content and morphology. Moreover the effectiveness of shielding varies from process to process and affects the delta ferrite content of the resulting weldmetal. The effect to the absorption of nitrogen can be visualised from Delong diagram (Fig. 2B) which gives it a coefficient of 30 indicating its strong austenitising tendency. The amount of nitrogen pick up varies with the process. The amount of nitrogen that can be normally expected to be in the weldmetal deposited by different processes are given below :

SMAW	:	0.06% N
GTAW	:	0.02% N
GMAW	:	0.04% N

In SMAW process, the effect of nitrogen has been clearly brought out by D S Honavar[5] in his paper. According to his investigations the main factors which control the ingress of nitrogen and the ferrite content are the arc length, type of electrodes and type of current. The variations are shown in Fig. 4. This also indicates the beneficial use of basic coated electrodes which provide good arc shielding, helping the deposition of a weldmetal with consistent chemistry and ferrite.

3.0 MEASUREMENT OF FERRITE

The measurement of ferrite has been a widely discussed topic. This is because of the wide discrepancies observed in the different methods of measurement of ferrite. Several methods of measurements exist and all have their limitations in terms of accuracy and reproducibility of the results. Some of the most popular methods will be discussed here. The variations and inaccuracies involved in the measurement of ferrite have been well recognized by the AWS who switched over to ferrite numbers (FN) instead of percentage ferrite since FN is derived by a standard measurement and calibration procedure established by WRC.

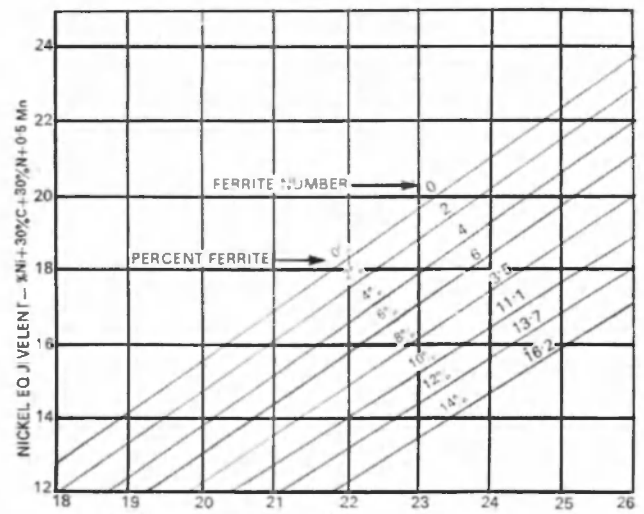


Fig 2B. Delong Diagram

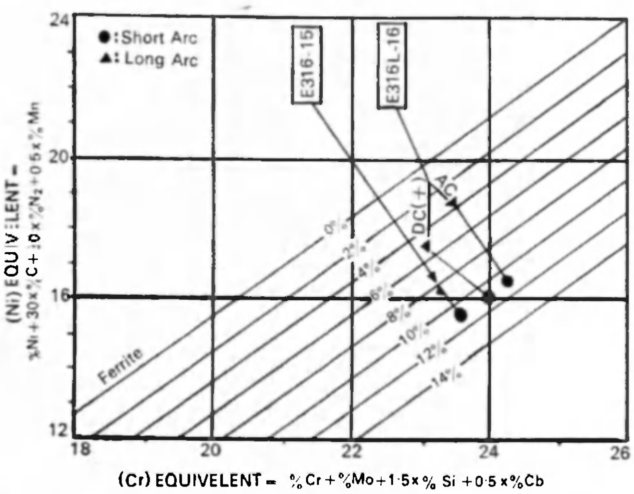


Fig 4. Effect of Arc length on Ferrite Content (Ref. 5)

3.1 Prediction of Ferrite Based on Chemical Composition

In these methods the chemical composition of the weldmetal is used to calculate the ferrite content. The limitations of these methods are :

(i) the accuracy of prediction of ferrite content will be dependent on the accuracy of the chemical analysis.

(ii) these methods do not take into account the effect of welding conditions like cooling rate etc. which influence the ferrite content to a certain extent.

The most popular methods based on chemical composition are by using (i) Saferian Equation (ii) Schaeffler/Delong diagram

(i) Saferian Equation :
$\%$ Ferrite : $3(Cr_{eq} - 0.93Ni_{eq} - 6.7)$

(ii) Schaeffler/Delong diagram :
By calculating the Nickel equivalent and the Chromium equivalent the percentage of delta ferrite can be obtained by plotting the values. The accuracy of prediction that can be normally expected from these diagrams is :

Schaeffler Diagram	:	$\pm 4\%$
Delong diagram	:	$\pm 2\%$

3.2 Methods based on actual measurement of ferrite

These methods take into account all the welding variables as they measure the actual ferrite present. The most popular methods are :

(i) Metallography

(ii) Magnetic methods

3.2.1 *Metallography*

This method involves actually counting the ferrite phase using the point counter method and estimating its percentage. The limitations of this method are :

(i) the ferrite phase is fine and accurate counting may not be possible.
(ii) the etching behaviour of ferrite is found to vary
(iii) ferrite is in volumetric distribution and the plane under observation may not represent the actual amount of ferrite.
(iv) the distribution of ferrite is not uniform and so measuring ferrite over a small area may not represent the actual percentage.

3.2.2 *Magnetic methods*

These methods make use of the fact that ferrite is a magnetic phase in a non-magnetic austenitic matrix.

Magnetic saturation method is one of the destructive tests to determine the percentage of delta ferrite. The principle involved in this method is that the intensity of magnetisation as saturation of the given sample is proportional to the quantity of magnetic phase in it. This method measures the absolute ferrite in the sample and the result is independent of size, shape and orientation of the phase. But this is a destructive test and cannot be used for measurement of ferrite on the actual equipment.

The other methods like ferrite scope, magna gage etc. measure the local ferrite content and their resuts are not independent of size, shape and orientation of the phase. But these methods are widely practised because of their simplicity and near accurate values on the actual jobs. It is also appropriate to point out here that these magnetic methods may be misleading in certain cases as they measure ferrite as a magnetic phase. The presence of any other magnetic phase will also be measured as ferrite. This is one of the major draw backs in these magnetic measurements especially when they are used on cold worked stainless steel which might contain some amount of strain induced martensite and other magnetic phase.

Other than the methods described above special techniques like Mossbauer effect studies, X-ray diffraction methods, electro chemical methods are also used to determine the ferrite content but mainly as tools for advanced research.

The discussion on the various methods of ferrite measurement will not be complete if a note is not made of the variations encountered in the measurements. Extensive work done in this direction by C J Long and W T Delong[6] gives the comparative tolerances that can be expected for various methods as compared to the standard pad (MIL-E-19933D) values

Single (avg.) measured pad FN compared to	Est. 2 sigma (95%) tolerance where the avg. ferrite content is	
	0-8 FN	8-14 FN
(1) Avg. measured FN of 5 or more pads of the batch	±1.6 FN	±2.4 FN
(2) Calculated FN from good deposit chemistry and Schaeffler diagram		
covered	±5.0 FN	±5.5 FN
bare	±2.7 FN	±3.3 FN
Delong		
covered	±3.3 FN	±4.0 FN
bare	±2.7 FN	±3.3 FN

The data clearly reveals that broader tolerances will be required when one desires to meet both the calculated as well as the measured values. Apart from this one has to strictly practise the standard procedure for sample pad preparation. Investigations[7] have revealed that even variation in pad welding procedures and surface preparation like grinding etc. can change ferrite number by ±3. Though these values are based on the variations in procedure and surfaces examined by these researchers it clearly indicates the amount of extra care that has to be exercised in adopting standard procedures apart from careful measurement and calibration of instruments.

4.0 EFFECTS OF DELTA FERRITE

The effects of delta ferrite can be considered under the following headings :

(i) Effect on hot cracking and microfissuring
(ii) Effect on corrosion resistance
(iii) Effect on low temperature properties
(iv) Effect on elevated temperature properties
(v) Effect on tensile properties

0.1 Effect on hot cracking and Microfissuring

It is well known that fully austenitic stainless steels are prone to cracking during solidification and this cracking susceptibility is reduced when small amounts of delta ferrite is present in the solidifying weldmetal. The exact mechanism of hot cracking has not been clear so far though there is a general agreement that this is due to a liquid phase formation at about 1350°C.

Before dealing in depth with this topic, distinction between hot cracking and microfissuring may be of help.

Hot cracking

This is directly related to the final stages of the solidification process and is directly controlled by the welding variables which can be modified to achieve crack free welds. According to T G Gooch and Honeycombe[8] these can be either inter columnar, inter dendritic or inter cellular depending on solidification mode.

Microfissuring

This takes place in fully austenitic stainless steels in an intergranular manner in the fusion zone of single run beads, in the HAZ of the base metal and in the HAZ of weldmetal produced by subsequent beads in multipass welds.[9] T H Gooch and Honeycombe[8] observed in their recent investigation that the control of microfissuing cannot be guaranteed by control of welding variables like current, travel speed, preheat, interpass temperature, number of layers, interrupted welding etc.

According to W T Delong[6] cracking in general indicates centre line or crater cracks and is related to final stages of solidification whereas microfissures occur during reheating process and they are small cracks perpendicular to the direction of stress and perpendicular to the axis of the weld. Several parallels can be drawn between cracking and fissuring and the factors affecting them also seem to be common. In the following discussions both these aspects will be considered together.

Several mechanisms have been put forth to explain the cracking/fissuring behaviour in austenitic stainless steels. Only two of them appear to explain the exact mechanism involved in this fissuring. They are :

(i) HAZ liquation cracking which states that cracking is due to the solidification stresses which break the thin liquid film of low melting segregates formed at the grain boundaries.

(ii) Ductility-dip cracking which states that cracking occurs because of the reduction in ductility which occurs over a temperature near the bulk solidus.

4.1.1 *Ferrite and fissuring behaviour*

It was stated earlier that if some percentage of delta ferrite is present in solidifying austenitic stainless steel weldmetal it reduces the susceptibility to cracking. This is in general accepted to be because of the fact that the impurity elements like Si, S, P, O, Nb have greater solubility in ferrite and so do not form low melting liquid films at the grain boundaries. This theory is also in conformity with Hulls theories based on interfacial energies which states that because of lower interfacial energy of the austenite/ferrite boundary it can withstand higher contraction stresses than the austenite/austenite boundary. According to T G Gooch[10] even the pool shape affects the cracking sensitivity. A tear shaped weld pool is more deteremental than an eliptical pool as the former leads to centre line segregation. C D Lundin, W T Delong, D F Spond[11] have examined the ferrite fissure relationship in several austenitic stainless steel weldmetals. Their investigation included several types of stainless steel weldmetals with varying ferrite contents and they used fissure bend tests to determine the susceptibility of the material to fissuring. Their work led to one of the most important conclusions regarding the minimum amount of ferrite that is required to give freedom from cracking. These values are given below.

Type	FN (min) required for nil fissures
16-8-2	2.0
316 L	1.5
308	2.0
316	2.5
308 L	3.0
309	4.0
318	5.0
347	6.0

They also observed that the fissure size was in general smaller usually less than 1/16″ but in stabilised versions like 318, 347 larger sizes were observed. As the ferrite level reduced, the fissure size increased. In general the Cb stabilised versionss showed larger size and more number of fissures than their unstabilised versions.

	Fissure Count			
Type	FN	2FN	4FN	6FN
316	15	0	0	0
318	160	20	5	0
308	30	0	0	0
347	240	80	30	0

Though this work seems to be the ultimate solution to the problem it is not so. Furth rework done by C D Lendin and D F Spond[9] indicated that the minimum amount of ferrite specification may not be helpful in many cases. This is when the distinction between hot cracking and microfissuring was felt since microfissuring occurred in multipass welds and it was observed that the fissures formed in the ferrite free areas of ferrite containing austenitic stainless steels. From their investigation it was observed that

(i) fissures occur primarily along the grain boundaries in the HAZ of the previously deposited pass

(ii) the fissuring tendency increases with multiple thermal cycling

	Area fissure density (no/in^2)	Linear fissure (no/in)
Single thermal cycle :	8-17	2-4
Double thermal cycle :	95-120	19-24

(iii) the fissures form in ferrite free areas

(iv) the fissures do not propogate with applied strain during bend testing

(v) the number of fissures changed with the surface preparation of specimen. Smoother surfaces helped in detection of fine fissures.

Many solutions have been suggested to this fissuring problem. Modification in the welding parameters also to some extent help in reducing the fissuring tendency. Gooch and Honey Combe[8] have studied the effect of welding variables to conclude that a slight reduction in current may be beneficial. Welder techniques also may influence fissuring. Their main conclusion which will be of practical importance is that neither preheat and interpass temperature nor joint restraint and fit up have any major influence on the microfissuring tendency.

Reduction of non metallic impurities reduce the microfissuring tendency. This can also be achieved by GTAW remelting as this reduces the concentration of the non metallic impurities and produces equiaxed grains with relatively clean grain boundaries.

Increasing the Mn and Mo contents help in reducing the fissuring tendency[12]. A mathematical expression for the % of cracking has been developed by Moores and Gunia[13] and it clearly brings out the effect of various elements.

$$\% \text{ Cracking} = 133.6 + 6.44\,C + 43.1\,Mn + 1.8Si + 384S$$
$$2295P + 998Ni - 4.48Cr - 28.8(Cb+Ta) - 487N$$

On comparing this with the equation developed by F C Hull[14] for the amount of Ni required for zero delta ferrite=

$$-4.71+0.92Cr-0.088Mn+0.007Mn^2+1.3Mo+0.51Si +2.22V+0.69W+2.12Ti+0.17Cb+0.32Ta-14.6N- -16.7C-0.47Co-0.42Cu+2.3Al$$

it can be inferred that by increasing Mn and N, both reduction in ferrite and stabilisation of austenite can be achieved. Further work done in this direction[15] revealed that higher Mn content would be beneficial to withstand the heavy joint restraint conditions developed by root gap variations etc. The tendency to cracking reduces with higher N contents. Also it enables a fine dispersed nitride which act as nuclei for fine grained structure which in effect increases the grain boundary area thereby reducing the concentration of impurity elements. The effect of fissures in ferrite containing austenitic stainless steel weldments under actual service conditions has not yet been studied thoroughly and there are practically no cases where a failure can be attributed to the presence of fissures.

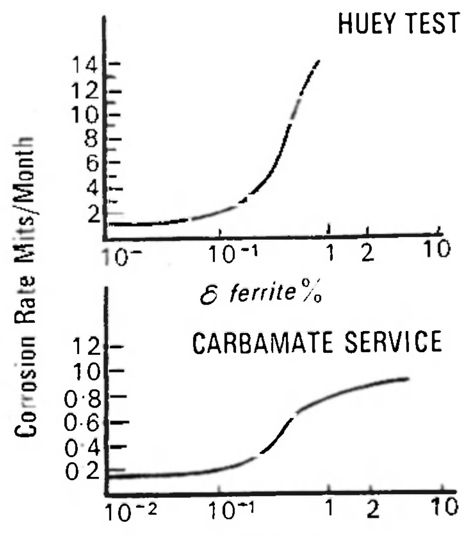
4.2 Effect of Delta Ferrite on corrosion resistance

The austenite matrix and the ferrite present in it do not have the same composition and in general austenite contains more of austenite formers like Ni, Mn, C etc. and ferrite contains more of ferrite formers like Cr, Mo, Si etc. Because of this compositional difference there exist areas in the austenite matrix near the austenite/ferrite boundaries which are depleted of Cr, resulting in lower resistance to corrosion. As the ferrite contents increase (4-7%) the ferrite forms a continuous network and this further reduces the corrosion resistance.

Stainless steels of the modified 316 L type are used in many of the urea plants where severe corrosion is encountered. In these service conditions the amount of delta ferrite has to be controlled within specified limits say below 2%. Higher amount of ferrite leads to severe corrosion rates as shown in Fig. 5. The corrosion rates in urea service is similar to that of Huey Test (ASTM 262 Practice-C) which is normally conducted to test the corrosion resistance of the weldmetal.

In the recent past welding consumable manufacturers in India have developed modified E 316 L type electrodes with zero ferrite. Inspite of zero ferrite the weld deposits of these electrodes have adequate crack resistance. This is achieved by modifying the composition of the E 316 L type weldmetal with additions of manganese upto 5% and nitrogen. Addition of nitrogen helps in increasing the matrix strength which helps to reduce carbon to a sufficiently low level and also stabilise the austenite. The addition of manganese plays a role in reducing the fissuring tendency of the weldmetal. It has been found that manganese at higher percentages acts as a ferrite stabiliser at elevated temperatures. So, manganese helps in the formation of an intermediate ferrite phase during solidification of the weldmetal and reduces the risk of cracking. Subsequently when the weldmetal cools it doesnot contain this ferrite phase. However, further investigations have also led to the conclusion that at higher manganese levels the sulphide morphology becomes discontinuous and this aids in reducing cracking susceptibility.

It will not be out of place to mention here the beneficial effects of nitrogen additions. It can be seen from Delong Diagram (Fig. 2) that nitrogen is as good as carbon in stabilising austenite. So, nitrogen to the level of 0.10—0.15% was introduced in the alloy. With this addition, the strength of the stainless steels considerably improves and nitrogen also acts as a grain refiner. The carbon content could also be lowered without loss of strength. Since the nitrogen refines grain size as described earlier a leaner distribution of impurity elements results. Several of these nitrogen versions of normal stainless steels are in use for highly corrosive equipments and matching welding consumables with nitrogen additions are available for their fabrication.



Effect of δ ferrite on corrosion resistance of 316L stainless steel

Fig. 5 Corrosion rates in urea Service.

4.2.1 *Stress corrosion behaviour*

This area has not been subjected to extensive research and data available rarely agree with each other. This is likely because the effect of delta ferrite on stress corrosion behaviour is also dependent on the type of test and the medium in which the testing is carried out. In water containing chlorides the initial delta ferrite content does not seem to have any influence on the stress corrosion behaviour of the material[16]. But in $MgCl_2$ solution constant extension rate tests were conducted by W A Bacslack et. al[17] to conclude that decrease in ferrite level increases the susceptibility to stress corrosion cracking.

4.3 Delta ferrite and low temperature properties

The normal austenitic stainless steels of type 304 retain good subzero temperature properties and are commonly used for low temperature application upto minus 196°C. Therefore it becomes more important in such cases to study the effect of delta ferrite especially on the toughness of the weldment at such low temperatures.

Fig. 6 shows a rapid drop in the notch toughness with increasing ferrite content. The role of ferrite in lowering the impact toughness of SMA weldmetal has been investigated by H F Reid et. al[18] who compared several weldmetal properties at varying ferrite levels, the toughness criteria being 15 mil. min. lateral expansion. They have determined the maximum permissible ferrite for each grade

Grade	Maxmum permissible Ferrite for weldmetal with 15 mil lateral expansion		
	Testing Temperature		
	-196°C	-157°C	-129°C
E 308-15	0.3	2.5	5.5
E 308-16	—2.2	0.4	3.0
E 308L-15	1.2	4.5	7.5
E 308L-16	1.3	4.5	9.1
E 309-15	—0.7	3.3	14.0
E 316L-15	3.6	7.3	>10
E 316L-16	1.7	5.9	9.2
16-8-2-15	>10	>10	>10
16-8-2-16	—1.5	3.5	—

The above table also indicates the superiority of basic coated (lime coated) electrodes over rutile types for cryogenic applications because of greater shielding of the molten metal and lesser pick up of nitrogen.

It has been observed that solution annealing of the weldments containing ferrite improved the impact values because of the conversion of ferrite into austenite[7].

Weld-metal Type	Aswelded ferrite(%) Calculated	Measured	Avg. (3 specimens) CVN Impact strength at-320°F (-160°C) ft. lb Aswelded	Annealed
308	2.5	5	27.3	47.3
308L	3.0	5.0	33.5	44.2
347	3.5	6.0	17.8	36.7
347L	3.5	5.5	27.5	51.5
316L	7.0	8.0	21.5	45.7

4.4 Effect of Delta Ferrite on Elevated Temperature Properties

The austenitic stainless steels have good resistance to corrosion, oxidation, good short term elevated temperature strength and also good creep properties. The most important factor to be taken into account apart from the sensitisation phenomenon is the formation of sigma phase, an intermetalic phase, on prolonged exposures at high temperature. The formation of this chromium rich phase results in drastic reduction in ductility and corrosion resistance of the adjacent areas.

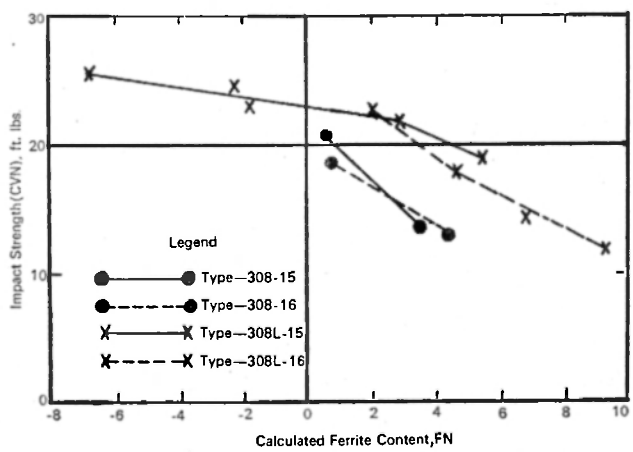


Fig. 6—Impact strength (vs) Ferrite Content for 308/308L grades tested at—196°C (Ref. 18).

Sigma phase required diffusion of several elements and the steel should be exposed for long periods to temperatures below the upper limit of sigma stability which is in the range of 900-950°C. Though the transformation is prevalent at all temperatures below this, the rates are quite significant at 800-850°C. In normal welding practice this phase seldom forms as it required considerably long periods of exposures. However, if stainless steel contains delta ferrite, it gets transformed into sigma phase because, (i) delta ferrite phase is as such rich in ferritising elements (ii) the diffusion rates are faster in ferrite phase (b.c.c.) than in austenitic (f.c.c.)

It is also observed that the ferrite present in the initial runs of a multipass welds sometimes get transformed to sigma phase because of the heating by the deposition of other runs.

All the compositional modification to reduce the formation of sigma phase aim at reducing 'ferritisers' like Cr, Mo, Si etc. Increase of carbon tends to stabilise austenite and forms carbides with ferritiser like Cr, Mo and prevent ferrite sigma formation. Increase of Ni increases austenite stability and reduces the diffusion rates of ferrite formers. It should be noted that Mn has the same influence on sigma formation of ferrite formers. Thomas et.al.[19] estimated the amount of delta ferrite transformed to carbides and austenite as a function of time and temperature. Their results are shown in Fig. 7. Delta ferrite can also transform to 'Chi' phase a b.c.c. intermetallic compound of Fe, Cr, Mo when stainless steels of type 316 are heat treated at 800°C for 10 hours.[19] This phase, unlike the carbides which are precipitated at other lower temperature, does not embrittle the matrix. In fact, it improves the creep properties.

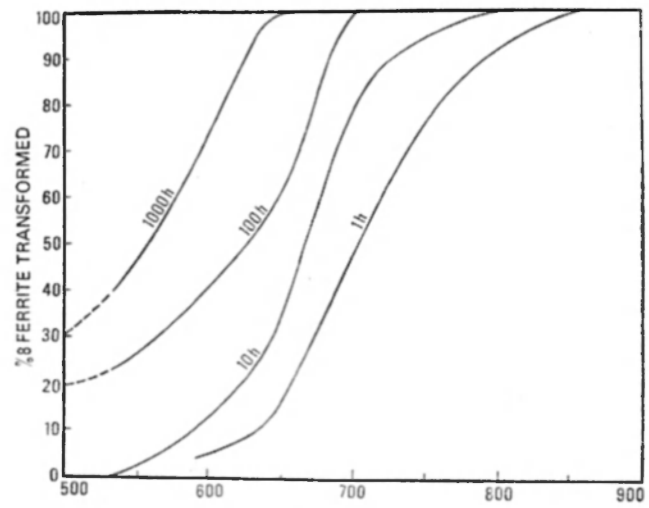


Fig. 7. Rate of transformation of Delta Fhrrite (Ref. 09)

Thus it can be seen that the presence of delta ferrite and the subsequent heat treatment may lead to embrittlement unless sufficient care is taken to select the temperature range and time.

4.5 Effect on Tensile Properties

The effect of delta ferrite on tensile properties has been brought out in Fig. 8 which shows the strengthening effect of delta ferrite and the resulting reduction in ductility.

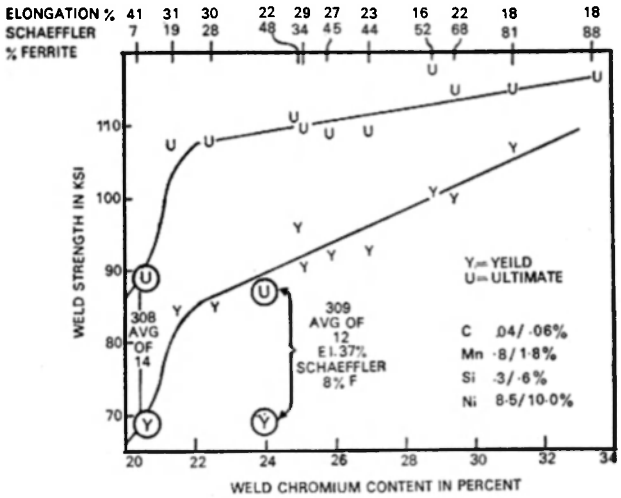


Fig 0—Effect of Ferrite on Tensile Properties (Ref. 7)

5.0 CONCLUSION

Certain amount of delta ferrite is desired in austenitic stainless steel welds to avoid hot cracks and fissures. High delta ferrite in the weld, on the other hand, is deterimental from the stand points of corrosion and mechanical properties. In the case of critical equipment, the designers, therefore, specify the minimum and/or maximum level of ferrite in the welds. However, unless the exact procedure for preparation of sample pads and the method of measurement are specified, the determination could lead to various problems on account of variations observed from one method to the other and even with the same method.

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