Design and Fabrication of Hydraulic Flaring Machine

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Abstract - *The hydraulic flaring machine can be used to increase the inner diameter of pipes particularly used in high-pressure applications. Moreover, it also provides a means for compression fit and it also aids in locking loose end connectors. By using hydraulics, the pipes can be flared into desired cross-sections without losing their pressure bearing capacity. Using standard pipes as raw material. This process is economical and saves time. With the primary focus being with carbon steel and stainless-steel pipes which are extensively used in industrial and commercial lines*

Key Words: Hydraulic, Flaring, Carbon steel, Stainless steel, Pipe

1. INTRODUCTION

Flaring is a method used to produce compression fitting by deflecting the deforming the surface of the tube commonly used in metal tubes when the leak-proof fitting is required in a location where either mechanical separation is required or welding is not desired. It is classified under the cold forging operation. These fitting provide sound resistance to internal pressure, leak tight-fitting and long term reliability. Hence, used in critical and inaccessible locations (Copper Development Association Inc., 2020). Sometimes flare nuts are used for further securing the joint. Unlike flanged joints these joints are less expensive and compact.

Tool used for flaring pipes comprise of a die which forces a mandrel inside the pipe. The specification of flare nuts is in accordance with the SAE J512 1996.

Flaring is extensively used in HVAC and RAC for its leak-tight and pressure resistance capacity. However, they are not used for thick pipe connections.

2. DESIGN

Dassault SolidWorks 2018 has been used for drafting and assembly drawing the machine and their component. Autodesk AutoCAD 2012 was used for drafting machine tool.

2.1 Working

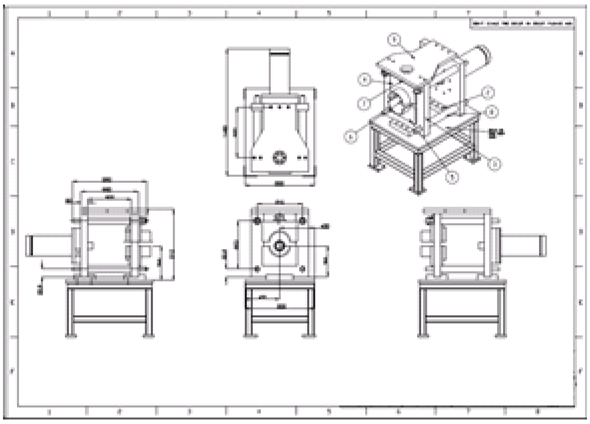

Fig -1: Machine Drawing

The pipe to be flared must be placed between the serrated split clamp (6) the clamp is different for different pipe schedule. The movement of (6) is controlled by split block (4) which is actuated by top mounted cylinder.

3. DESIGN

Calculation done for 8” Schedule 80 pipe, for the desired operation the diameter is to be increased by 2.8 mm up-to a depth of 20mm (ASME B36.10M, 2015).

Table -1: ASTM NB 8” Pipe

NB	O.D. in	Pipe Schedules							
		5s	5	10	10s	20	30	40s Std	80
8	8.625	0.109	0.109	0.148	0.148	0.25	0.277	0.322	0.5

3.1 Cylinder pressure for punching

Using the properties of pipes under internal pressure (Hibbeler, 2010)

Thickness of Cylinder = 4.06 in

$= 4.06 \times 25.4 = 10.3124mm$

$MeanRadius(r) = 99.822mm$

$Young'sModulus(E) = 2.1 \times 10^5 Mpa(AISI1040)$

$RequiredChangeinradius(\Delta r) = 1.4mm$

$Lengthofinsertion(L) = 20mm(Required)$

$AreaofContact(A) = L \times 2r$

$$A = 20 \times 2(99.82)$$

$$A = 3992.8mm^2$$

$$AppliedPressure(P) = \frac{\Delta r \times Et}{r^2}$$

$$P = \frac{1.4 \times 2.1 \times 10^5 \times 10.314}{99.82^2}$$

$$P = 304.32MPa$$

$ForceApplied(F) = P \times A$

$$F = 304.32 \times 3992.8$$

$$= 1213.08KN$$

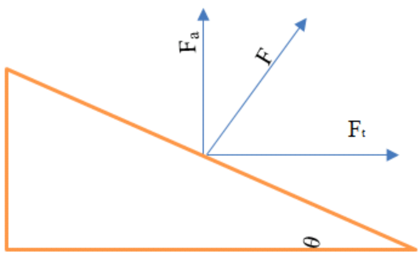

Fig -2: Resolution of forces

$AngleofInclination(\theta) = 30°(AsperDesign)$

$AxialForce(F_a) = F\ cos\ \theta$

$F_a = 1213.08\ cos\ 30$

F_a =1050 KN

Standard cylinder pressure 3000psi

Rod Diameter for requires force = 200 mm

3.2 Clamping Force Required

Coefficient of friction (μ) = 2

Fc = $\frac{F}{\mu}$ = $\frac{1050}{2}$ = 525 kN

Cylinder pressure 3000psi

Rod Diameter= 150 mm

Hydraulic Cylinders are selected as per standard (ISO 6020-1:1981, 1981)

4. FABRICATION

All the components of the Hydraulic flaring machine were machined using a CNC vertical milling machine to meet the required dimensional accuracy and for fast machining. The problem faced during machining was due to the weight of the components and hardness, there was vibration in the machine. Hence, the machine feed was reduced to avoid failure and to get better accuracy.

In a vertical milling machine, the tool is pivoted vertically and the work-piece is held on the table with the help of tool holding devices like fixtures or clamp, as required. The spindle provides the vertical feed and a servo motor is present to give horizontal feed to the spindle across the rails.

The following components were outsourced for to meet the deadline and specialization in some parts:

1. Hydraulic Cylinder

2. Electronics controllers

3. Motor

5. RESULT AND CONCLUSION

5.1 Result

The photograph shows the assembled hydraulic flaring machine.

Fig -3: Final Machine Assembly

The machine pipes of intended dimensions are flared as per the design specification.

5.2 Conclusion

The machine operated for all the designed size of the pipe. However, a drawback faced is when a pipe of short length is to be flared. There is no enough surface to hold the pipe in position for the press to work.

Also, the die is made of carbon steel which may show galvanic reaction with stainless steel pipe. Hence, the use of oil is avoided and the contact time is to be minimized.

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REFERENCE

1. Achchagam, K. (2012). Data Book of Engineers. Coimbatore: PSG College.
2. Adriana Palacios, D. B. (2020). Hydrogen generation, and its venting from nuclear reactors. Fire Safety Journal, 113. doi:https://doi.org/10.1016/j.firesaf.2020.102968
3. ASME B36.10M. (2015). New York, USA: ASME.
4. ASTM 36/A 36M – 01. (2001). West Conshohocken, USA: American Society for Testing and Material.
5. BS ISO 6022:2006, B. I. (2006). Hydraulic fluid power. Mounting dimensions for single rod cylinder. USA: International Organization for Standardization.
6. Copper Development Association Inc. (2020, April 22). Copper Development Association Inc. Retrieved from https://www.copper.org: https://www.copper.org/applications/plumbing/cth/cth_8flrdjts.html
7. Hamed Movahedinia, M. J. (2018). An investigation on flaring process of thin-walled tubes using multistage single point incremental forming. The International Journal of Advanced Manufacturing Technology-94, 867–880.
8. Hibbeler, R. (2010). Combined Loading. In R. Hibbeler, Mechanics of Materials (pp. 413-441). New Jersey: Prentice Hall.
9. Huang, Y. M. (2009, August). Flaring and nosing process for composite annoy tube in circular cone tool application. The International Journal of Advanced Manufacturing Technology, 43, 1167–1176. doi:https://doi.org/10.1007/s00170-008-1795-8
10. ISO 6020-1:1981, I. (1981). Hydraulic fluid power — Single rod cylinders — Mounting dimensions. USA: International Organization for Standardization.
11. LunaBearing. (2020, April 17). Retrieved from http://www.lunabearings.com/: http://www.lunabearings.com/new/Linear_Motion_Shafts.pdf
12. Mamros, E. M. (2018). Experimental investigation on tube flaring with a rotating tool. International Deep Drawing Research Group, (p. 567). Erie, USA. doi:10.1088/1757-899X/418/1/012118
13. Nikhare, C. K. (2015). Formability Enhancement in Titanium Tube-Flaring by Manipulating the Deformation Path. Journal of Manufacturing Science and Engineering, (p. 137).
14. Rao, P. N. (2016). Welding Processes. In P. N. Rao, Manufacruring Technology (pp. 359-442). New Delhi: McGraw Hill Education (India) Private Limited.
15. Tan Chin Joo, M. H. (2017). Experimental study on tube end flaring process for different bottom end surface texture. International Journal of Mechanical And Production Engineering, Volume- 5, Issue-7,.
16. Yeh, F.-H. (2007). Study of tube flaring forming limit in the tube flaring process. The Journal of Strain Analysis for Engineering Design, 315–324. doi:https://doi.org/10.1243/03093247JSA272