International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 02 | Feb-2016 www.irjet.net p-ISSN: 2395-0072

Analysis of deviation observed during conventional oxy-fuel cutting of low carbon steel pipes

Hiral Pandya[1], Ronak Wani[2], Anuj Patel[3], Vaibhav Patel[4]

Department of Mechanical Engineering, Babaria Institute of Technology, Vadodara, India

---

Abstract - Steel pipes and tubes are one of the most widely used forms of steel in the present industrial scenario, which is continuously observing a growth. In 2013 the sector accounted for 9% of the total steel consumption in India, which evaluates to a value of 7.785 million tons. [1] It is obvious that pipes and tubes undergo various processes to be finally used in a desired way. Cutting and welding being the most prominent amongst all. We restrict ourselves to the cutting process. Indian steel consumer industry is majorly comprised of medium scale and small scale industry which opts for conventional cutting processes i.e. oxy-fuel gas cutting. Though this method comes with its own sets of benefits but it also does have some inherent problems. This paper discusses some observed problems, while cutting a pipe using conventional gas cutting, both due to human error and kerf observed during gas cutting.[2]

Key Words: Deviation, kerf, mild steel (MS), pipe, tube, conventional gas cutting, process, LPG, acetylene, oxygen, surface finishing

1. INTRODUCTION

While manually cutting Mild Steel/Carbon Steel pipe using a gas cutter, lot of *deviation* is observed from the line to be cut, due to human error. Due to this, considerable amount of material is wasted. Also lot of time and resources are utilized for proper finishing of these irregularities. Surface finishing processes such as grinding, facing then require more time to eliminate these irregularities, also utilizing more power, time, and human resources. Also this method requires skilled labor as the position of cutting is critical. The labor also undergoes a lot of fatigue, if repeatedly does this process. Experiencing all such problems, the industry needs a new and improved method such that these problems can be eliminated. This can be done followed by a detailed study, based on the existing methods.

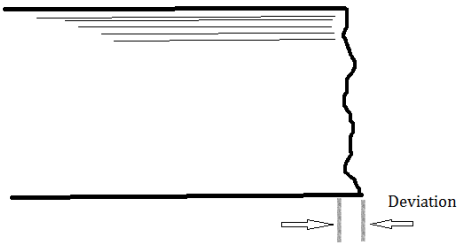

Figure A- Image depicting deviation during conventional gas cutting of pipe

1.1 Principal of Oxy-Fuel Gas cutting:

The principle of gas cutting is bifurcated in two steps, the first heating the base metal to temperature where it gets oxidized using flame of oxygen and acetylene. The second phase is consisted of oxidizing the base metal using high pressure oxygen flame, that simultaneously flows away the molten metal.[3] This being the most widely used method in cutting method in cutting pipes is required to be closely studied, so as to develop a better and improved process. Thus, the research is based on the errors that are inherent while cutting a MS/CS pipe using hand operated gas cutting torch.

The major problem that is observed in Conventional gas cutting, when done on a pipe results due to various factors. The major factors are mentioned in detail based on various studies carried out in the industry.

1.2 General setup

As observed in the industry, the pipe is cut being kept on ground, by a worker assisting the cutting torch around the periphery of pipe. The pipe is then turned at certain angle so as to expose the uncut side. Generally it requires 3-4 times of rolling a pipe, since only 90-120 degree of pipe is visible at front. Prior to this, the worker marks a line at circumference so as to assist the torch while cutting. Thus the setup is time consuming.

Figure B- General Setup of conventional gas cutting of pipe

Drawbacks of setup:

- The worker experiences fatigue while cutting.
- Idol time increases, as the pipe is required to turn multiple times.
- Waste of oxygen and fuel due to higher idol time.
- Lower productivity
- Time consuming setup.

1.3 Human Error

Despite of the marking, the worker is not capable enough to follow the reference line with cent percent accuracy. The accuracy varies from person to person, but based on the observation, it is stated that some deviation in the cut always exist when conducted manually. The error is also observed while marking the reference line.

2. TIME STUDY

Conducting the time study is important, so as to calculate the feed, and study various other aspects of a particular cut.

The terms mentioned below are used in the time study, and hence explained in the following section.

Length of reference line: The reference line marked on the periphery is sometimes not perpendicular to axis of pipe. Thus its length is different than that of the actual circumference of pipe. This results in the worker following a longer and incorrect path.

Deviation: It is due to the human error that the cut is not exactly perpendicular to the axis of pipe, and thus there is lot of up and down on the cut face. These irregularities are to be removed before using the pipe. Thus deviation is to be restricted to a minimum possible value. It is measured by drawing a reference line, and measuring the distance of various points to the reference line. The difference between the maximum and minimum value is taken as deviation.

Kerf: The width of the cut produced during a cutting process. [4]

Note: The following studies are conducted over pipes of various sizes using oxy-LPG gas cutter, by workers of varying skill so as to judge the average cut quality. Also all the pipes are of mild steel of varying schedule.

2.1 Time Study 1

Outer diameter	273
Thickness	4
Circumference	857
Pressure of oxygen (kg/cm^2)	32
Length of reference line	865
Time taken	135 s
W.r.t reference line: Higher value- Lower value-	 66 55
Deviation	11

Table I

Figure C- View of pipe during and post cutting

2.2 Time Study 2

Outer diameter	273
Thickness	4
Circumference	857
Pressure of oxygen (kg/cm^2)	32
Length of reference line	870
Time taken	128s
W.r.t reference line: Higher value- Lower value-	 70 58
Deviation	12

Table II

2.3 Time Study 3

Outer diameter	90
Thickness	5
Circumference	282
Pressure of oxygen (kg/cm^2)	31
Length of reference line	289
Time taken	81s
W.r.t reference line: Higher value- Lower value-	 64 53
Deviation	11

Table III

Figure D- Side and front view of MS pipe during and after cutting

Figure E- Top view of MS pipe after being cut

2.4 Time Study 4

Outer diameter	219.1
Thickness	3.8
Circumference	688
Pressure of oxygen (kg/cm^2)	32
Length of reference line	697
Time taken	104s
W.r.t reference line: Higher value- Lower value-	 72 57
Deviation	15

Table IV

Figure F- Top view and side view of low carbon steel pipe post cutting

Similarly the results obtained by conducting several experiments, the deviation ranged between 11-15 mm. On an average, deviation for every single cut stands equal to 13mm.

3. INFERENCE

From the above study, it is stated that an average loss of 13*CSA of volume of a given pipe is lost due to the deviation observed during cutting.

Depending upon the size of pipe the weight of material lost and the corresponding loss in monetary terms is calculated below:

- **Schedule 5**

  → OD- 219.1 mm
  (THICKNESS-2.8mm)
  ID-213.5mm
  Present cost per kg= 62Rs

Average deviation observed during manual gas cutting on a pipe of 219.1mm = 13 mm (l)

→ The deviation leads to irregularities, which are to be eliminated. Thus we can consider that 13 mm of material is to be removed by grinding.

→ Therefore volume of material wasted = 3.14/4*13*(OD^2-ID^2) =24734.76mm^3

→ Density of Mild steel= 0.00785g/mm^3

→ Mass of steel wasted= density*volume
=194.16 g

→ Average Capital loss of material every time operation is performed= 12.038 Rs

Similarly average loss of capital, due to loss of material in every cut is as follows

(All the calculations are based on 219.1 mm pipes of varying thickness)

- **Schedule 10**

  → Average Capital loss every time operation is performed= 16.224Rs

- **Schedule 20**

  → Average Capital loss every time operation is performed= 27.03 Rs

- **Schedule 40**

  → Average Capital loss every time operation is performed= 34.34 Rs

4. CONCLUSIONS

Based on the experiments performed, the conclusion drawn for the prevailing methods of gas cutting in the industry has following inherent drawbacks.

i) Due to the inaccuracy of the worker in gas cutting process over a pipe, it majorly results in deviation of 13 mm on an average.
ii) Operator fatigue.
iii) Post cutting surface finishing processes takes considerably higher time due to greater deviation.
iv) Require greater time to eliminate those irregularities, resulting in higher costs due to utilization of resources, power and wages.
v) Higher loss of material and consecutive loss of capital.

ACKNOWLEDGEMENT

We would like to thank Simem Construction and Environment Pvt. Ltd. and Polcon engineering for their valuable cooperation in data acquisition. We also thank Mrs. Jayati Girish and Mr. Pankaj Zunjarrao for their timely guidance and apt suggestions.

REFERENCES

[1]http://www.eximbankindia.in/sites/default/files/Research%20Brief/Final%20Copy_RB_%20INDIAN_STEEL_INDUSTRY_GROWTH_PROSPECTS_OVERSEAS.pdf

[2]http://www.esab.ca/shared/content/upload/oxy-fuel-cutting-quality.pdf

[3]Sukani Sunny on ' Optimization of various gases cutting processes by changing various parameters ', IRJET, volume-02/issue-02, 2015

[4]Welding term definitions and Glossary- Praxair Direct

BIOGRAPHIES

Hiral Pandya is currently pursuing his bachelor's in Mechanical Engineering from Babaria Institute of Technology, Gujarat, India. His areas of interest lie in manufacturing processes and modifications and corresponding study, automobile engineering. He is simultaneously working with Simem Construction & Environment Pvt Ltd undertaking a development project.

Ronak Wani is currently pursuing his bachelor's in Mechanical Engineering from Babaria Institute of Technology, Gujarat, India. He has a keen interest in manufacturing processes and production technology. He is working with Simem Construction & Environment Pvt Ltd. for developing a circumferential gas cutter.

Anuj Patel is presently undergoing his bachelor's degree in Mechanical Engineering from Babaria Institute of Technology, India. He holds impressive knowledge in subjects of Vibrations and Thermodynamics. He is working on a development project of Circumferential Gas cutter with Simem Construction & Environment Pvt Ltd.

Vaibhav Patel being a follower of Mechanical branch of engineering, from Babaria Institute of Technology,, Vadodara is well versed with technical and managerial skills. He also is working with Simem Construction & Environment Pvt Ltd. For development of a new mechanism.