WELDWELL SPECTRUM

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SERVICE TO THE WELDING COMMUNITY

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Mr. Paras Kamble of Nivek Agencies explaining intricacies of inverter welding machines at the Naval Dockyard Exhibition held in November, 2007.

Highlights

- Tandem MIG Welding Process
- Choosing of Welding Electrodes
- Automating a welding job
- New Kemppi Welding Helmet
- Trouble shooting in GTAW process
- Safety and Fact about thoriated Welding Electrode

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INSIDE

Editorial

Dear Reader,

The tempo with which India was marching ahead has slowed down a little. Of course not to any alarming extent. Global interest in India is still striving. Unfortunately, welding fraternity is last to benefit from development plans and first to be shunted out. This makes welding industry most sensitive to any change. Now more and more welding companies will be forced to look outward to international market. Improvement in productivity and quality will obviously be under limelight.

The first lead article deals with improvement in productivity by taking advantage of developments in power source where Dual-wire Tandem MIG process has been described. The second article describes the development of how to select welding electrode for joining high strength steel. Probably one of the most common route adapted by the production units to improve productivity is to auto mate welding jobs. There are many pit falls. One needs to be very cautious while going for automation. There are many aspects which need consideration before one should automate a welding job. The article in the education section deals with some of the major such considerations. The other article in the education sections describes what one can learn by conducting failure analysis scientifically. The knowledge gained could be extremely beneficial to prevent recurrence of simiilar failures in future. We have been repeatedly emphasizing the importance of safety of welders. Kemppi's new Beta 90X welding helmet which has been recently introduced in the market is a positive step in this direction. High productivity process like narrow groove submerged process is now being developed for welding of ships. The work carried out by EWI - leading welding research institute of USA is presented in the technical section. The technical section also provides a ready reckoner for trouble

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shooting in GTA process. Items like news and reviews are there as regular ones.

Regards

Dr. S.Bhattacharya
Editor

Event

AWF Meeting in Indonesia

Asian Welding Federation (AWF) in co-operation with Indonesian Welding Society organised a two days seminar on 23rd and 24th October 2007 on “Recent Welding Technology and Materials on Oil, Gas and Construction Industries” at Jakarta. Twelve papers were presented. The seminar was attended by about 200 delegates from various member countries including India.

The seminar was followed by meeting of AWF Task Force for Certification at Bali. The meeting was attended by representatives from China, India, Malaysia, Indonesia, Japan, Korea, Singapore and Thailand. Iran and Vietnam were not represented. The Task Force deliberated on the draft standard of Qualification Test of Fusion Welders; ISO: 9606-1. The comments received from member societies were discussed and it was decided that the common scheme to be established in Asia should be in line with the international standard with minimum changes possible. As far as implementation system of certification of welders in AWF is concerned it was agreed to adopt ISO 17024: Conformity Assessment – General Requirement for Bodies Operating Certification for Persons, in toto. One of the important points which was agreed to be presented to ISO was that the testing of job knowledge should not be made mandatory in view of illiteracy / limited formal education in many countries. Test of job knowledge should be only a recommendation. It was decided that Japan will present the views of AWF to ISO in their forthcoming meeting in November. The next meeting of the Task Force will be held on 14th February 2008 at New Delhi.

Tandem MIG Process for Increased Production *

INTRODUCTION

There is a constant effort in the welding industry to reduce cost by increasing productivity of welding processes. The early efforts were to use multiple wires in automated arc welding processes. Initially this approach was focused only on submerged arc process. The availability of high-powered inverter power sources and Waveform Control has enabled dual-wire welding using the MIG (GMAW) process. The success of dual-wire Tandem MIG process has made it popular as a means to increase production in automated arc welding applications.

Since the introduction of Tandem MIG in the early 1990s, the estimated installed base of dual wire MIG (GMAW) systems has grown significantly worldwide. The majority of the duel wire systems installed have replaced single-wire processes that had been pushed to the extreme high end of the useable operating range in an attempt to improve productivity and lower cost by depositing as much metal as possible in the shortest time frame. Tandem MIG extends the welding productivity range beyond that possible with conventional single-wire processes. A comparison of weld metal deposit rates of popular single wire processes to that of Tandem MIG demonstrates the possible production gains associated with the Tandem MIG process is given in figure 1.

Process Comparision

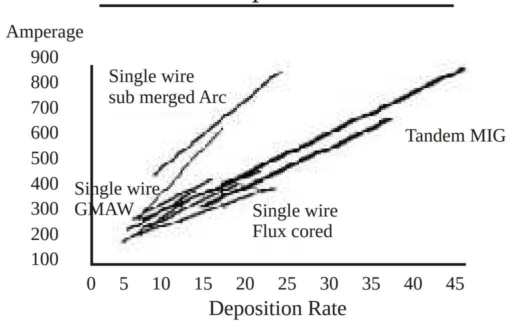


Fig. 1 - Process Comparision

PROCESS FUNDAMENTALS

The Tandem MIG process employs two electrically isolated wire electrodes positioned in line, one behind the other, in the direction of welding. The first electrode is referred to as the lead electrode and the second electrode in line is referred to as the trail electrode. The spacing between the two wires is usually less than ½ inch so that both welding arcs are delivering to a common weld puddle. The function of the lead wire is to generate the majority of the base plate penetration, while the trail wire performs the function of controlling the weld puddle for bead contour, edge wetting and adding to the overall weld metal deposit rate. The process works best with a large diameter lead wire and a small diameter trail wire. The larger lead wire may represent as much as 65% of the total deposition rate, while providing greater penetration. The smaller, trail welding wire is focused on the trail edge of the weld puddle. The trail wire is typically smaller in diameter and therefore draws less current. This helps to control the shared weld puddle and aids in keeping it cool.

A common compromise is to specify the lead and trail welding wires to be the same diameter to satisfy inventory constraints or because the direction of welding must be reversed somewhere on the weldment. Satisfactory operation may be achieved with this compromise but the maximum travel speed is limited and the robustness of the process is reduced.

Tandem MIG depends on specialized power source control software that facilitates the stable operation of two independent welding arcs working in close proximity. The power source must be controlled to stabilize the disruptive electromagnetic influences that cause severe instability when two unregulated direct currents (DC) welding arcs are operated close together.

**Lincoln Electric Publication*

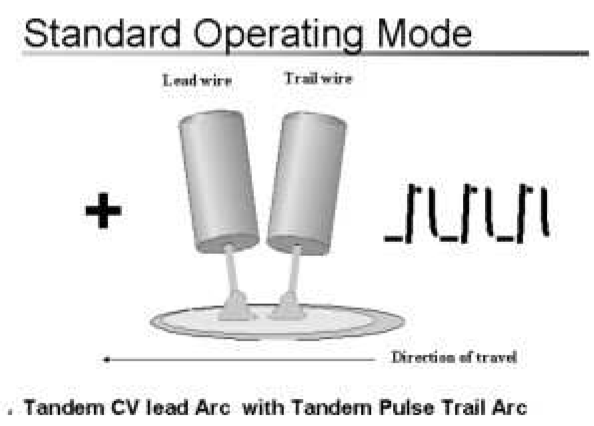


Fig. 2 - Standard Operating Module

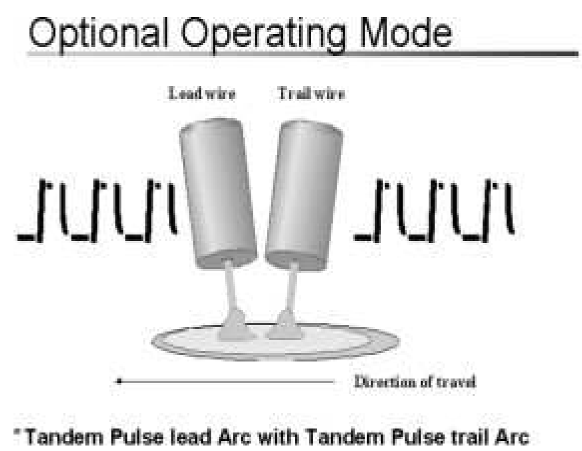


Fig. 3 - Optional Operating Module

In the standard operating mode, the lead arc is programmed for a Tandem MIG DC positive constant voltage mode, and the trail for operation in a Tandem MIG DC positive pulse mode. The constant voltage lead arc is desirable to maximize penetration and travel speed. The lower heat input pulsed trail arc is instrumental in minimizing possible electromagnetic arc interference between the two arcs, as well as cooling and controlling the common molten weld puddle that is generated.

The combination of the constant voltage (CV) lead and Tandem MIG pulse trail configuration provides a wide operating range. The lead and trail arc procedures may be changed independently to achieve a balance between penetration and fill. A second potential configuration calls for operating both the lead and trail welding wires in a Tandem MIG pulse mode. This configuration is typically used to manage total process heat input on thin gauge material and other heat sensitive applications. This configuration requires synchronization of the pulse frequency of both electrodes so that the peak of each pulse on one of the arcs occurs during the background of the other arc. Synchronization implies that both the lead and trail arcs must be operated at the same frequency (or frequencies that are an integer multiple of each other). The requirement imposes strict operation constraints and the process must be carefully applied.
Some of the constraints one has to keep in mind while using this process are:

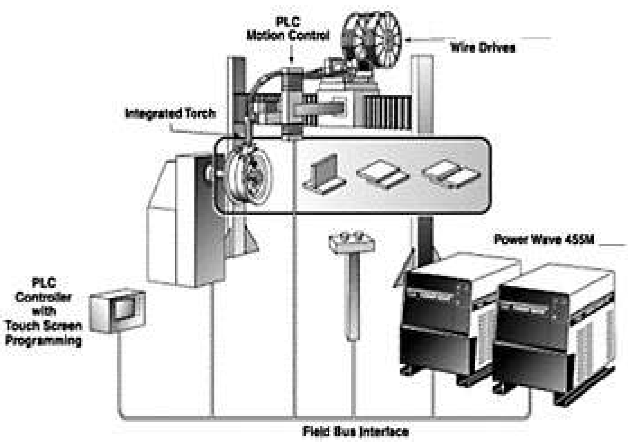
- The lead and trail procedures must be programmed to operate at the same frequencies or at integer multiples of each other.
- To increase or decrease deposition, the lead and trail wire feed speeds must be varied together. This reduces the degree of independence between penetration and fill.

Arc voltage regulation cannot be achieved by dynamically varying the frequency.

EQUIPMENT CONFIGURATION

The Tandem MIG equipment is configured to provide individual parameter control for each of two separate, and electrically isolated, welding arcs. This requires a pairing of all equipment; two specially designed high-speed inverter power sources, two wire drives, two separate welding wire pay-off sources and a Tandem MIG welding torch. The power sources used for this process rely on fast digital control and Tandem MIG specific software. Welding parameters are set at the power source via digital communication from either a Programmable Logic Controller (PLC) associated with a dedicated hard automation work cell or by a robot controller.

The Tandem MIG torch is a critical component of the system, engineered with specific contact tip alignment and spacing to achieve proper arc control. Due to the need to withstand the demands of high amperage, high duty cycle production runs the torches are generally rated in terms of the total current flowing in both wires. This rating is typically in the 600-1200 amp range. Additionally, the maximum current for each wire is specified. This rating is typically in the 400-800 amp range. An example of a hard automation equipment configuration would be:



PROCESS BENEFITS

The increased production benefits of the Tandem MIG process have been used to:

- Justify the cost of automation equipment
- Improve profitability of existing automation
- Reduce the initial capital expense costs of new production lines by reducing the number of weld stations required.
- Shorten payback periods associated with new welding automation.

The Tandem MIG process has a wide operating range that can be generally segmented into two categories addressing high speed sheet metal welding and heavy plate welding. On sheet metal, the process is often operated at travel speeds in excess of 254 cm per minute on thin gauge material (1- 2.5 mm). On heavy gage material, weld metal deposition rates exceeding 16 kg / hr are possible.

HIGH TRAVEL SPEED APPLICATIONS

The ability to distribute the total welding current across two separate welding wires provides unique benefits for high-speed welding. When pushed to increase travel speeds on thin gauge metal components in industries such as automotive, tank and general sheet metal fabrication, welding operations are faced with one or two quality issues, either burn through or lack of weld metal flow characteristics. The Tandem process addresses both of these speed-limiting issues. The ability to distribute the necessary welding current over two welding wires allows the lead wire to generate needed penetration while the trail wire rides on the back edge of the weld puddle creating added fill. Also, the trail wire acts as an additional force that pushes the puddle for better follow and wetting capabilities. This trail arc behavior in the shared weld puddle provides excellent gap filling characteristics. Improved gap filling capabilities are of particular value to industries processing high volumes of stamped or formed parts. The system utilizes robot touch sensing software to locate the weld joint and through-the-arc seam tracking (T.A.S.T.) software option for real-time tracking. The Tandem system welding at an average speed of 150 cm per minute was installed to replace an older single wire robotic system that was averaging 60 cm per minute. Overall welding speed was increased by150 %.

HIGH DEPOSIT RATE APPLICATIONS

As illustrated in Fig.1, the Tandem MIG process can on average represent a 30-80% increase in deposition potential when compared to conventional single-wire processes

The Tandem MIG process typically employs small diameter electrodes. As higher welding currents are applied to the small diameter electrodes (0.9 - 1.6 mm) the electrode melt-off rate rises exponentially. The resulting electrode melt-off rate for a given current draw is higher for Tandem MIG than that of a single large diameter electrode. This higher melt-off rate potential and lower amperage draw provides unique benefits for the heavy plate fabricating industry. The high deposit rate obviously provides the means for improved production throughput. The lower heat input can be used effectively to reduce plate distortion and time between passes when controlling inter-pass temperature on multipass welds. The process is capable of producing x-ray quality welds with excellent mechanical properties.

RETURN ON INVESTMENT

The Tandem MIG process is designed for use on automated welding station or automated lines. Common host automation is either a hard-automated work station that has dedicated motion functions or a robotic station with flexible, programmable motion. Investment in these high-volume production lines is generally a significant capital expenditure that requires detailed analysis and cost justification. Part floor-to-floor time, including welding speed as a critical component, plays an important role in determining if a project can be cost justified. When compared to single-wire processes, Tandem MIG higher travel speed capabilities can assist in cost justifying greater capital expenditures as well as accelerate equipment payback periods.(Fig. 4)

Tandem MIG has assisted in reducing the cost of new production lines by meeting production needs with fewer welding stations. This is particularly true for high-volume production lines producing automotive components or similar parts where tooling and part handling equipment constitutes a sizeable portion of the initial installation costs. The cost of hydraulic tooling and handling equipment may be reduced by using fewer weld stations based on the higher per-station throughput of Tandem MIG. Additionally, the expense of up-keep and maintenance of duplicate tooling sets to insure consistent part dimensions is minimized.

Production cells welding large components must be cost justified in a different way based more on welding time and not part count. The heavy equipment industry, which was the first to embrace the Tandem MIG process, typically utilizes large robotic work stations that include expensive positioners to handle the large and heavy weldments that often take two or more hours to weld. Most weldments must be placed in the flat or horizontal position. This requires the use of large positioners and makes the use of multiple robots per station difficult. Tandem MIG has repeatedly been used to replace single-wire robotic systems welding at averaging deposit rates in the range of 6.5-9 kg/hr with Tandem MIG operating in the 12.5-15.5 kg/hr range.(Fig. 5)

The increased weld metal deposit rate has been used to justify the cost of purchasing new more technically sophisticated workstations. Tandem MIG continues to benefit a number of industries, from companies welding thin sheet metal automotive components to companies performing multi-pass welding of large earth moving equipment and offshore drilling rigs.

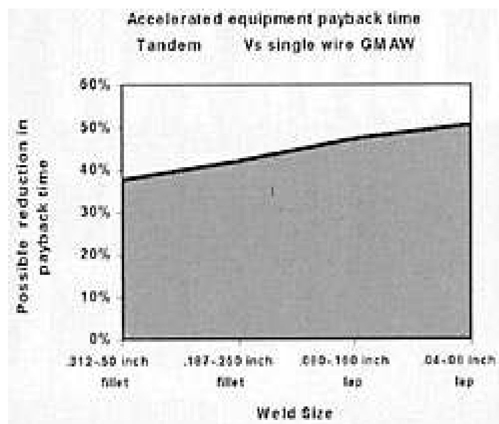


Fig.4 - Possible Payback Time

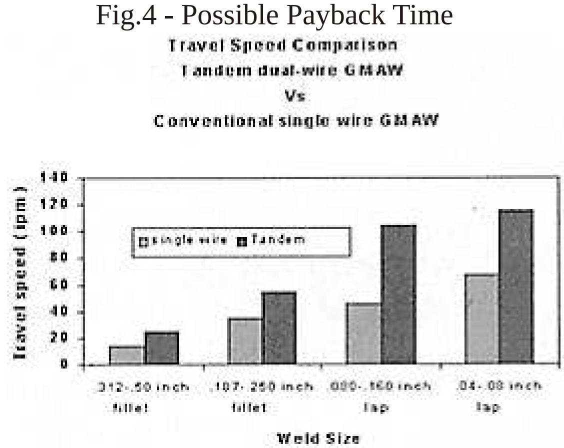


Fig.5 - Travel speed comparison

How to Choose Electrodes for Joining High-Strength Steels*

Technical insight is provided in this article for evaluating the variety of GMAW and FCAW electrodes for joining high-strength steel.

INTRODUCTION

All over the world, adoption of gas metal arc welding (GMAW) and flux cored arc welding (FCAW) processes continues to grow for low-cost fabrication of various grades of structural steels, including high-strength steels. The growth of GMAW / FCAW is driven primarily by the increased availability of numerous consumables, including solid, flux cored and metal cored wire electrodes. But, how does one select an electrode for joining a particular grade of high-strength steel? Will a simple reliance on relevant AWS/ ANSI electrode specifications be adequate? How does one evaluate data from a multitude of electrode manufacturers? This article offers to provide technical insight into those questions.

FACTORS TO CONSIDER

Selection of an electrode for a particular application is based on several factors. Chief among them is a fundamental understanding of the relationships among chemical composition, processing, microstructure, and mechanical properties of the steel being welded. Also, specific design requirements for mechanical properties of the welded component or structure should be known. The "things to-do" list is long while underlying issues are complex. However, such an understanding is a prerequisite for achieving quality, productivity, and improved performance of welded constructions, while controlling overall fabrication cost.

BASIC PRINCIPLES OF ELECTRODE SELECTION

Electrode selection is based on an electrode's ability to provide weld metal that is chemically compatible with the base metal. Electrodes that offer a similar (not same but matching) chemical composition as the base metal minimize potential adverse effects of base metal dilution, which can include localized corrosion. Welding electrodes are also selected to enhance weldability. A major aspect of weldability is the ability to obtain crack free weldments. In the case of high strength steels, the primary concern is achieving resistance to hydrogen-assisted cracking (HAC) in both the weld metal and the heat-affected zone (HAZ). Resistance to solidification cracking is seldom a concern. Most often, solidification cracking in weld metal is attributed to segregation of impurities such as sulfur and phosphorus along the weld centerline. Control of impurities (sulfur and phosphorus, each at 0.01 wt-% maximum) and trace elements in the welding electrode, and control of weld solidification conditions through manipulation of travel speed, most often avoid solidification cracking in weld metal.

MICROSTRUCTURE

Microstructure underpins mechanical properties. The term microstructure includes type, size distribution, morphology, and volume fraction of various microstructural constituents. Microstructure, in turn, is dependent on chemical composition and processing conditions, especially cooling rate. Based on a need to achieve desired mechanical properties, weldability may be looked upon as the ability to "recreate and / or retain" microstructures similar to the base metal. Various carbon equivalent formulas allow one to relate chemical composition with weldability of steel. In particular, Yurioka's carbon equivalent number (CEN), as shown in Equation 1, offers a viable means to assess relative effects of various alloy elements on weldability.

$$CEN = C + A(C) \times \left\{ \frac{Si}{24} + \frac{Mn}{6} + \frac{Cu}{15} + \frac{Ni}{20} + \frac{Cr + Mo + V + Nb}{6} + 5B \right\} \quad ...(1)$$

** Based on an article by K. SAMPATH is a technology / business consultant, published in Welding Journal, Vol.86, No. 7,.July, 2007* where CEN is known as Carbon Equivalent Number, $A(C) = 0.75 + 0.25 \times \tanh [20 \times (C - 0.12)]$, tanh is perbolic tangent and concentrations of all elements are expressed in wt-%. Although the CEN equation was originally developed to assess hydrogen cracking sensitivity of structural steels, the equation is also relevant to weld metal. (For a nominal composition electrode of E9015B9 grade the CEN is 0.87 as the maximum value with C as 0.12% whereas Carbon Equivalent of this grade is not applicable). The higher the CEN, the lower is the resistance to HAC. Carbon has by far the greatest impact on weldability. So, it is essential to select welding electrodes with a carbon content lower than that of the steel being welded. Considering possible carbon pick-up from CO_2 in the weld shielding gas, and base metal dilution, it is prudent to select welding electrodes with about 0.02 to 0.04 wt-% lower carbon than the base metal. Lowering carbon content must be compensated for by using other alloy elements to maintain or further increase CEN. A 0.12 wt-% for carbon is considered an appropriate upper limit in high-strength steel welding electrodes, as twinned martensite, which has an extremely poor resistance to HAC, is likely to form above this limit. The CEN equation is helpful in selecting various principal alloy elements in the welding electrode. Alloy elements with a lower coefficient (nickel, copper, and manganese) are preferable to those with a higher coefficient (chromium and molybdenum). Yet, weld metal must remain chemically compatible with the base metal. A prior knowledge of the chemical composition of the base metal and the roles of various alloy elements is valuable.

OVERMATCHING STRENGTH AND OVERALL ALLOY CONTENT

Welding electrodes must provide weld metals with a minimum required weld tensile strength and acceptable impact toughness properties, either in the as-welded or postweld heat treated condition. Use of a welding consumable that offers a deposited weld metal with higher weld tensile strength than the tensile strength of steel being welded is called overmatching. Overmatching is used primarily to “protect” the weld deposit from the presence of fabrication-related weld flaws. These flaws when subjected to occasional excessive service loads can potentially lead to catastrophic consequences. However, overmatching of high strength steels using welding electrodes with high-carbon content requires expensive preheat, interpass, and occasionally post-soak temperature controls during welding to ensure against HAC, thus hurting productivity and overall economics of fabrication. Therefore, overmatching is an option only when the overmatched weld metal offers adequate toughness, particularly acceptable low-temperature impact toughness, and overmatching allows cost-effective fabrication. Other aspects of strength consideration are heat input and cooling rates. It is well known that high weld energy input and associated slow weld cooling rates produce a lower strength weld metal, and vice versa. Depending on the electrode diameter, the weld energy input commonly ranges between 20 and 80 kJ/in. A high performance welding electrode is expected to overmatch at the highest usable weld energy input while meeting or exceeding weld metal toughness requirements. This invariably means that at the lowest usable weld energy input, the same welding electrode may overmatch the minimum specified tensile strength of the base metal, possibly in excess of 10%. In other words, an electrode that provides marginal overmatching at the highest usable energy input is likely to offer excessive overmatching at the lowest usable weld energy input. Fortuitously, the high strength weld metal simultaneously offers higher toughness, primarily due to the presence of refined grains and microstructural constituents. Expectedly, CEN of the corresponding welding electrode would be higher than the base metal, in excess of 10%. The strength and other mechanical properties of a clean, defect-free weld metal depend primarily on chemical composition, and secondarily on weld cooling rate. As shown in Equation 1, a higher alloy content results in a higher CEN, and thus a higher tensile strength. As a higher CEN progressively impairs weldability, control of alloy content of the selected electrode to a desirable range of CEN is crucial. The inherent conflict requires "balancing" or optimization of competing criteria. When there is an inability to resolve this underlying conflict, as in the case of certain very high-strength steels such as HY-130, overmatching may no longer be a viable option.

TOUGHNESS AND TRANSFORMATION TEMPERATURE

How does one select a welding electrode to improve weld metal toughness? Besides chemical composition, welding conditions (particularly weld cooling rate) contribute to microstructure development. The following on-cooling transformation temperatures are important with regard to microstructural development in high-strength steels: 1) austenite–to-ferrite (Ar3), 2) austenite-to-pearlite (i.e., eutectoid transformation), 3) austenite-to-bainite (i.e., BS, bainite-start and BF, bainite-finish), and 4) austenite-to-martensite (i.e., MS, martensite-start and MF, martensite-finish) temperatures. Controlled lowering of the relevant transformation temperatures allows one to refine grains and microstructural constituents in weld metal, and thus simultaneously improve both strength and overall toughness. Here again, several constitutive equations allow one to relate chemical composition with transformation temperatures, thus further allowing selection and manipulation of various microstructural constituents. The Ar3 temperature is approximately related to chemical composition as shown in Equation 2. Likewise, BS, BF, and MS temperatures are statistically related to chemical composition of low-alloy steels as shown in Equations 3–5.

Ar3 (°C)= 910 (310 .C) (80 .Mn) (80 .Mo) (55 .Ni) (20 .Cu) (15 .Cr) …….(2)

BS (°C) = 830 (270 .C) (90 .Mn) (37 .Ni) (70 .Cr) (83 .Mo) ……(3)

BF (°C) = 710 (270 .C) (90 .Mn) (37 .Ni) (70 .Cr) (83 .Mo) …..(4)

MS (°C) = 561 (474 .C) (33 .Mn) (17.Ni) (17 .Cr) (21 .Mo) ……(5)

The above statistically valid relationships between chemical composition and transformation temperatures were originally developed for particular types of steels, under specific experimental conditions. Nevertheless, these equations are useful for manipulating alloying elements in welding electrodes, thus targeting desirable ranges of transformation temperatures. The objective is to select a welding electrode or control its alloy content within a desirable range of CEN, while achieving a 30° to 50°C lowering of the relevant transformation temperatures compared to the characteristics of the high strength steel being welded. Thus, a complete understanding of chemical composition and microstructures of the base metal is a prerequisite to selecting a high performance welding electrode. Besides alloy content, increasing (weld) cooling rate is known to suppress (undercool) transformation temperatures. The welding operational envelope controls weld cooling rate. As mentioned previously, increasing the weld cooling rate contributes to a further refining of both grain size and various microstructural constituents, thus strengthening the weld metal while simultaneously increasing its toughness. Despite this potential, it must be recognized that in fusion welding situations, because of epitaxial growth considerations, the level of undercooling achieved is often minimal, not exceeding a few degrees.

DISSOLVED GASES AND TOUGHNESS

Weld metal toughness can be severely impaired by the presence of dissolved gases such as oxygen and nitrogen (in excess of 500 ppm, total), and too many inclusions that contribute to "a dirty weld." Proper control of shielding gas during welding, and the presence of controlled amounts of aluminum, titanium, and zirconium (each at 0.03 wt-% maximum) in the welding electrode are necessary to minimize air ingress, and effectively deoxidize, fix nitrogen in weld metal, allow "scavenging and grain refining," and thus enhance weld metal toughness.

SPECIFICATIONS

Standard setting organizations such as the American Welding Society (AWS) codify the above rationale and knowledge for welding electrode selection into appropriate welding electrode specifications, such as AWS A5.28/A5.28M:2005, Specification for Low-Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding, and A5.29-05, Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding. Underlying parameters in a specification are supported by both historical data and test data developed by electrode manufacturers and researchers, among others. The specification parameters allow users to select one or more electrode classification(s), and corresponding electrodes offered by one or more welding electrode manufacturer(s). Welding electrode specifications simplify the above complex electrode selection criteria, and present the recommendations, as clearly and concisely as possible. To maintain neutrality or eliminate bias, the recommendations are classified into groups of welding electrodes based on chemical composition of the electrode or the as-deposited weld metal (as in the case of cored electrodes), and appropriate and acceptable mechanical property (commonly strength and toughness) test results of undiluted, buttered, or diluted weld metal. The relevant electrode classification system also recognizes the fact that electrode manufacturers often produce one type of electrode that can be used to join a broad range of high-strength steels. It is instructive to recognize that despite a strong attention to detail in reducing various risks inherent to welding electrodes while enhancing reliability of welded structures, welding electrode specifications do not offer an ability to distinguish the combined effects of critical elements in electrodes and weld metals. All the same, as shown by the effects of CEN and calculated transformation temperatures on weldability, microstructure development, and weld mechanical properties, such an ability is essential to achieving desirable combinations of high productivity and superior performance. Current welding electrode specifications do not distinguish a high-performance welding electrode composition from either a rich or a lean welding electrode composition, although all of them meet electrode specification requirements. Compared to either a rich or a lean welding electrode composition, a high performance welding electrode composition is flexible or "more forgiving" when it allows welding over a wide welding operational envelope while providing weld metals meeting minimum mechanical property requirements. Current welding electrode specifications also do not highlight to a potential user various fabrication-related cost risks in selecting either a rich or a lean welding electrode composition that otherwise meets electrode specification requirements. Such limitations could adversely impact weld procedure qualification efforts, particularly in terms of meeting schedules and cost estimates.

SUMMARY

Selection and use of GMAW/FCAW electrodes that eliminate a need for expensive preheat, interpass, and post-soak temperature controls during welding of high-strength steels, yet perform satisfactorily over a broad welding operational envelope, while providing weld metal with an overmatched tensile strength and acceptable toughness, offer exceptional value to both electrode manufacturers and weld fabricators. To find such high-performance GMAW/FCAW electrodes,

... continued on Page 21

Refinery order

Essar Construction (India), a subsidiary of Essar Projects, has secured a Rs.186 crore contract from Bharat Oman Refineries (BORL), a joint venture of Bharat Petroleum Corporation, for laying a 504 km crude oil pipeline. The 14 month project entails laying pipeline from Vadinar in Gujarat to Bina in Madhya Pradesh, where BORL is putting up a refinery.

SCI in ship building

After its proposed foray into dredging, Shipping Corporation of India has decided to step into ship-building. The government owned shipping major has opened talks with two foreign shipyards for a joint venture in India. SCI will bid for the two mega shipyards proposed by the government – one each on east and west coast. Ennore Port Company and Mumbai Port Trust, the nodal agencies, have started the bidding process.

Global warming may melt Indian economy

According to a recent study conducted by Lehman Brothers it is reported that climate change will severely affect GDP of India. It is said that for every 2°C rise India’s GDP will dip by 5%. The dip will be more adverse for the next 6° C rise. The GDP will dip by 15-16% every year.

BPCL to sell 1,000 tonnes of metal cutting gas

Bharat Petroleum Corporation Limited (BPCL) would be selling more than 1000 tonnes of specially blended LPG for metal cutting and welding purposes in southern states this year.

The metal cutting gas introduced about two years back was a result of the company's in-house R and D efforts. Liquefied petroleum gas is mixed with high performance additives to make the product, which is more powerful than the commonly used acetylene gas cutting system. The gas was economically 40 per cent efficient than the acetylene gas cutting applications. The gas is patronized by fabrication industry and welding applications and is made available by BPCL through the LPG distributors. The gas is sold in cylinders weighing about 19 kgs.

Last year, BPCL sold 990 tonnes of the gas across the country and the southern region accounted more than 400 tonnes of the sales For the current year, the target is fixed to surpass 1,000 tonnes in southern region alone.

Energy City near Mumbai

Gulf Finance House, in association with Gulf Energy, has announced their plans to develop India's first integrated energy business district—Energy City India—with an estimated investment of $2 billion. An MoU was signed with the Government of Maharashtra to facilitate the creation of this project.

Energy City India will be developed on approximately 300 acres of land near Mumbai. GFH is being assisted by Valuable Infrastructure Pvt. Ltd in the suitability and final feasibility studies for project land acquisition. GFH also plans to develop a further two such hubs in other Asian markets, details of which will be announced early next year. The Energy City concept involves the master planning and construction of an integrated business centre that specialises in the provision of complete business infrastructure for leading oil and gas producers, both local and international, downstream refiners and producers, support services, shipping and energy trading businesses. An important component of the Energy City concept is the International Mercantile Exchange (IMEX), which will provide a platform for electronic trading of energy contracts and derivatives. Commenting on Energy City India, Chief Minister Vilasrao Deshmukh said: "Energy City India is a concept whose time has come. The importance of energy to our future prosperity cannot be underestimated. I am very pleased at this initiative, and that the project will be based in Maharashtra." Deshmukh further stated that GFH would directly

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Welding failures *

WELDING-FAILURES: CHANCE OR NEGLIGENCE?

You know a success from a failure, don't you? The problem with Welding-failures is that they happen without warning, and at the worst moment, in the most damaging way, with most costly repair procedures. That is common to all failures, probably. What can we learn from a failure? If we are keen and determined we can learn how to avoid it next time, how to improve what we do. Investigating failure origins for correction and prevention

Welding-failures have a most important, if costly, function. That is to teach what is at fault and what needs correction and improvement. But only if we investigate making an effort to see the reality without being clouded by any theory. And if we know how to learn from experience. What are really Welding-failures? In our opinion Welding-failures occur only in service. Regarding production, the inability of a test piece to stand up to mechanical requirements, or of a workpiece to meet nondestructive inspection demands, should be called a defective condition, and should be addressed with a different approach. Investigation of the causes could be easier, and corrective action simpler to implement as all contributing elements are known. The good news is that not all Welding-failures can be imputed to the welder, or to the shop, or to the procedure. The bad news is that you may have to prove it. So does it make sense to understand what an investigation is and how it is done? Don't you think you might profit from looking somewhat deeper into this subject? Tip!: When Welding-failures arise it is good practice to leave everything as is at the time of occurrence, until the expert arrives. Any needless manipulation of the fractured surface and surroundings could erase important clues that the investigator would have used to reach his conclusions. Responsibility and damage assessment

WHY WOULD YOU WANT AN EXPERT?

Sometimes because of legal requirements or insurance claims, especially if life or property were endangered. In every other case whenever the origins of the failure are not obvious. There is a need for a wealth of knowledge and experience that form the tools of the expert's trade. Would you like to know how an investigation is conducted? If yes then you can find here a few outlines for orientation. As for any metallurgical investigation one should first collect all the available evidence including witnesses reports, details on time and circumstances of failure occurrence, on operating conditions before failure, was there fire, explosion or any other accident connected. What were the operating fluids and their temperature and pressure, and other auxiliary materials, if any. Notes on shut down procedure for the facility and removal of heat or load or both should be included. Description of the appearance and first assessment of failure's importance, collateral damage if any, photographic documentation of the appearance of the cracked or fractured surface is part of the expert's work and should be left under his/her responsibility. Then one should collect all documentation available on the manufacture of the item involved, on base material and filler material specification and certificates, on the welding process used, on the welding procedure and inspection record, on the welder involved (welders identification code marked near the welds is required by many specifications), on all the tests and inspections that were performed, including radiographs of the failed area, if any exist: these records must be preserved for a specified number of years, according to binding specifications. Final load test report at the time of

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manufacture should also be made available.

IMPORTANCE OF UNBIASED OBSERVATION

One should assess if the welded assembly was realized as prescribed by drawing and relevant specifications. Then one should review if design took into account the working stresses as applicable for the service involved. One should also investigate if working conditions were significantly different from those presumed in design. Having collected all available information the investigator is now ready to take a closer look of the Welding-failures. First a thorough visual inspection is needed, by the naked eye but also with some low power enlarging stereomicroscope. The important features must be documented by photographic imaging. Finally one should confirm by analysis and tests that the chemical composition of the material and its heat treatment condition were in effect as prescribed and requested by design. One should investigate if the physical condition of the surrounding area presents evidence of local damage by mishandling or by some other accident. The nature of many failures resulting in fractures, if ductile or brittle, if signs of fatigue propagation are present or of corrosion products, if there are wear marks, gross deformation, burst or other features can be determined by examining the fracture surface by the techniques of fractographic analysis. Subtle clues show major culprits

Only when all studies of visual characteristics have been completed, time is ripe for metallographic sections. These sections, duly prepared with grinding and polishing, can be examined under the optical microscope, after etching to reveal the form and consistency of weld beads and the appearance of the heat affected zone, with possible defects and unwanted metallurgical phases being present. In certain cases where clear cut results cannot be obtained, the expert may have recourse to more sophisticated means like scanning electron microscope (SEM) and other specialized techniques. In many cases any expert will profit from unbiased observations, especially when they appear as striking deviations from usual instructions or behavior, when they are proposed by a curious and thorough observer, familiar with the facility and its operation, no matter what his/her official rank or preparation. Of the common service Welding-failures we shall address burst fractures, overload failures, deformation, corrosion generated or heat dependent failures, wear dependent, metallurgical failures, faulty design failures, wrong material selection and inadequate welding procedures. Only expert metallurgists, familiar with this type of inquiries and knowledgeable with the disciplines involved can conduct a thorough investigation.

BURST FAILURE

Burst failure, usually of ductile character, can derive from overpressure, or overload, if the original thickness and soundness of the material at the failure place is still in good condition, not undermined by wear or corrosion. The actual position of the fracture in relation to weld location can hint at possible metallurgical problems to be addressed by metallographic examination.

DEFORMATION

Deformation caused by faulty assembly could easily build up excessive stresses capable of inducing fatigue cracks especially if combined with superficial stress raisers, in presence of vibrations or shocks.

CORROSION

Corrosion diffused on the surface or concentrated in fissures can be evaluated if there is line of sight to the place. For looking at restricted areas one inserts borescopes, visual instruments including a light source for examining features at low power enlargement, in internal cavities or tubes. Intergranular corrosive attack can best be assessed by examining a metallographic section. Once assessed the presence of corrosion one should still determine the cause of its formation. Stress corrosion is a dangerous combined condition that could have been easily avoided if anticipated.

OVERHEAT

Overheat as a condition generating failure can have many outcomes, including distortion, intergranular fracture, and oxidation. It is usually possible to find the traces of unwanted heat, like color, surface appearance, lower hardness, metallographic evidence. Wear

Wear or erosion on a visible surface can easily be assessed. The opposite mating surface also should be investigated to answer the question why the two surfaces came together in the first place.

CRACKS

Cracks can appear of two different kinds. Hot cracks form when the material solidifies, generally because of the presence of low melting constituents. Cold cracks are generated later, when the material is cold and under stress, sometimes by the presence of dissolved atomic hydrogen. They are easily differentiated under the microscope, but anyhow, hot or cold they should not be allowed in a sound structure, otherwise the structure is in danger if not already failed altogether.

STRESS RAISERS

Arc strikes should have been detected and repaired in production. If they were not removed they act as stress raisers and also as crack origins. By retracing the fracture course one can easily find them as culprits. Arc strikes could also be generated by careless use of electric current application during magnetic particles inspection procedures. Poor weld contours, incomplete penetration and inadequate fusion have a manifest side and a hidden one. They can cause or contribute to a failure as stress raisers and least resistant path. A properly approved welding procedure should have detected these defects in time and have avoided occurrence of failure. Brittle

FAILURE

When in presence of a brittle failure one should investigate if the material selected was adequate, and if all means of influencing the metallurgical structure, like preheating and post heating were applied correctly within a balanced welding procedure. Welding-failures can be attributed to faulty design only if it did not take into account the service conditions or if the details of the construction generated stress concentration conducive to brittle fracture. Tip!: One should be most careful with such a conclusion, making sure it is well documented and proven, because of the fierce resistance from the designer who obviously will not like it...

Strategies For Automating A Welding Job*

INTRODUCTION

Automation can reduce time and costs-to-manufacture while improving quality and efficiency, but implementing automation for welding requires strategic planning, and evaluating the job and the expected outcome. It also requires the right employees and a good robotics company or integrator if it is going to achieve the goals set out for it.

A lot of companies are trying to maintain their business through the use of automation. Companies that previously didn't think about automating are thinking about it for survival. The rules of the game are changing, and we are looking closer at a lot of the small to mid-sized businesses and suggesting areas where automation might help.

However, before a company starts to automate its processes there are a number of things to consider, especially if the automation includes a shop's first robotic welding cell.

MARKET SIZE

Depending on the markets you serve you need to look at the needs of the markets, where the business is within the market, and the impact of offshore competition. Additionally one must look at what the competition is doing: Are they automating? And will automating welding operations help you be more competitive? etc.

REPEATABILITY

One of the first things to consider is whether the parts you are considering for welding automation are consistent in size. For robots to work well, the parts need to be consistent for a repeatable fit. One of the major challenges to implementing a robot on a job is high part variability. If you're producing parts by hand or using non-CNC equipment, you may be getting a lot of batch variation or non-repeatability. That would be difficult for a robot to handle. If a job shop is using CNC equipment to produce parts for welding, it's a sure bet that the parts are repeatable enough to automate the welding. However, over a decade ago, a lot of job shops were using shears and break presses to produce parts, but today so many have invested in CNC equipment that we do not see repeatability is an issues anymore.

NUMBER OF JOBS

It has been pointed out that the number of jobs with which to occupy the robot is another important consideration. Are you doing one job? Two jobs? That determines how many sets of positioning equipment you need to keep that robot moving. Often, the cost of the robot is dwarfed by the fixturing to keep it going.

BATCH VOLUME

The part volumes are also an important consideration. With low batch volumes, if you have five of this part and 10 of that part, you may find yourself doing more in setup than in actual production, so volume is key. A thousand pieces would be a good number to consider automating a welding job, but it could be that 100 pieces would warrant automating, depending on how much welding there is on the part. You need some degree of repetitiveness with jobs so you can change over the fixture and do another job as well.

EXTENT OF WELDING

Another issue is the ratio of low weld content to high part handling or part size for a robotic cell. There should be a significant number of welds, for example 18 to 20 welds per part – that's pretty significant. With a small number of welds, often there's a lot of part handling and a small amount of weld time. If the part needs to be turned to accommodate the welds, a part positioner is required, and that will add to the cost of the system.

GEOMETRY OF THE JOB

As parts get bigger, the system costs more. That is the reason that evaluating the part size is critical when making the decision to automate. If you're talking about something that is a meter cubed, that's one size. A part that's a meter in diameter and two or three meters long is another size. Once you get bigger than four meters long and two meters in diameter, the system gets really expensive because of the tracks and other equipment required to move the robot.

NUMBER OF PARTS PER JOB

Another consideration with respect to the price of the system is the number of pieces welded for each unit. A high quantity of pieces per each unit can make the positioning fixture quite expensive. For example, if a product has four parts and requires 18 to 20 welds, that's one thing, and it may be a good job to automate. However, if a part requires 18 to 20 welds and it has a dozen component parts, it becomes difficult to fixture. It has been suggested that more-complex welding jobs with a high number of parts to be welded in each component can be broken up into sub-assemblies, using the robot to weld smaller sections and then finishing it by hand. If you use your 80-20 rule and let the robot do 80 percent of the job and the other 20 percent is done manually, you can save money and complexity in the automation cell, and get better productivity.

FLEXIBILITY

Versatility also is an important consideration when choosing a robotic welding system. The answer to the question: How versatile today's robot systems are? It is still evolving. 10 years ago it was not evolving. If you had a guy welding a part seven days a week, 52 weeks a year, that was probably a good job to automate. Today, we are looking now at shorter parts runs, which change the scope of things. Robots today are more versatile than years ago, and we are selling a 6-axis robot that gives us great versatility. While the robot is flexible enough to handle a variety of jobs in a production job shop setting, the key is to also implement an easy tool change system, including fixture plates with dowel pins so that fixtures can be easily changed in and out of the automation cell to accommodate job changes.

SYSTEM INTEGRATION

Another consideration, and something that is often overlooked by companies looking to automate a welding job, particularly if it is their first foray into automation in welding, is system integration i.e. between the equipment and systems. What typically happens is that a customer might buy a standard welding cell, positioner, and safeguarding and be ready to weld. But the integration aspect is something the customer needs to address on his own. Often someone buys a cell and didn't anticipate how much work would be involved in system integration. You are better off contracting with a systems integrator, a consulting firm that specializes in this, or buying an integrated system from the get-go. You save a lot of time that way.

THE EMPLOYEES

When it comes to the employees needed to help a company operate a welding automation cell, and that with the shortage of young people filling vacant slots in the welding trade, automation helps. But, welders will still be needed even though a company has automated certain jobs. In addition to engineering functions, they do tasks such as write the procedures on how things are done. The staff you have on hand, if they have been welding manually for years, can help with automating the process. One place the programmer can gain expertise is to talk to the welder, find out how they are doing the specific job currently. People working on the manufacturing floor can be a wealth of information on how jobs are currently being done and can be extremely helpful in developing the automation.

HOW TO DETERMINE IF AUTOMATING A JOB IS RIGHT

There are some simple steps for evaluating whether to automate a welding job:

1: Evaluate your parts and the current labor applied to it. How many semi-automated welders are you using currently? If you're using two to six welders for a job, that job may be a candidate for complete automation. If you're using more than 10 welders, that job is a certainty for automation. Crunching the numbers by looking at lease rates, and factoring those into a wage or dollars per hour, shows that a $75,000 to $150,000 expenditure in automation equates about $9.00 to $18.00 rate per hour (based on a 24/7, 50week year). It can be very economical when implementing automation with semi-automatic welders. If you have simple parts with high volume, you can probably set up a robot and use a low-skilled operator to load and unload the parts. If you're doing more complex or heavier parts, you may want the cell run by a welder who can pre-tack and finish parts as he loads and unloads the cell.

2: Ensure that you have experienced welders on staff to program and operate the robot. Do not send your CNC operator to a welding robot programming class and think that he will be able to run an automated welding cell, unless he knows welding. Robots are relatively easy to program, and there are one week class geared toward shop floor programming. But in the end, the robot has to weld, so someone with welding know-how will be most effective at applying it.

... continued on Page 21

Kemppi Beta 90X Welding Helmet*

The upgraded Kemppi Beta 90X welding helmet combines ADC technology and the new headband mechanisms in a unique way to stop the disturbing light rays coming from the side. Kemppi's welding helmet Beta 90X has got a new advanced filter that very efficiently stops light rays and reflections entering also from diagonal direction. The new filter and the more versatile adjustment possibilities make Beta 90X a unique safety device both for welding and grinding work. Autodarkening Kemppi Beta 90X is equipped with an autodarkening welding filter. The auto darkening welding filter is based on liquid crystal technology. When the welding arc is lit, the filter immediately darkens before the eye is able to react to the light. When the arc is extinguished the filter becomes transparent again. The filter gets the required energy from the welding arc radiation. Filter equipped with a delay adjustment. The auto darkening LCD filter has been replaced with a more advanced model in the new Beta 90X helmet. The new filter allows you also to adjust the delay of the filter, i.e. change how fast the filter becomes transparent when the arc is extinguished. The adjustment range is from 0.2 to 0.8 seconds. It is recommended to adjust the delay longer with larger welding currents. A long delay is suitable also for pulse welding and TIG welding with small currents as it prevents the filter from turning transparent if the welder's hand or the welding torch momentarily prevents the light from entering the photo sensors. ADC Technology

The new filter also utilises the so called ADC technology, i.e. the angular dependency compensation. This refers to the ability of the filter to stop light that hits it diagonally. The value of this feature in the new filter is +/-30º, which is a considerable improved compared to the +/-10º value of the previous model. In practice this means that the new welding filter is very effective in stopping light rays and reflections entering from the side. Furthermore, Kemppi has shown resourcefulness in combining the advantages of the new ADC technology with the previously reconstructed fastening mechanism of the Kemppi Beta 90X helmet in a clever way not yet seen on the market. The improved angle of view of the filter enables more flexible fastening adjustment of the helmet according to the user's needs.

Adjustmentments

The possibility of adjusting the filter in an inclined position following the shape of the face helps to bring the view window closer to the eyes, and thus widen the view area. This makes it easier to see the work piece, which improves working safety. Also the centre of gravity on the helmet moves closer to the neck, which helps to decrease the strain on the neck and add comfort to working. Thus the improvements have a direct effect on working efficiency and productivity. Better fit adds comfort and safety. The welding

... continued on Page 21

** Kemppi ProNews 2 2007, pg 37*

EWI works with shipbuilding to reduce distortion in welded thin steel panels*

Edison Welding Institute (EWI) is working with the National Shipbuilding Research Program (NSRP) to develop narrow groove submerged arc welding for thin steel application for shipbuilding. The main thrust of NSRP is to develop technologies for the US Navy and other Department of Defense customers by leveraging best practices to improve the efficiency of the US shipbuilding and the ship repair industries.

Through collaborative research and development efforts with the ship construction industry, education and research institutions, and government, the NSRP seeks to achieve significant reductions in commercial and USS Navy ship construction time and costs through advancements in technology. The key challenges that NSRP addresses include

- Preserving critical defense infrastructure
- Reducing the costs to military and commercial customers
- Shrinking the technology gap
- Improving productivity
- Reducing the cost of materials

In response to increased performance requirements for US Navy ships, ship structures have become more complex. As a result, the use of thinner steels is major trend in ship structure design. Current and future Navy ship programs, including the DDG, DD(X), LPD, LHD, and Coast Guard Deepwater System, are deploying more thin plate (3 to 6mm) to reduce weight.

Recent research efforts have identified several limitations in welding technology required for fabrication with thin steel in the current shipbuilding infrastructure that was designed to fabricate structures with thick plate.

Submerged arc welding (SAW) using flux copper backing (FCB) is currently used in shipyards for long joint welding of plates into panels using single-sided welding procedures. This process is well established for thick steel where high heat input welding procedures are used to accommodate joint fit-up variations. This process produces excessive distortion in thin plate panel joints. New welding techniques are needed to minimize weld distortion in thin plates.

In this NSRP project activity, EWI developed a novel narrow-groove (NG) SAW welding process using precision machined weld preparations and advanced SAW power source technology. The advanced power source supports the use of tandem weld touches for increased travel speed and deposition rates, thus yielding increased productivity. Also advanced tooling concepts using FCB have been employed to reduce weld distortion. The NG tandem SAW butt joint welding procedures were developed and successfully demonstrated on 5-, 8-, and 10-mm DH36 plate. For each plate thickness preferred parameters were selected that increased welding productivity while improving weld quality and mechanical properties. The new welding procedures reduced welding distortion and improved weld consistency for the thin steel panels.

Through this NSRP effort, technology is being transitioned to several shipyards for welding thin plate for Navy ships. Valuable and quantifiable results have been obtained that indicate the tandem NG SAW process increases welding travel speed 100%, require 50% less weld filler metal, produces a high-quality weld more consistently, and takes less time to set up. A preliminary cost analysis reveals that the tandem SAW process can reduce welding cost per foot by approximately 50% as compared to current single-wire SAW process.

Contact Weldwell Speciality Pvt. Ltd., the representatives of EWI in India, for further details.

** Ref. Welding Journal, vol. 85, No. 7, July 2006, Page 51*

Trouble Shooting in TIG Welding Process

With the increase in demand for better quality of weld and extensive use of automation in TIG welding process it is convenient to have a ready reckoner for trouble shooting in TIG welding. The following table provides a comprehensive overview of what are the most common troubles faced by the TIG welders and their likely solutions

PROBLEM	CAUSE	SOLUTION
Excessive Electrode Consumtion	1. Inadequate gas flow.	1. Increase gas flow.
	2. Improper size electrode for current required.	2. Use larger electrode.
	3. Operating of reverse polarity.	3. Use larger electrode or change polarity.
	4. Electrode contamination.	4. Remove contaminated portion, then prepare again.
	5. Excessive heating inside torch.	5. Replace collet, try wedge collet or reverse collet.
	6. Electrode oxidizing during cooling.	6. Increase gas post flow time to 1 sec. per 10 amps.
	7. Shield gas incorrect.	7. Change to proper gas (no oxygen or CO_2).
Erratic arc	1. Incorrect voltage (arc too long).	1. Maintain short arc length.
	2. Current too low for electrode size.	2. Use smaller electrode or increase current.
	3. Electrode contaminated.	3. Remove contaminated portion, then prepare again.
	4. Joint too narrow.	4. Open joint groove.
	5. Contaminated shield gas, dark stains on the electrode or weld bead indicate contamination.	5. The most common cause is moisture or aspirated air in gas stream. Use welding grade gas only.Find the source of the contamination and eliminate it promptly.
	6. Base metal is oxidized, dirty or oily.	6. Use appropriate chemical cleaners, wire brush, or abrasives prior to welding.
Inclusion of Tungsten or Oxides in Weld	1. Poor scratch starting technique..	1. Many codes do not allow scratch starts. Use copper strike plate. Use high frequency arc starter.
	2. Excessive current for tungsten size used.	2. Reduce the current or use larger electrode.
	3. Accidental contact of electrode with puddle.	3. Maintain proper arc length.

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PROBLEM	CAUSE	SOLUTION
Inclusion of Tungsten or Oxides in Weld	4. Accidental contact of electrode to filler rod.	4. Maintain a distance between electrode and filler metal.
	5. Using excessive electrode extension.	5. Reduce the electrode extension to recommended limits.
	6. Inadequate shielding or excessive drafts.	6. Increase gas flow, shield arc from wind, or use gas lens.
	7. Wrong gas.	7. Do not use Ar-02 or Ar-Co2 GMA (MIG) gases for TIG welding.
	8. Heavy surface oxides not being removed.	8. Use ACHF, adjust balance control for maximum cleaning, or wire brush and clean the weld joint prior to welding.
Porosity in Weld deposit	1. Entrapped impurities, hydrogen, air, nitrogen, water vapor.	1. Do not weld on wet material. Remove condensation from line with adequate gas pre-flow time.
	2. Defective gas hose or lose connection.	2. Check hoses and connections for leaks.
	3. Filler material is damp (particularly aluminum).	3. Dry filler metal in oven prior to welding.
	4. Filler material is oily or dusty.	4. Replace filler metal.
	5. Alloy impurities in the base metal such as sulpher, phosphorus, lead and zinc.	5. Change to a different alloy composition which is weldable. These impurities can cause a tendency to crack when hot.
	6. Excessive travel speed with rapid freezing of weld trapping gases before they escape.	6. Lower the travel speed.
	7. Contaminated shield gas.	7. Replace the shielding gas.
Cracking in Welds	1. Hot cracking in heavy section or with metals which are hot shorts.	1. Preheat, increase weld bead cross-section size, change weld bead contour. Use metal with fewer alloy impurities.
	2. Crater cracks due to improperly breaking the arc or terminating the weld at the joint edge.	2. Reverse direction and weld back into previous weld at edge. Use Amptrak or foot control to manually down slope current.
	3. Post weld cold cracking, due to excessive joint restraint, rapid cooling, or hydrogen embrittlement.	3. Preheat prior to welding, use pure or non-contaminated gas. Increase the bead size. Prevent craters or notches, Change the weld joint design.

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first, know the chemical composition, microstructure, and mechanical properties (strength and toughness) of the steel being welded. Know the actual carbon content, and calculate CEN. Based on microstructures of the high strength steel, identify and calculate relevant transformation temperatures. Second, know the minimum acceptable structural design requirements for strength and toughness. Third, refer to AWS A5.28/ A5.28M:205, Specification for Low-Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding, and A5.29/A5.29M:205, Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding, and identify appropriate electrode classifications based on minimum acceptable requirements for transverse-weld tensile strength and toughness. Fourth, obtain electrode manufacturers' data sheets for the relevant electrode classification. Identify an electrode that has 0.02 to 0.04 wt-% less carbon, is chemically compatible, and shows a desirable CEN and 30° to 50°C lower calculated transformation temperatures than the steel being welded. Lastly, evaluate the candidate welding electrode using previously certified welding procedures, and determine that minimum acceptable requirements for weld metal

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acquire the land for this project.

The Energy City concept was developed by both GFH and Gulf Energy, an international energy consulting firm. Elaborating on the concept, Esam Janahi, Chief Executive, Chief Executive, and Chairman, Gulf Energy, said: "India is one of the largest energy markets in the world along with China, with a rapidly rising consumption rate. Some forecasts suggest that Indian consumption could double to 5.3 million barrels a day by 2025." On the choice of Maharashtra for the location of the project, Janahi said: "The Maharashtra government's pro-industry, pro-investment policy, and its strategic position in India's energy sector were (some of) the key deciding factors behind our decision to locate the project in Maharashtra." GFH is currently working with its Indian consultants and architects to finalise the specific components of the project, after which the master-planning exercise will commence.

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3: Consult with the robot manufacturer or integrator on the automation of parts before you make the investment. They can provide some cell concepts and give you estimated cycle times.

4: Consider automated welding as a part of your overall growth strategy. Some shops invest in an automated welding cell knowing it won't be used 100 percent of the time at first, but they use it to promote a high-tech advantage and to get more work.

... continued from Page 17

helmet is a welder's personal accessory, and its perfect fit is extremely important for working safety, efficiency and comfort.

Adjusting the new Kemppi Beta 90X welding helmet according to personal requirements is easier than ever, because the possibilities for adjusting the headbands have previously been improved. The number of headbands has been increased, and there are now two adjustable overhead bands instead of only one band in the previous model. They improve the fit and hold the helmet securely in place both in the up and down positions. The new band enables more versatile adjustments. You can change the height of the helmet, and adjust the back band exactly the way you want it. You can also adjust the distance of the filter if you want to widen the view area by bringing the view window closer to the face. The advanced features of the new welding filter and the versatile adjustment options of the headbands make the renewed Kemppi Beta 90X a unique safety device both for welding and grinding work.

Safety and Health Fact Sheet

Thoriated Tungsten Electrodes*

INTRODUCTION

Thoriated tungsten electrodes contain thorium, a radioactive material that can pose health and environmental risks at elevated exposure levels. Thorium is a low-level radioactive material that primarily emits alpha particles as well as some beta and gamma radiation. These electrodes are normally sharpened by grinding as part of the standard procedure while preparing to perform gas tungsten arc welding (GTAW). Dust particles from this grinding process can cause internal radiation exposure if the dust is accidentally ingested or inhaled, so caution is necessary. Concern regarding radiation exposure to the external body from these electrodes is minimal. Thoriated tungsten electrodes are widely used because they make good welds and are long lasting and quite easy to use. A thoriated tungsten electrode operates at a temperature well below its melting temperature compared to a pure tungsten electrode. This results in a much lower rate of consumption of the electrode during welding, which eliminates much of the "arc wander" associated with balled pure tungsten. Other reasons for their use include easier arc initiation, reduced weld metal contamination, higher current carrying capacity, the ability to sharpen the electrode, and long life.

IS THERE A CONCERN TO THE USER?

The risk of internal exposure during welding is negligible in most circumstances since the thoriated electrode is consumed at a very slow rate. During the grinding of the thoriated tungsten electrodes, radioactive dust is created, posing the potential hazard of internal radiation exposure by inhalation or ingestion unless care is taken to control the dust.

HOW TO REDUCE EXPOSURE

There are number of ways to reduce exposure to the hazards of thoriated tungsten electrodes. The significant ones are as follows:

• Choose thorium-free tungsten electrodes such as those containing cerium, lanthanum, yttrium, or zirconium whenever possible.

• Read, understand, and follow all information in the Material Safety Data Sheet (MSDS) for the selected tungsten electrode.

• Use a high-efficiency dust collection system to capture particles created during the grinding of electrodes or disturbed during housekeeping.

• Evaluate the ventilation system before acceptance and periodically thereafter to minimize personnel and environmental contamination.

• Develop and implement standard operating procedures for the use of thoriated tungsten electrodes, including proper procedures for storage, grinding, use, housekeeping and disposal. • Provide training in the operation of the welding and grinding equipment, personal hygiene, and safety.

WHAT TO DO WITH THE COLLECTED DUST PARTICLES

The dust collected after grinding of the tungsten electrode needs to be suitable and regularly disposed off. It should be done as per the regulation of local and central authorities.

SUMMARY

Several of the information sources used indicate that the risk of occupational exposure to radiation during storage, handling, and welding with thoriated

** Safety and Health*
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tungsten electrodes is negligible where simple precautions are taken. Special care should be taken to control and collect dust from grinding these electrodes in order to prevent a potential ingestion and inhalation exposure to radioactive dust particles resulting from this operation.

*Safety and Health
Fact Sheet No. 27 October 2003

Chromium and Nickel in Welding Fume**

INTRODUCTION

The fume from welding processes may contain compounds of chromium, including hexavalent chromium, and of nickel. The composition of the base metals, the welding materials used, and the welding processes affect the specific compounds and concentrations found in the welding fume.

IMMEDIATE EFFECTS OF OVEREXPOSURE TO FUMES CONTAINING CHROMIUM AND NICKEL

If one is overexposed to fumes containing chromium and nickel certain effects are immediately seen. The effects are similar to that produced by fumes from other metals. Symptoms such as nausea, headaches, dizziness, and respiratory irritation are observed. Some persons may develop a sensitivity to chromium or nickel which can result in dermatitis or skin rash.

CHRONIC (LONG TERM) EFFECTS OF EXPOSURE TO FUMES CONTAINING CHROMIUM AND NICKEL

Definite effects of overexposure are not yet determined. According to the conclusions from the National Institute for Occupational Safety and Health (NIOSH) some forms of hexavalent chromium and nickel and their inorganic compounds should be considered occupational carcinogens (cancer causing agents). These conclusions are based on data from the chromate producing industry and from nickel ore-refining processes. However, according to the conclusions from the International Agency for Research on Cancer (IARC) there is limited evidence in humans for the carcinogenicity of welding fumes and gases. Further, there is inadequate evidence in experimental animals for the carcinogenicity of welding fumes as well.

OVERALL EVALUATION

Welding fumes are possibly carcinogenic to humans (Group 2B) though no determination has yet been made concerning the health effects on welders or users of chromium- or nickel-containing alloys. Nevertheless, consideration should be given to the NIOSH and IARC conclusions while dealing with welding fumes.

HOW TO PROTECT AGAINST OVEREXPOSURE

There are certain precautions one should take to protect against overexposure. They are:

• Do not breathe fumes and gases. Keep your head out of the fumes.

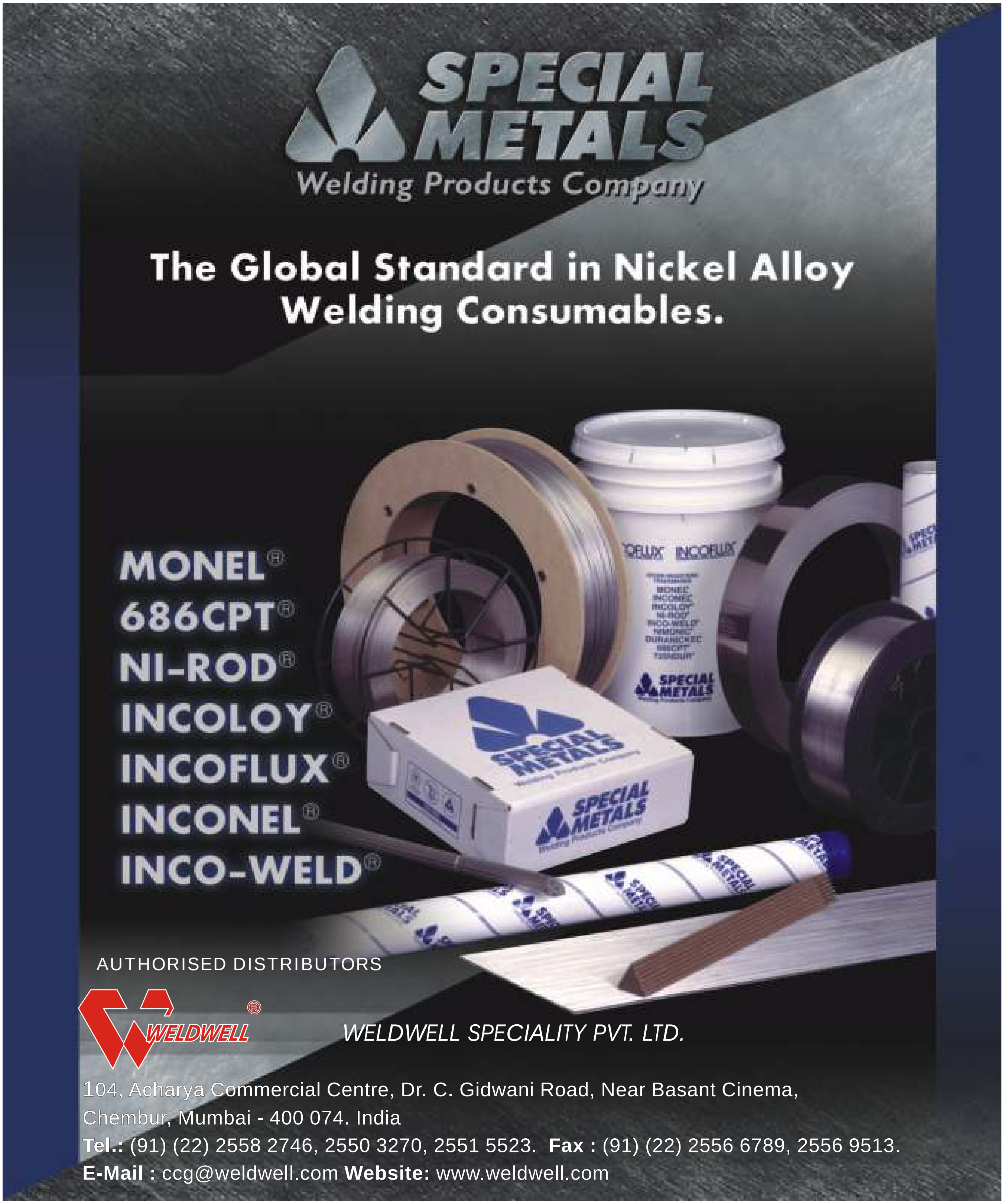
• Use enough ventilation or exhaust at the arc or both to keep fumes and gases from your breathing zone and general area.

• If ventilation is questionable, use air sampling to determine the need for mcorrective measures.

• Keep exposure as low as possible.

"Everyone talks about the weather, but no one does anything about it."
... Mark Twain

*** Safety and Health*
Fact Sheet No. 4 October 2003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