ROLE OF WELDING IN THE PROCESS PLANTS PETROCHEMICAL INDUSTRY

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INTRODUCTION

Huge investments had been made in India in the chemical and petrochemical industry during the last 40 years. Presently, many process plants in public & private sectors are under planning a implementation stage. Some of these plants involve heavy expenditure to the tune of four to five thousand crore rupees each.

There has been considerable growth in Welding Technology which include modern techniques, mechanisation and sutomation in welding technology. However, this rapid pace of modernisation is still to reach many industries. In order to meet the international challenges on productivity, competitiveness, quality and for the overall growth of the country, it is most desirable that detailed knowledge of these techniques is available to all concerned industries. I feel, this platform of Indian Institute of welding can be effectively used to guide these industries and enhance their capabilities for improved quality and reliability. Such gatherings can be of great asistance to provide interaction with industries, users & consultants where experts can share the knowledge and deliberate on the problems.

I am pleased to note that Indian Institute of Welding is conducting a seminar on an area of paramount importance to the industry.

Process industry in the country has seen rapid changes in last two decades. In early 70s, technology was not adequately available for manufacture of critical equipment involving high pressures, extreme temperatures & corrosive services leading to increased dependence on imports. Now the scenario has completely changed; more and more welding technologies are being introduced in the indigenous manufacture. As a result, there are encouraging trends in welding application. This has resulted in manufacture of all process equipment within country except those proprietary nature where foreign process licensors are involved.

As advanced welding technology is being processed into the fabrication activity, there is corresponding need to indigenise welding equipment and consumables. Availability of trained welding personnel must also be ensured. Research & welding technology also has to catch up with emerging trends in modern technology.

As enumerated above, the field of welding and its applications being very wide, we will be limiting the deliberations on the role of welding for equipments in process plants.

Process Plant Equipment

Process Plant equipments can be categorised broadly as below :

- ❑ Structures
- ❑ Storage Tanks
- ❑ Boilers, Pressure Vessels
- ❑ Heat Exchangers
- ❑ Tubes and Pipes
- ❑ Pipe lines

With advancement in technologies, equipments are manufactured with materials to various specifications to meet process requirements.

Amongst the variety of materials used for the process industry, following find their application in one or the other industry :

i) Carbon steels

ii) Low Alloy Steels

iii) High alloy steels

iv) Stainless Steels/Duplex Stainless Steels

v) High Nickel Alloys (Inconel/ Monel)

vi) Aluminium & Aluminium Alloys

vii) Copper and copper alloys (Brass, Bronze, Cupro Nickel etc.)

Structures :

The application of welding for structures did not witness a revolution in the country for various reasons. There had been reluctance to the use of bridges of welded construction for a long time and it is only recently that welded bridges have been accepted upto certain spans. Welding has been used for industrial sheds involving the fabrication of columns, trusses, purlins, platforms and ladders and crane girders. The welding was carried out mostly by shielded metal arc method. Submerged arc welding has been applied for the columns, piles and plates girders in a limited way.

With the increasing emphasis on offshore oil industry, welding is playing significant role in the fabrication of offshore platforms and other structures having high material thicknesses which involve the use of automatic and semi-automatic submerged arc welding carbon-dioxide MIG welding and flux cored wire welding are being extensively used in the advanced countries. In our country, however, the use of such welding techniques is far below the desired level. Some firms have already started manufacturing good quality consumables including flux cored wires and welding equipments. Therefore, the use of flux cored welding is likely to get a boost.

Storage Tanks :

Field erected large storage tanks are required for refineries, petrochemicals, fertilizer projects, etc. to store crude oil as well as petroleum products. Double walled storage tanks are used for storage of low temperature fluids like ethelene, propylene etc. The storage tanks are plate welded and involve huge fabrication work. The plate materials may be carbon steel, quenched and tempered steel, nickel alloy steels etc., These tanks are welded in India using shielded metal arc process. The foreign contractors employ automatic welding. Submerged arc welding process is used for welding of circumferential weld seams. Carbon dioxide MIG welding or electro gas welding is applied for vertical joints. These processes are faster, economical & consistent in quality.

In order to use these faster productive methods of welding for storage tanks, the contractor has to invest on welding heads & fixtures. Some of the Indian contractors have tried to introduce these methods and have met with some success. However shielded metal arc welding still holds the fort. With the use of this process alone, it is nor possible to meet present day short time project schedules. The fabricator, the welding plant manufacturer and others concerned will have to join together to provide a system approach to get the maximum out of the available productive technology.

In case of spherical storage tanks, the welding is done using shielded metal arc welding method. Methods such as submerged arc welding or other automatic gas shielded welding systems popular in foreign countries have yet to be put in practice by Indian industry. There is a good shope to investigate the position and popularise such productive welding techniques.

Stainless steel, nickel steel, aluminium and other non-ferrous metal tanks are welded with GTAW or GMAW welding processes. Some fabricators have acquired the skill in the use of double operator technique in case of GTAW process. This technique is bound to have wide application because it is very efficient as compared to single side welding at a time.

Boilers and pressure vessels

There are several manufacturing shops which are equipped with automatic submerged arc welding equipments. Most of the units in the country have these equipments using single electrode wire type. It is available to apply submerged tandem arc welding process and also use hot wire additions in order to derive maximum benefit from the processes.

In case of thick walled boiler shells, electro slag welding process is the most appropriate choice, particualrly for the long seam. Few fabricators have this facility and very few of them are able to exploit it because of various constraints. Now a days, transistorised power sources are employed to provide greater control of welding parameters. Improved systems such as seam tracking for positioning of the welding head etc. are also available. The process holds a good future.

Many vessel manufacturers are still depending on shielded metal arc process. They have to aug-

ment their facilities to faster and better welding techniques.

Dished ends, shell and nozzles made out of carbon or low alloy steels are weld cladded to improve corrosion resistance properties. Stainless steel, monel, nickel and other such metals used for overlay are deposited using submerged arc welding processes with either strip electrodes or single and twin wires with oscillations. Shielded metal arc welding and gas metal arc welding are also used for metal overlay.

Heat exchangers

Heat Exchangers and pressure vessels have almost identical welding applications. However, the heat exchanger manufacturer has typical welding problems such as joining of tube to tube plate and weld overlay of tube plate by corrosion resistant material. Besides there have to be better controls on dimensional tolerances & welding distortions.

The Welding of tube to tube sheet involves the use of shielded metal arc welding and gas tungsten arc welding. While mostly manual welding is resorted for tube to tube sheet welding, there are a few companies where automatic welding processes (orbital welding) is employed ensuring welding with consistent quality & high productivity.

Tube and pipe welding

Tubes and pipes are manufactured at the mill using seamless or welded design. The welding processes used are resistance welding, submerged arc welding and gas tungsten arc welding.

Electric resistance welding is employed mainly for carbon steel tubes/pipes. These are manufactured in a large number of mills in the country. Only few companies have on line NDT systems. There is lot of need to augment the NDT facilities and make improvements in the sensitivity of the defect detection levels.

Submerged arc welding is used for the spiral welded pipes. there is only one mill in the country which has the capacity to make such pipes. The largest size is upto 64 inches diameter. These pipes are made of carbon steel materials.

Submerged arc welding is also used for the longitudinal weld seams in the mill made pipes using UOE process. This method of manufacture is highly popular in some countries. There is one manufacturer using this technology in the country while few others are in process of installing such facilities.

The use of submerged arc welding shall increase as the requirement of pipes of pipeline construction picks up.

Gas tungsten arc welding is used for the manufacture of tubes made out of stainless steel, high nickel alloys and some nonferrous metals. There are a couple of mills making stainless steel pipes in India. But for higher diameter pipes of stainless steel construction (above 8"), facilities for mechanised welding & NDT testing need to be put up.

The entire requirement of pipes of special materials such as high nickel alloys etc. is being imported at present. As the manufacture is indigenised, the growth of this welding process will be accelerated.

Mill supplied tubes and pipes made out of carbon steels, chrome-moly steels, nickel steels, stainles steels, high nickel alloy and nonferrous metals are welded in large quantities in the construction of chemical and petrochemical plants. Shielded metal arc welding is mainly used for the welding of carbon steels and gas tungsten arc welding is employed for carbon steels as well as other materials. Root welds in the circumferential joints are invariably laid using GTAW process because of good root penetration and smooth surface of the welded joint at the inside.

Pipelines

Cross country and submarine pipelines are used for transporting crude, gas, petroleum, coal slurry, oreslurry and other such products over large distances, cross country pipelines have emerged economically viable as compared to rail or road transport systems for conveying these fluids. As such many countries are venturing into this industrial activity. Our country is making huge investments in pipelines during next 10 to 15 years. Thus Welding finds extensive use in cross country pipelines.

Shielded metal arc welding method has been extensively employed for field welding of pipelines. Automatic welding systems have been developed to achieve higher welding output as compared to the manual method of welding. Besides, being more efficient, the automatic methods provide uniform quality of the weld joint. These automatic welding systems are imported from

abroad. Very little has been done to indigenise these systems in our country and this aspect needs the attention of all concerned, EIL is deeply involved with the pipeline projects. Shielded metal arc welding as well as automatic welding processes are being used for joining purposes in these projects.

Under Water Welding (Structures & pipelines)

The exploration and exploitation of offshore oil and gas fields is relatively new. The underwater welding carried out can be broadly classified as follows :

1 Wet Welding

2 Dry environment welding

- Chamber at hydrostatic test pressure

- Chamber at atmospheric pressure

The term wet welding is used when welding is performed under water directly exposed to wet environment. The welding arc is separated from surrounding water by the gaseous environment composed of the gas produced from the convering and the gas formed by the heat due to intense heat of the arc.

In the dry welding process, the regions of metals to be joined are kept dry during welding. When welding is performed under pressure higher then atmospheric pressure, it is often called "hyperbaric" welding. Since welding is done in completely dry environment, the quality of welds can be as high as that of welds made in air. Therefore, dry welding processes are widely used for critical jobs such as joining underwater pipelines. The major problem of these processes is their high cost especially when done under deep sea.

Pressure modifies the characteristics of electric arc and it is now well known that the electrical variables of welding arc are effected by a modification of physical properties of the plasma. It is, therefore, interesting to examine the effects it has on the geometry of weld bead thus made.

In gas metal arc welding, the metal transfer acros the arc is affected by the pressure. This is caused essentially by modification of distribution of energy losses both in electrode extension and in the arc poorly adopted to the perfect control of energy within the arc during short circuit period. Significant developments made in the power sources suitable for welding go a long way in solving the problems. The chemical composition mechanical properties obtainable need to be studied. The welders and welding operators need to be trained for welding. Sophisticated simulation chamber to carry out tests and to develop procedures are required. At present, the requirements for welding arise for this welding because of damage caused by inadequate design, accident, corrosion or fatigue. The welding is mostly undertaken by foreign contractors. With more and more Indian envolvement some Indian contractors are likely to come up with some facilities for carrying out this welding in future.

Quality Management

The quality functions in general related to process equipment manufacture are the same as those applicable to any other industry.

They are :

- Quality of bought out materials
- Quality of bought out services
- Inspection
- Functional Testing
- Managing non-conformities

The availability of right quality of steel is a major problem and manufacturers have to stock huge quantities of imported raw materials to meet the schedules.

Large number of highly specialised components like pipes, flanges, fittings are required for manufacture of process equipments. Specialised fabrication forming, heat treatment procedures are needed. Various NDT tests, corrosion tests are needed. Destructive tests on samples of procedures & production test & coupons are needed to ensure confromance. An elaborate system of audit of manufacturers capabilities is required before a manufacturer can be considered capable to supply the item.

The inspection of the products is carried out as per an approved quality assurance plan. The amount of inspection depends on the criticality of the equipment. Various factors are taken into consideration such as how much experience is there about the process, to what extent a sample is representative of the lot or batches as a whole and what will be the effect on the finished product or on service of the defects in its component parts.

Non-conformities are be disposed objectively. In effect, this means assessing facts and quantifying results. All characteristics consid-

ered must in some form be measurable. It may take time to establish right level but at least any changes required can be controlled and managed in an orderly and cost effective manner.

Lastly, computerised data logging and storage will go along way in eliminating errors and monotony.

Non distructive testing

Non destructive testing is a very important tool in the evaluation of welds for routine and critical fabrications.

The following are the methods generally employed :

- Visual Examination
- Radiography using x-ray and gamma ray sources
- Ultrasonic examination
- Magnetic particle Inspection
- Eddy Current Inspection
- Liquid penetrant inspection

Visual examination and liquid penetrant inspection are the two most popular methods employed by most industries. Magnetic particle inspection is used to detect/ evaluate even tight cracks.

The use of X-ray Gamma-rays sources is quite popular with the industry. The defect sensitivity obtainable for most applications is acceptable. Iridium-192 emits its gamma radiation in principal energies ranging from 0.30 - 0.60 Mev. This is too high radiation energy to produce radiographs which are comparable to X-Ray radiographs on steels. on thickness less than 12 mm.

Consequently many specifications limit the use of Iridium-192 to 19mm steel or thicker. Unfortunately, we do not have any alternative in our sites and we continue to use Iridium-192 source for radiography knowing fully well that radiography is not of desired quality.

There is some information available that ytterbium 169 gives better quality and these sources are presently not available within the country.

For pipe line joints, X-ray, Gamma-Ray crawlers are used which automatically locate and radiograph up to 100 joints a day. These equipments are very expensive and only few specialised agencies have this type of equipments.

Film radiography is very expensive in routine manufacture of welded pipes. X-Ray realtime imaging is a technique of producing a radiographic types of image on a television monitor screen as an alternative to taking radiograph on a film. By digitising the image a computer can be used to store and process the image thus making it possible to improve the image quality. Further improvements are also made in the image sharpness using microfocus tubes. The use of real time imaging with proper image sharpness and evaluation methods will go a long way in improving the reliability of the fabricated pipes. Ultrasonics is widely used for non-destructive examination. Manual Ultrasonic equipments are available indigenously. Automatic ultrasonic systems for fabricated pipes available in pipe mills with most countries in Far-east like Japan and Korea are hard to find in India. These are mostly imported. These systems with automatic recording facilities provide an inexpensive method of examining 100% welds for complete length thus giving greater reliability. In some of the countries, electric resistance welded pipes examined with these systems are used in the construction of pipelines for transportation of hydrocarbons.

As such, reinforcement of better NDT facilities would go in a big way of increased and better quality production. With better quality controls, such inprovement would result in cost benefits.

Training

Training plays a very important role in welding Training imparts the skills required to perform the job. Most of the national and international codes require the welder/operator ro be qualified for the specific job before employing them on the actual job. The requirement are specific to materials, position, process and other parameters.

Supervisors, inspection engineers have to be educated about the materials and the type of defects likely to occur during the manufacture. Some thoufht should be given for organising regular courses in different welding processes, testing, study and application of standards. These could further be supplemented by imparting advance courses in all areas of welding including process technology, welding, metallurgy, design calculations, fabrication practices, quality management etc.

The implementation of welding parameters, preheat, post heat requirements get better compliance when concerned people are properly educated. Handling of

electrodes and filler material is another area which needs attention. The use of proper drying and baking procedures for electrodes is a must for reproducible results. Repair of defective welds is extremely costly. Repairs are costly in the sense that they require cutting, joint preparation and rewelding followed by non destructive testing which is often very expensive. A repair in excess of 20% of joints is equivalent to fresh production.

CONCLUSION

With advancement in process technology and development of materials suitable for extreme service conditions, present day process plants definitely demand high quality with consistency. As such, the working system of fabrication units for process industry have got to be well organised and there have to be constant efforts for upgrading of the facilities so as to ensure that the product meet these specifications. Lot of effort is needed to understand the processes, their limitations, and establish proper working zones of parameters. Similarly, welding equipment and weld consumable manufacturers have also to come up with newer products and equipments to meet the demands of the industry. With development and use of fully automated systems, the benefits can then be fully exploited to achieve high levels of quality and productivity.