WELDING HUB

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NEWSLETTER

FROM THE EDITOR'S DESK

'STAYING IN TOUCH' OR 'TOUCH BASE' as the Englishman would phrase, staying connected has been bit of a challenge during Covid times. Strict limits on 'nonessential' travel have hindered the salesman's movement. SOP has made one to one meeting more complicated.

The virus has altered virtually all facets of everyday life since 2020. 'Social Distancing', 'New Normal' are the new phrases now commonly used.

It is during these times our CEO, Mr. M.V Pathy, came up with the idea of a Newsletter that lets us all stay connected with what's happening in the Welding World.

Welcome to the inaugural issue of our Newsletter aptly called 'Welding Hub'. By far the most important objective of this Newsletter will be to support and encourage scholarly debate among the growing community of welding professionals.

We at Nouveaux look forward to your continued support & patronage.

Stay Safe!

P S BABU
EDITOR IN CHIEF

THE EDITOR SPEAKS

While the international struggle with the COVID-19 disease continues to unfold, the past several months saw significant changes emerge within the welding industry. Now, the welding world is focused not only on managing the short-term effects of this crisis, but also on preparing for potential adjustments in the long-term.

In the preliminary stages of India's COVID response, the rush to adhere to new governmental guidelines frenzied businesses. The serious nature of the disease led lawmakers to enact strict rules aimed at preventing its further spread. No company wishes to lose even one day of business, so welding manufacturers worked at breakneck speeds to foster a work environment deemed safe enough for the return of their employees.

The government's mandate that all businesses deemed nonessential needed to close to the public panicked the welding industry. Many companies “scrambled” to learn their essential or nonessential status upon hearing this information.

If a company received the news that it could remain open to the public, then the next step to resuming business entailed following the plethora of new rules. These protocols include directives to constantly wipe down equipment, wash hands often, and cover employees head to toe with personal protection equipment. Manufacturers are implementing administrative controls like workers are working in thinner shifts and of course, 6-feet apart. The joke that made rounds “Most of us have washed our hands more in the past ten days than we have in the previous ten years”. Temperatures and potential symptoms are monitored every day when employees clock into the company's premises at Nouveaux.

The inability for many workers to appear onsite further complicated matters for welding manufacturers.

While most states permitted some essential employees to remain in facilities, other employees needed to adjust to completing their normal responsibilities from home. This latter group of personnel faced several new challenges within their remote workplace. Perhaps most prominently, difficulties in efficiently reaching onsite workers frustrated the staff of welding businesses attempting to establish some sense of normalcy.

Although the prospect of staying in a comfortable home environment all day instead of reporting to an office might sound ideal in theory, the challenges workers experienced during this pandemic disprove this idea. The inability to divert one's attention away from their remote desktop for even a moment irked some employees.

The physical distance between employees also seemed to amplify the workloads of remote workers. Employees found that the extra effort required for communication and "the sharing of information" during the pandemic added to their work in a significant manner.

This isn't to say that everyone in the industry felt the same intrusions to their workflow. Technologically savvy personnel saw boosts in productivity after shifting over to remote work. The first-hand experience that most employees gained with remote work over the past few months could also prove to be valuable in the long-term.

After resolving these immediate issues, manufacturers shifted their attention to analysing and adapting to the changes in their workload. The economic impact of the pandemic affected companies in different ways and to varied degrees. The wide range of consequences for businesses during the pandemic reflect the diversity within the welding industry.

Not every business is in dire straits because of the pandemic. The government allowed major construction and welding clients to remain open by gifting them essential status.

Unfortunately, several other companies suffered damaging changes to their business over the past few months. One key problem is the mass closure of client businesses and construction sites on a national level. Strict limits on nonessential travel hindered the staff movement. This obstructed by halting work at construction sites across the country.

Although most businesses are understandably preoccupied with handling the swarm of issues presented to them by COVID-19, there is also a degree of uncertainty about the future of the welding industry after the resolution of this pandemic. Some Welding Society members predict permanent changes to the welding industry. The changes could include indefinite extensions of the world we currently live in – it is predicted that masks and other personal protection equipment will remain mandatory long after this pandemic fades away. Handshakes will fade into obscurity because of the virus.

Welding experts disagree about the extent to which the pandemic will alter the future of welding, but the apparent consensus for the future contains a healthy amount of hope and optimism. There is excitement from various corners about the country's upcoming reliance on jobs to help the economy rebound from the virus. The manufacturing industry could experience a boom, which would cause a huge payoff for welders and others interested in welding. Most believe that it is currently "the best time to be in the welding field or to learn how to weld" and get into the workforce. The welding industry will flourish because the jobs will absolutely be there and ready to be filled.

While ambiguity surrounds the future of welding, every manufacturer should begin preparing for the post-pandemic world as soon as possible. Companies must build strategies to combat the downturn and assemble recovery teams to capitalize on potential future opportunities once the industry begins to rebound. Aroop Zutshi, global president and managing partner at Frost and Sullivan Industry and Strategy Experts, predicted that a global recession will last until Q3 of 2021 in a webinar conducted on April 9th, 2020. While Zutshi also predicted a recovery to pre-crisis levels, it is important that companies take the proper steps now to stay afloat throughout the remainder of the crisis.

Frost and Sullivan stressed the urgency of formulating and mobilizing teams to deal with the pandemic. They suggested that companies assemble three separate teams to address "crisis management, growth, and digital transformation". These teams need to possess specific and intense focuses on the necessary steps that their business must take to adapt, stay relevant, and grow.

Some of the changes mentioned that could find their way into the welding industry include the further adoption of automation technology and the increased use of remote inspection.

Welding, along with every other industry, finds itself in the middle of an unforeseen shift in the manner business is conducted. Between increased safety measures and remote workplaces, manufacturers improvised to avoid shutdowns and maintain productivity. Workers adapted to this new normal, but companies still need to plan for the future of this industry. As countries around the world battle to end this pandemic, manufacturers anticipate an influx of new work and remain hopeful for the next chapter of the welding industry.

We must force ourselves to find a new normal.

P S BABU
EDITOR IN CHIEF

Non - Equilibrium Solidification Effect Studies in Nickel Base Super Alloys using Scheil – Gulliver Model

G. Meenakshi Sundaram[1], Dr.R. Sivasankari[1&2], Dr.J. Krishnamoorthi[1&2], Dr.K.Asokkumar[1&2], Murali R Thamban[2], M V Pathy

[1]- Department of Metallurgical Engineering, PSGCT

[2]- Centre of Excellence in Welding Engineering and Technology, PSGCT

ABSTRACT

Inconel 625 is being widely used in many applications like seawater systems, aircraft ducting systems, jet engine exhaust systems and welding of turbine shroud rings bellows. The solidification cracking is the major problem in Inconel 625 alloys. Generally, hot cracking is predominant in nickel alloys with high niobium content. This is because niobium promotes low melting eutectic with higher solidification range which aids solidification cracking. In the present work, an attempt has been made to analysis the effect of tantalum and vanadium on solidification behaviour. The Scheil solidification result shows the tantalum addition in the Inconel 625 electrodes tend to minimize the hot cracking susceptibility. The solidification range is minimized through the addition of tantalum. This minimises the formation of low melting constituents which avoids hot cracking.

KEYWORDS: ENiCrMo-3, SMAW, Hot Cracking, Low Melting Eutectic, Scheil Solidification.

1.0 INTRODUCTION

Alloy 625 is a highly alloyed nickel-base alloy that can provide high strength, corrosion resistance in a variety of environments and exhibit good fabricability and weldability. Because of this attractive combination of properties, Alloy 625 has found wide-spread applications. The high levels of Cr and Mo provide good corrosion resistance plus strength, while Fe and Nb provide further solid solution strengthening. The Al and Ti additions are principally for refining purposes and are kept low compared to alloys like 718 to enhance weldability [1]. These alloys generally solidify by a three-step process which includes primary liquid to solidification, followed by secondary liquid to γ + NbC eutectic-type reaction which occurs over a broad temperature range, finally followed by a terminal liquid to γ + Laves eutectic-type reaction which occurs over a smaller temperature interval. This solidification process is very similar to what is expected in the simple Ni-Nb-C system. Minor additions of Nb and C have a strong influence on the transformation temperatures of the liquid to **γ** + NbC and liquid to **γ** + Laves eutectic-type reactions as well as the relative amounts of **γ**/NbC and **γ**/Laves constituents that form during solidification [1].

2.0 Solidification Behavior of Alloy 625 based on Nb and Ta Addition

The dominating solidification reaction in alloy 625 is the enrichment of the remaining interdendritic liquid in niobium[1], and the consequent formation of niobium-rich Laves phase and/or niobium carbide during the final stages of solidification. Figure 1 is a Psuedo-binary phase diagram for Alloy 718 originally proposed by Eiselstein to explain the enrichment of the remaining liquid in Nb (and Ta) and the resultant formation of A_2B Laves phase.

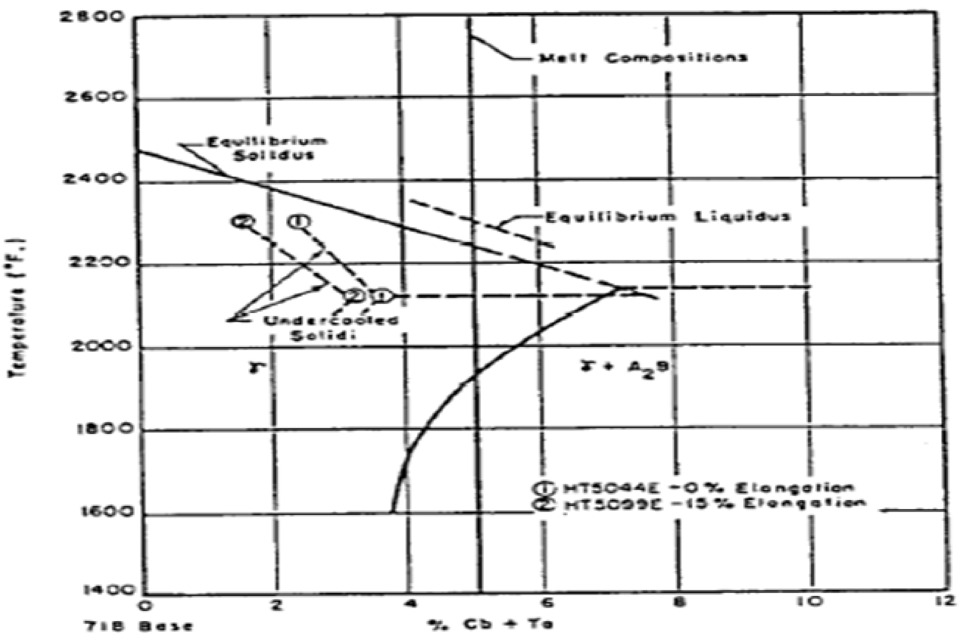


Figure 1 : Psuedo-binary phase diagram for Alloy 718[1]

A better way to view the solidification is represented in figure 2 which is a Psuedo ternary equilibrium diagram. This is a schematic representation based on the Alloy 718 diagram proposed by Radhakrishnan and Thompson. As shown in Figure 1, the C/Nb ratio dictates the solidification path and the resultant microstructures. Three different paths can be followed. Path 1, at high C/Nb ratios, leads to the formation of γ + NbC with no Laves phase. Path 2, at intermediate C/Nb ratios, leads first to γ + NbC, followed by Laves phase formation at the end of solidification. Path 3, at low C/Nb ratios leads to γ + Laves with no NbC.

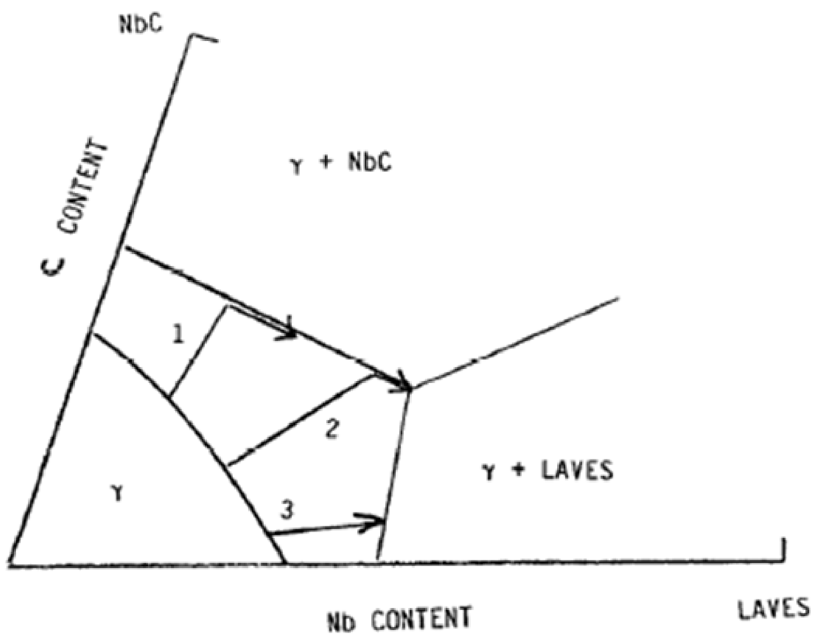


Figure 2 : Psuedo ternary equilibrium phase diagram for Alloy 625

However, a well-defined C/Nb value at which the solidification changes from Path 1 to Path 2 is not apparent from these examinations. This doubtless reflects the fact that the solidification rate and other alloy chemistry variations also affect the microstructure in addition to the C/Nb ratio. Path 3 microstructures, without NbC particles, are not common but have been seen in Alloy 625 heats containing less than 0.01% C.

3.0 EXPERIMENTAL PROCEDURE

Scheil solidification mode in Thermocalc was used to study the solidification range of the specified composition. The nickel database TCNI8 was used for all simulations. Scheil solidification simulates the real time solidification and predicts the liquidus and solidus temperature of the specified alloy composition along with the phases formed during solidification. The simulation results were used to compare the effect of alloy additions on the solidification range of Inconel 625. The tested alloy additions were tantalum and vanadium. Tantalum was substituted in varying amounts with respect to niobium to meet the alloy 625 specification i.e., Nb+Ta =3.58. Vanadium was added up to their maximum limits in the alloy. The standard chemical composition of Inconel 625 electrode and the various alloy compositions simulated were tabulated in the table 1.

ELEMENT	Standard	Alloy 1	Alloy 2	Alloy 3	Alloy 4	Alloy 5	Alloy 6
C	0.086	0.017	0.017	0.017	0.017	0.017	0.017
Mn	1.099	0.1	0.1	0.1	0.1	0.1	0.1
P	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Si	0.445	0.1	0.1	0.1	0.1	0.1	0.1
Fe	6.47	1.38	1.38	1.38	1.38	1.38	1.38
Cr	23.08	20.8	20.8	20.8	20.8	20.8	20.8
Mo	8.695	8.35	8.35	8.35	8.35	8.35	8.35
Ta	-	1.69	2.54	3.38	-	-	-
Nb	3.119	1.69	0.84	-	3.38	3.38	3.38
Co	-	0.1	0.1	0.1	0.1	0.1	0.1
Al	-	0.32	0.32	0.32	0.32	0.32	0.32
W	-	0.1	0.1	0.1	0.1	0.1	0.1
V	0.94	-	-	-	0.01	0.05	0.1
Ti	0.129	0.28	0.28	0.28	0.4	0.4	0.4
Ni	55.69	65.4	65.4	65.4	65.4	65.4	65.4

Table 1. Chemical composition used for simulation

4.0 RESULTS AND DISCUSSION

The alloy 625 with standard specifications has a solidification range of 235 °C. To decrease the solidification range, the chemical composition is suitably altered by varying the Nb, Ta, V, content and their corresponding Scheil simulation are simulated. The simulation diagram were shown in the figure 3.

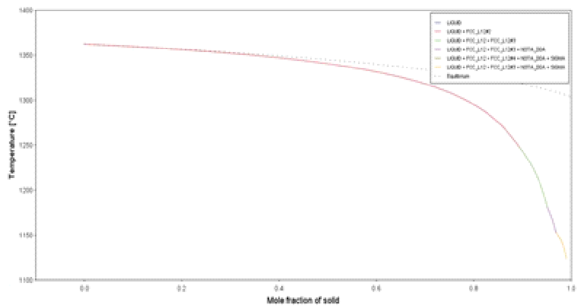


Figure 3 : The Scheil Solidification simulation for Standard Composition

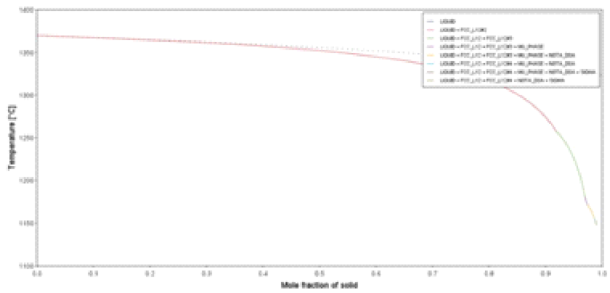
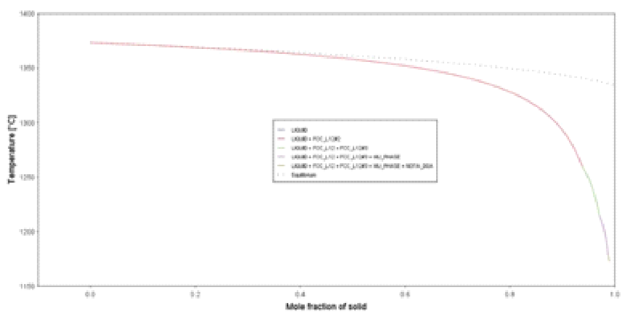


Figure 4(a) The Scheil Solidification simulation equal amount of Nb & Ta

To decrease the solidification range, the chemical composition is suitably altered by varying the Nb, Ta, V content and their corresponding Scheil simulation is performed. Tantalum being most similar in properties compared to niobium in terms of atomic size and ability of strengthening provided with an added advantage of formation of low number of eutectics was chosen to replace Nb in 25%, 50% and 100%. The higher the amount of Nb replaced by Ta the lower the solidification range. The solidification range drops from 235 °C when Nb is 3.38 wt% to150 °C when Ta is 3.38 wt %. The overall reduction in solidification range is 85 °C when Nb is replaced by tantalum completely.



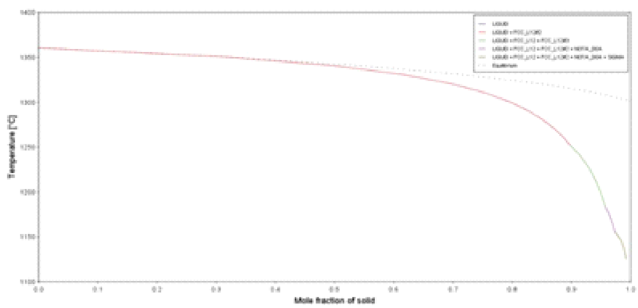


Figure 4(b) The Scheil Solidification simulation higher amount of Ta& Figure 4(c) only Ta

Vanadium was added and the corresponding variation of solidification range with respect the increasing amount of Vanadium was studied. Vanadium was varied in steps of 0.05.The maximum reduction in solidification range was 10 °C when upto 0.1% of V was added. Vanadium not being a part of alloy specification was not added in higher limits. The difference being very minimal vanadium is considered non-beneficial.

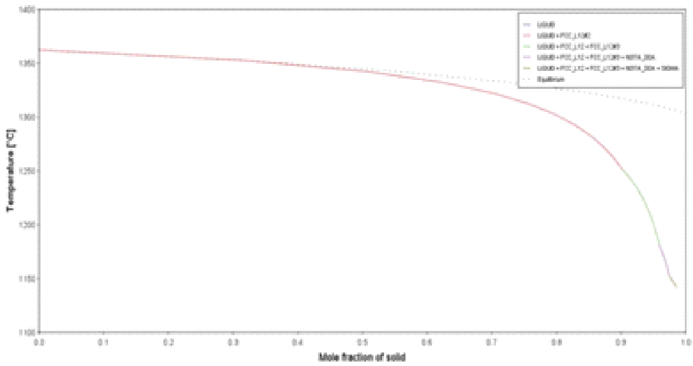


Figure 5(a) The Scheil Solidification simulation for minimum vanadium addition

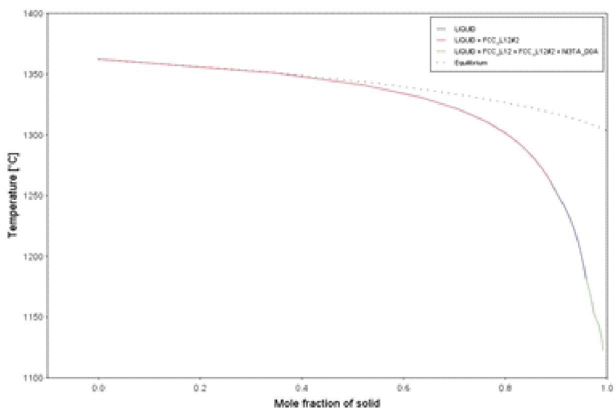


Figure 5(b) The Scheil Solidification simulation for neutral V addition

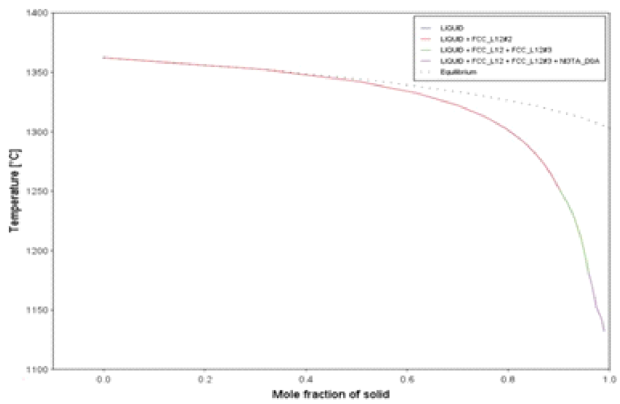


Figure 5(c) Max V addition

From the Simulated Scheil Solidification, it is observed that addition of Ta decreases the solidification range significantly. Therefore, it is advisable to add Ta in flux coating for lowering the solidification range.

ELEMENT	Wt%	SOLIDIFICATION RANGE
Ta	1.69	215°C
	2.54	190°C
	3.38	150°C
V	0.01	232°C
	0.05	229°C
	0.1	225°C
Standard	-	235°C

Table.2 Solidification range with varying composition

The variation level with respect to the AWS specification in tantalum percentage and newly added vanadium percentage were shown in the table 2. The solidification range obtained in the results were increasing with increase in tantalum & decrease in niobium.

5.0 CONCLUSION

It has been shown how the software based solidification range can be used to simulate the minimization of low melting eutectic formation. A design methodology for developing SMAW consumable electrode flux coatings for high nickel alloys has been successfully developed This has enhanced extrudability, alloying recovery and minimised hot cracking susceptibility. A larger solidification range can be reduced by addition of Tantalum as an alloying element through flux thus avoiding the formation of low melting eutectic formation. With the developed approach, the hot cracking susceptibility of the electrode is decreased.

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COMPARISON STUDY OF NOUVE6013 WITH OTHER MARKET BRANDS

This comparison, made purely as an academic study, is between Nouve6013 & ten other different manufacturers' electrodes from the various location for this study. AWS A5.1 E6013 & Diameter 3.15 and length 350 mm. We have followed BS EN 22401:1994 & ISO 2401:1972 for weld metal deposition efficiency, Deposition co-efficient, weld metal recovery, and so on throughout the study.

In this article, we shall discuss fume level, Spatter level, Slag detachability, and Deposition efficiency.

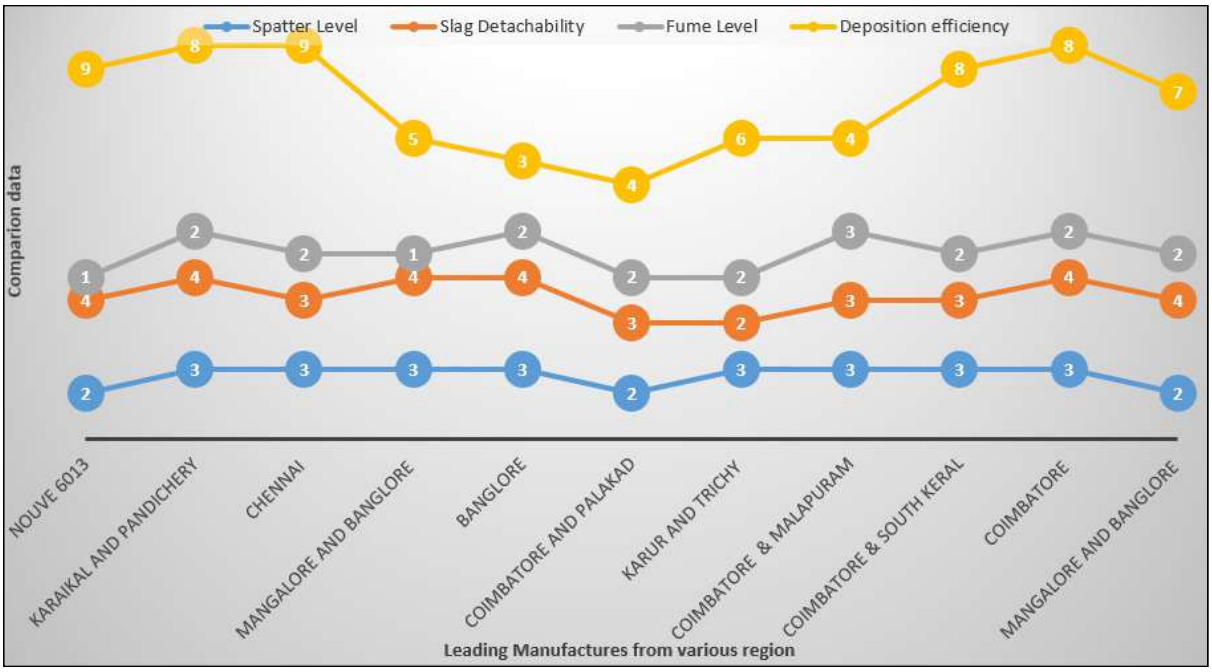
SPATTER LEVEL

Weld spatter are droplets of molten metal or non-metallic material that are produced during a welding process. The drops of hot material can spray or splash from the weld and hit the workbench, floor, base material, or other surrounding areas. As they cool, they form small round balls of material where they land.

The weld spatter can be caused by a variety of different factors, although the main cause is turbulence in the weld pool as the electrode is transferred into the weld. This is typically caused by the amperage and voltage settings used during welding. If the voltage is too low or the amperage too high for a wire. Spatter can happen at both low and high current ranges, causing an explosion that creates spatter and is sometimes referred to as 'arc explosion' by welders. Dirt or contamination can also cause molten metal to spit, leading to weld spatter

Spatter can be reduced by using different techniques depending on what causes it. The following methods/techniques can be used to solve them.

- **WELDER SETTINGS**
- **WELDING TECHNIQUE**
- **PARENT AND FILLER COMPOSITION**
- **MAINTAINING PROPER ARC LENGTH**



Totally 4 levels of spatter were considered in our study. Our Nouve6013 electrode produced a very low spatter compared to other manufacturers' electrodes. This results in higher weld metal deposition efficiency & good weld metal recovery, which otherwise is lost through spatter.

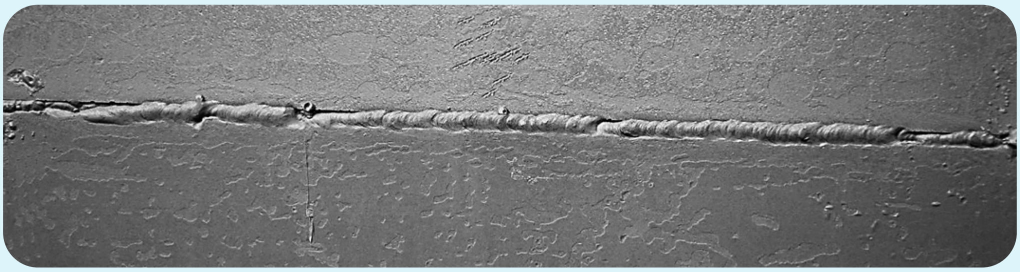
SLAG DETACHABILITY

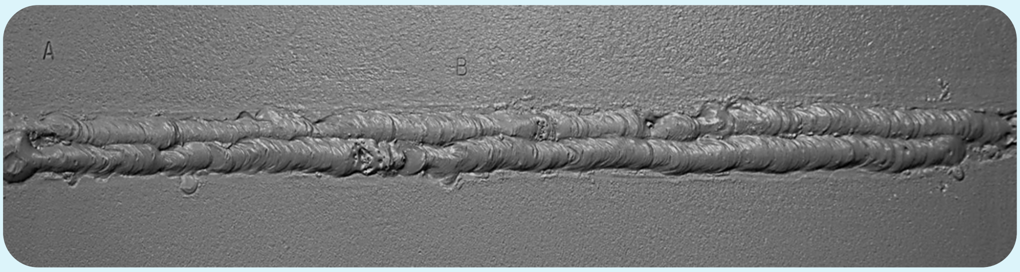
Welding slag is a form of slag, material produced as a byproduct of arc welding processes.

It is essential and important that slag which protects the molten metal from atmospheric contamination during the shielded metal arc welding (SMAW) process gets removed as the weld metal gets solidified. Slag is formed when flux, melts in or on top of the weld zone. Slag is the solidified remaining flux after the weld area cools. The ease with which the slag gets detached from the weld, termed slag detachability, is an essential parameter in deciding the weld quality. To date, slag detachability has been assessed on qualitative terms only.

Slag Removal is usually done using manual or power tools. Manual tools may include a welding or chipping but this rarely happens. In the SMAW process, metal losses may arise due to Spatter, Fumes, and stub length, all of which are considered when calculating Weld metal deposition efficiency. The increase in welding current increases the deposition rate. For E6013 electrodes the deposition rate is higher when welding with DCEP. The deposition efficiency, there seems to be no significant difference in all welding conditions but found the difference in various manufacture's Electrode. From the data, it can be seen that Nouve6013 shows a better rate of deposition efficiency compared to others.

QUIZ





Identify as many welding defects as you can find,
in the pictures above
&
send your answers to
newsletter@nouveaux.in

hammer, which has a pointed tip on one end to break up large chunks of slag efficiently, or wire brushes. A good Flux-based welding process slag, tries to self-detach, from weld metal without applying manual or power tools. Only then it can be said that the electrode is good for welding.

In our study, our Nouve6013 meets the best Detachability rating, when similar welding parameters were applied to all manufacturers. The study found that other Electrodes slag adhered to the side boundary of the weld bead.

FUME LEVEL

About 90 to 95 percent of the fumes are generated from the filler metal and flux coating/core of consumable electrodes. Because the base metal and weld pool are much cooler than the electrode tip, the base metal contributes only a minor amount of the total fumes. However, the base metal surface residue like oil, rust, grease, and paint, may contribute significantly to the welding fumes.

Shielded Metal Arc Welding without fumes is very difficult to achieve because fumes may arise from various factors like Improper cleaning of base metal, Improper Arc length, too much current, Improper redrying of electrodes to eliminate moisture from electrode coating, etc. Moreover, in the fume, we may find some alloy elements. This may lead to affect weld metal chemistry. As the welding rate increases, the fume generation rate increases. The angle of the electrode to the workpiece has a slight (but random) effect on the fume generation rate. We have to control this fume by Proper redrying the electrode before starting the welding, Proper Current, and voltage used.

Our Nouve6013 Electrode shows better performance than others when Welding parameters are strictly the same to all and welding is carried out on properly cleaned base metal.

WELD METAL DEPOSITION EFFICIENCY

Weld metal deposition efficiency is calculated according to BS EN 22401:1994 & ISO 2401:1972. In this comparison, we have taken 10+ manufacturers' E6013 electrodes for comparing the deposition efficiency. Generally, it is expected that the output should be equal to the input,

WELDING HUB

PRECAUTIONS TO BE TAKEN FOR STORAGE OF WELDING CONSUMABLES ON ACCOUNT OF BAD WEATHER CONDITIONS

PROBLEM

- The Covered electrodes are sensitive to moisture pick-up during the rainy season. High moisture contents in the coating can cause Fumes and porosity or Hydrogen cracking.
- Solid MIG/ MAG wires, TIG rods, and SAW wires will pick up the moisture from rain or the condensation of moisture on a cold wire which will cause rusting of filler wires.
- The flux coating on damp electrodes will be broken into loose powder when in use after baking
- These factors may cause of High weld Rejection rate.
- Cost involvement for re-procurement (Vendors / stockiest will not agree to take a return because of poor handling and storage).
- Causes delay in Project completion

SOLUTION

- Consumables shall be stored under correct climatic conditions & as per the manufacturer's instructions on storage & usage.
- The humidity level can be maintained at low levels by ensuring a storage temperature of at least 10°C above the outside temperature.
- Solid MIG / MAG wires, TIG rods, and SAW wires and Fluxes should be stored in dry conditions, in original sealed undamaged packaging as supplied, and properly sealed in polythene covers.
- Partly used spools should be replaced in plastic bags for storage to prevent moisture pick up.
- TIG wires should be stored in original packages or polythene covers or dry boxes if they are removed from the packaging.