Successful Pipe Welding Management at Indian Oil Corporation, Panipat Refinery

By
P.R. Das[1], N. K. Khosla[2], Narendra Pandey [3], Arvind Kumar [4*]
1.Executive Director (Projects), Panipat Refinery, Indian Oil Corporation Ltd.
2.General Manager (Projects), Panipat Refinery, Indian Oil Corporation Ltd.
3.Chief Inspection Manager (Projects), Panipat Refinery, Indian Oil Corporation Ltd.
4.Sr. Project Manager, Panipat Refinery, Indian Oil Corporation Ltd.
* communicating Author E.mail : kumarar@iocl.co.in

Background

Indian Oil Corporation Limited started work at Panipat way back in 1980s to set up a Refinery along with TATA's. At that time, the Project was known as Karnal Refinery Project(KRP). Collaboration of setting up Refinery with TATA's could not be materialized and finally IOCL started making the Refinery in early 1990s and completed the 6 MMTPA Refinery on 12th July, 1999. Trial production, of course, started during 1998 itself.

During 1998-99, Indian Oil Corporation Ltd. decided to set-up another oil refinery of 6 MMTPA capacity in the same complex adding a Delayed Coking Unit to improve the Distillate Yield of the entire complex from 78% to 82.5% at a cost of nearly Rs.4165 crore. Simultaneously, IOCL also decided to set up a mega Petro-Chemical Complex to produce Paraxylene (PX) and purified Terepthalic Acid (PTA) out of the Naphtha available from its Panipat as well as Mathura Refinery at a cost of Rs.5104 crore. PX-PTA project was originally envisaged for setting up at a distance of nearly 5 Kms from the existing Refinery Complex. Subsequently, to improve the economics of the Petrochemical Complex, along with total economics of old Panipat Refinery (PR) and PREP., it was thought prudent to relocate PX-PTA Project inside the existing Refinery Complex thereby consolidating the Power, Utilitity and Offsite facilities for PR, PREP and PX-PTA.

Project execution job started in the last quarter of 2002 and commissioning of the plants in phases started w.e.f. December, 2005 which is expected to continue till June, 2006. These huge, massive, mega project execution in a green field situation would have been comparatively easier task compared to executing the same in an operating Refinery, Pipeline and Marketing Complex of nearly 3000 acres. Prime consideration of the execution all the time remains safe working. The execution & commissioning of PREP & PX-PTA took 40-46 months. Volume of jobs handled in this mega massive project could be appreciated based on the details given below:
At the peak of the project total number of workmen at this site was around 27000. Safety training imparted by the Safety Group runs into more than 1.0 lac persons (without repetition) and more than 118 million man hours loss time accident could be achieved at a time. These statistics are remarkable in their own way and in India this kind of project execution inside an operating refinery, pipeline and marketing complex has not be done in the past and perhaps rarely to be repeated in the future.

Sl. No.	Item	Unit	Quantum
1	RCC	Cu.M	2,82,268
2	Structural Steel + TOR	MT	2,00,000
3	Pipes	Km	1700
4	Pipe Fabrication	Inch Dia	47,00,000
5	Cables	Km	4556
6	Major Equipment	Nos.	2367
7	Pipe Fittings	Nos.	5,00,485
8	Flanges	Nos.	2,02,557
9	Valves	Nos.	1,06,128

People involved in the petroleum refining and Petro-Chemical will be able to better appreciate and realize the nature and complexity of plant and the volume of equipment and accessories which

are required to construct / make Refinery and Petrochemical plants. To present a bird's eye view about the plants there are static equipment like columns, vessels, heat exchangers, high pressure reactors, boilers, furnace etc. and rotary equipment like compressors, pumps, turbines, mixtures, fans etc. along with associated electrical, instrumentation and automation accessories. All these equipment are connected to each other with pipelines with pipe fittings, flanges, valves and the plant looks like a complex network of pipelines. These pipelines are required to be formed as per the drawings which are known as Isometric drawings. These pipes are of different metallurgy and of different sizes and thickness based on nature of process liquid handled and parameters like pressure and temperature. Initially, formation of pipeline is done based on Isometric drawing in the shop which is known as fabrication welding. Finally, these pipelines are required to be erected and connected with the equipment which are known as Erection Welding at site. The unit of measurement for welding either at fabrication yard or at erection site is denoted as 'Inch dia'. To exemplify the same : If 2 pipes of 10" dia are required to be welded, the one joint of this welding shall be known as 10 Inch dia welding. Similarly, erection of the piping is denoted by 'Inch metre'. To exemplify a 10" pipe of 100 meters when erected, it will be denoted as 10X100 = 1000 inch meter erection. In these projects, the total welding involvement was to the tune of 47 lac inch dia and 100 lac Inch meter. Pipe sizes varying from ½ inch diameter to 88 inch diameter having total length of more than 1700 Km were used in the project. During the peak period, when 27000 persons worked, out of them 1000 numbers of welders were for pipe welding and about 1500 numbers of structural welders also worked at this site. In case of structural welding also, automation process was utilized by mainly Bridge and Roof due to which they could achieve around 115 MT fabrication per day which is a record in itself.

Almost every 5 years, in India we are going for construction of a Refinery / revamping refineries / petrochemicals / fertilizers etc. Apart from the above, the middle East countries as well as far East countries also have started investing in the chemical / Petrochemical refining plants. The demand of pipe welders have increased considerably. During the period of our construction, it was felt that one of the most important resource which would be in short supply - was piping welders. While ITI's being run by the State Governments, do provide welding as a trade but this learning is not at all sufficient to make a pipe welder who could properly work and do quality welding for refinery / petrochemical plants. Pipe welding is more of an art than science. Many automation processes / procedures for piping welding have been tried but not found successful with respect to manual precision welding since it calls for quality welding required for critical processes and in high pressure lines which need 100% radiography fault free welding. The technique required to be adopted by a pipe welder is unique and can be acquired only by practice. A good / quality welder loses his ability very quickly, if he is not practicing of welding. The most fruitful welding period of a welder varies from 10-15 years. These pipe welders being so precious are not given proper honour as required in the country as well as abroad for making them, nurturing them, giving comfort to them by any organization. This trade is honored and paid only as per demand supply scenario. Something is required to be done by some organizations in this regard particularly in the time when India is in the process of becoming a major player in global industrial scenario and it is predicted now that by 2013, India will surpass China in GDP growth.

Based on the scarcity experienced by us during the period of execution of the mega projects, we did several experiments which paid us dividends & are narrated and given in the following **approach paper and case studies 1 & 2.**

Approach Paper on Piping Welding Management

Introduction : It was the month of April'2004. Piping and mechanical works of three units (CDU/VDU, SRU and Off-sites-II) were awarded to M/s. Bridge & Roof in the conventional mode to be executed under Panipat Refinery Expansion Project. A summary of total quantum of piping welding and piping erection was huge as

given below :

Unit	Scope of Welding Inch dia	Piping Erection Inch Metre
CDU/VDU	3,25,000	5,25,000
Off-site-II	3,15,000	13,70,000
SRU	1,80,000	2,50,000
Total	**8,20,000**	**21,45,000**

It was thought prudent by IOCL-Project team to decide the execution philosophy to tide over the crisis of piping welding in peak time and to adopt certain innovative steps of project execution for faster completion of above three projects. Accordingly an approach paper was made deciding the execution philosophy having following salient points.

1. Use of advanced welding methods including semi automatic welding process apart from conventional SMAW (Shielded metal arc welding) technique.
2. Use of fully automatic Orbital welding machine to save time and increase quality and productivity.
3. Timely deployment of critical resources like trained welders along with fitter gangs etc.
4. Deployment of trained personnel / engineers / supervisors / sub-agencies for execution of above works.
5. Timely deployment of sub-agencies for NDT along with sufficient NDT machines matching with quantum of piping work like SR recorders and radiography equipment.

Since welders are the critical parameters in piping welding of any project, an analysis was made to know the peak requirement of welders for these three projects :

Unit	Scope of Welding Inch dia	Effective days for - tion	Welder Requirement	Remarks
CDU/VDU	3,25,000	250	65	Considering average productivity of welder as 20" dia welding per day.
Off-site-II	3,15,000	200	80	
SRU	1,80,000	200	45	
Total	8,20,000		190	

Since arrangement of approx. 200 welders on short notice was a difficult task, following approach was adopted in welding of pipes with relatively less numbers of welders:

1. By use of semi- automatic FCAW (Flux cored arc welding) machines in place of conventional SMAW machines. The deposition rate in FCAW machines is faster and average productivity of welding of one FCAW machine is equivalent to almost three to four SMAW machines. If about 25 FCAW machines are used (with 25 trained FCAW welders), it may substitute 75-100 SMAW welders and sufficient welding time. These FCAW/SAW/MIG semi-automatic machines can be effectively put for all fabrication (shop) joints (almost 60 to 70% of quantum of work).

Implemented :

FCAW concept was implemented at fabrication shop of CDU/VDU project. M/s. B&R deployed around 25 FCAW welding machines (purchased from M/s. Quality, Baroda) at fabrication shop under trained welders.

Feedback : FCAW process was found useful for big bore welding joints above 6" dia in fabrication shop. The process is not suitable for field welding.

Use of automatic welding machines like Orbital welding machine especially in Off-site can also be explored to reduce no. of welders and execution time.

Feedback : The Orbital welding machines were used in LSTK jobs of DHDT/H2 projects by M/s. L&T. The Orbital welding machine was found useful for shop welding as its productivity is very high under trained operator. Though site demo was carried out at site for conventional welding jobs, but Orbital welding machine (MIG process) could not be purchased by M/s. B&R due to its high capital cost (~ 50 Lacs per machine).

Use of Edge preparation machines for expediting 'fit-ups' can also be explored.

Feedback : The automatic edge preparation machines were used in LSTK jobs of DHDT/H2 and HCU projects by M/s. L&T & M/s. Daelim/ M/s. Punj Lloyds. The edge preparation machine was found useful for heavy thickness pipes saving time in grinding the pipe edges for fit-up. Though site demo was carried out at site, but automatic edge preparation machines were not found suitable for less thick pipes normally used for aforesaid projects in conventional mode.

Arrangement of piping welders and development of welders : Welder sector in India is an unorganized sector. Piping welders can be augmented at site by following means:

a) Welding gangs deployed by sub-agencies of main contractors.

Welding gangs associated with sub-agencies moves with them in different project. Major requirement of welders can be met from such arrangement. B&R has proposed to carry out the piping welding by engaging around 20-25 sub-agencies which are quite experienced and having dedicated welding / fitter gangs.

b) Mobilization of trained piping welders and fitters from different parts of India by B&R i.e. from Baroda, Jamnagar, Mumbai, Chennai, Vizag, Hyderabad, Haldia & Barauni which are known hubs of welders and fitters.

c) Development of welders : Efficient helpers/tackers working with site contractors can be trained to piping welders within 4-6 months by master welders at site **Welding school concept**. Such trained welder pool can cater 10-20% of total demand.

d) Retention of welders by payment of good wages and incentives. Reputed mechanical contractors give their welders the following wages and incentives (well above the minimum wages rates as per state laws) :

i) Wages of ~ Rs.125/ per day for SMAW welders with incentive based on Inch dia welding rate and fixed Over Time working along with house rent etc.

ii) Wages of Rs.150 to 200/ per day for TIG welders With all incentives and facilities.

iii) Wages of Rs.200 to 250 per day for alloy steel welders with all incentives and facilities

iv) Even fixed salary to the tune of Rs.20000 to 25000/ month for class one coil welders.

v) Facilities like rented houses for welders and provision of labour colonies by main agency can further motivate these welder gangs and restrict their changes of shifting out/ migration to other project site in mid of execution of above works.

Implemented : All above points were implemented at site. Welding school was organized in two phases with the help of M/s. ESAB & M/s. D&H which produced around 50 welders.

With the above execution philosophy, sound project management and micro planning & monitoring, resource crunch in piping welding was reduced to a great extent during execution of project.

CASE STUDY- 1

WELDING CONSUMABLE REQUIREMENT IN PREP/ PX-PTA PIPING

Case study : Total consumption of Welding Consumables in piping

A case study was carried out to analyse the total quantum of welding consumable required during course of mega projects of Expansion and PX-PTA at Panipat.

Electrode consumption per inch dia of pipe welding

A. **Empirical data : From Field experience**

Calculating weight of one piece of electrode :

- Electrode selected : E 7018, Dia : 3.15 mm Weight of one case of standard electrode : 20 kg. (containing 5 packets of electrode)
- Weight of one packet of electrode : 04 kg (Containing 90 pieces of electrode)

Weight of one piece of electrode : 45 gms

- Total nos. of electrode required for welding of 8" dia, sch. 40 pipe joint : 35 electrodes
- Total weight of 35 electrodes : 35 X 45 = 1575 gms.

Consumption of electrodes per inch dia of pipe welding :

1575/8 = 196.8 gms.

Say 200 gms.

The consumption per inch dia welding was also cross checked by theoretical analysis :

B. **Theoretical Analysis : From Tables (Welding Hand book)**

- For 8" dia pipe, sch 40 (~ 9 mm thick)

From the table 13.11 type E7018 electrode consumption for vertical up welding of pipe (d=8", t=3/8") = 2.5 lb/ joint

= 1.134 kg/ joint

Assuming weld deposition efficiency for coverage of spatter and stub Losses = 70%

Total consumption of electrodes = 1.620 kg/ joint

Electrode consumption per inch dia of pipe welding = 1620/8 gms

Say 200 gms.

Hence consumption per inch dia of pipe welding = 200 g

Total Scope of welding in PREP & PXPTA : 47,00,000 Inch Dia

Total welding consumable required for PREP & PXPTA pipe welding

= 200g x 4700000

= 940 Tons

Say 1000 MT

It is beyond imagination that such a huge quantum (~1000 MT) of welding consumables were used in PREP/PX-PTA projects at Panipat.

The above analysis helped in advance planning in procurement of welding consumable required for piping during course of project.

CASE STUDY- 2

How welder is born.....

Up bringing of a welder through Welder's Training School
- A real success story

Rajkumar today has a big smile on his face and is beaming with confidence. The dawn of New Year has brought a new horizon for him. He has become a qualified Piping Welder. His long lasting desire has come to a reality and a dream has come true. He gives full credit of his success to Welder's Training School organized by IOCL at PREP in Oct-Nov, 2004.

Rajkumar is a local boy and is resident of village Pabana about 15 km. away from Panipat Refinery. After doing his ITI from Karnal in 1996, he remained an unemployed youth till 1997 and came to Panipat Refinery in search of a job. He worked as messenger for about three years. He worked sincerely and adapted good skill in operating Photocopy machine/ Fax machine and was quite reliable in delivering of files to the right person. Very soon, he was liked by every one in the department. His artistic nature was also recognized and was awarded for singing 'Haryanvi Ragni' during Independence Day celebration. Life was passing easily for him but with a thought in mind An ITI qualification for doing job of a messenger.

He always had an inherent desire to become a skilled person and one day some one suggested to him- **"why don't you become a welder"**? The idea of a welder struck him deeply and this was the turning point of his life. He left the job as messenger and joined M/s. RDDK as **Helper** to a welder. After learning tricks of the trade for two months, he developed some skills in tacking and switched over to M/s. ISGEC column fabrication job as a **Tack Welder** in Nov'03. ***His incessant desire of becoming a welder was so strong that he even refused to accept the job of a supervisor at higher pay and remained associated with welding job.*** Seeing his interest and hard work, he was allowed by his supervisors to do welding practice on scrap material with waste electrodes pieces in off time. He continued the practice and after four months qualified welding test in 3G in Feb'04. This was the first step towards his success story. He worked as **Structural welder / 3G welder** at column fabrication site till Oct'04.

He came to know about Welder's Training School being organized by IOCL with the expert help of M/s. D&H at Petron Piping site in PREP and got himself enrolled for the training. Within one month of training he learnt the art and skill of doing welding on pipe and was developed to become a 6G welder in the school.

He cleared the welder's test conducted by EIL afterwards and is presently engaged in piping welding job in PREP and earning his livelihood with dignity of being a welding professional.

He has full praises for Welding School and the welding instructor by whose efforts he has been shaped to become a piping welder. He is moving on and on at steady pace to even higher goal to become an expert welder in argon and in specialized metallurgy welding.

After one year, an attempt was made again to trace the foot prints of Rajkumar in his success path. What comes next is even more interesting and journey full of challenges.

After qualifying as pipe Arc welder, this alumni of welding school, Rajkumar silently engrossed in his piping welding work at M/s. B&R(Off-sites) and continued to sharpen his skill in arc welding in real job and developed experptise in welding with E 6010, 6013 and 7018 electrodes. One thing he never forgot was his dream and goal to be an Argon welder (GTAW process) after developing skills in Arc welding (SMAW process).

In the month of Sept'05 he drew a monthly emoluments of 10,235.00 (the highest ever as welder) which he shares, was a never forgettable experience for him and his family. Praise-worthy words for his hard works from the parents and family on the moment when he handed over the aforesaid money at home was the most satisfying event of his life says Rajkumar with tears in his eyes : "Sir, I feel the pride of being employed now".

What Rajkumar did next is a lesson even for the great management gurus and change managers. During October, last year, one fine morning he met me at site and told me that he would like to become a helper to an Argon Welder in the on-going project at CDU/VDU. It was to my surprises, having drawn

a handsome salary last month & being a good arc welder, this gentleman wanted to go back to helper grade! Soon enough however, I realized and appreciated that he had broader aspects in mind and for this he would even forego short term gains - a visionary in his field who developed a perfect roadmap and already set to usher an experiment in his voyage. He aspired to adopt latest technique with the changing time - a tool must for growth.

Shortly, he joined CDU/VDU team of M/s. B&R as a helper attached to an expert Argon welder.

Next two months people saw Rajkumar working relentlessly, shifting Argon cylinders on his shoulders, pulling welding cables and doing all jobs of khalasi/ helper for his 'guru' the expert Argon Welder. He learnt the tricks of the trade & closely observed how skillfully & effortlessly his 'guru' performed on weld joints with the torch. Having won the confidence of B&R team with his hard work, good behaviour and fast response to any task, he was permitted to try his hands and practice on Argon welding on waste pipe pieces, off-job in the off-time.

He learnt the Argon welding in bits and pieces and developed proficiency in welding with torch and gas, a technique different from holder used in Arc welding. Later, he appeared in the qualification test for Argon welders in Feb'06 and passed. **His motto of welding : 'Fast and fair No repair'.**

Rajkumar is now a qualified welder in SMAW & GTAW. A good monthly salary is now assured says Rajkumar with big smile on his face having tasted the success. He now moves to SRU Project with different agency for giving his contribution to Project in the field of Argon welding.

Learning never ends, he is still on the success path with greater plans in his mind such as welding AS/SS and going for higher metallurgy critical welding. Some one rightly said : **Success is a journey and not a destination**

This is how a welder is born ...