

Hydraulic Expander

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Abstract— Expander machine is used to expand L-SAW and spiral welded pipes. Mechanical expander is used to expand pipes mechanically while hydro tester unit after that is used to hydro test pipes. Now a days technology is changing and people are always wish to save their cost of production, time, space and human power involvement. By combining mechanical expander and hydro tester unit of pipe manufacturing plant, one can easily achieve benefits of both. This paper is based on the combination of two machines of pipe manufacturing to increase the profit. Few pipe manufacturing plant have seen these benefits and have already implemented It ^[1].

Keywords— Expander, Hydro tester, Hydraulic expander, L-SAW pipe, Spiral welded pipe.

I. INTRODUCTION

In pipe manufacturing, there are several steps and machines to convert raw material (plate/coil) to the final product (pipe). Mechanical expander and hydro tester are two essential machines of it, cost wise as well as need wise. Mechanical expander expands the pipe to require diameter and hydro tester test it for any welding defect or leakage. Millions of rupees are involved in the construction of these two machines however now a days few companies have implemented the lean production concept and the combination of these two machines can save money and time.

Many researchers have already given their thoughts and research work regarding it. One of it described regarding elimination of hydro tester and stated many advantages plus drawbacks of it ^[2]. One has described regarding tube expansion issues and methods ^[3]. In one study there is a comparison between mechanical expansion and hydraulic expansion ^[4].

By hydraulic expander we can perform expansion as well as hydraulic testing of pipes at the same place which saves material transportation/handling. In this paper I have included detailed study of hydraulic expander with its advantages and drawbacks plus there is a comparison between hydraulic expander and mechanical expander.

This paper only includes the concept and conceptual designs. Designs can be made according to the requirement at the site.

A. PIPE MANUFACTURING

As the flow chart indicates, there are many sections which convert raw material to the finished pipe:

Pipe Mill – It includes following sections:

- Coil loading and Uncoiler- Loading of raw material (coil) and then uncoiling.
- Plasma Cutting- Cutting to form symmetrical edges which can weld easily to form continuous pipe.
- SAW welding- Submerged arc welding of two ends of coil/plate.
- Edge milling- Edge of the coil/plate in length area is milled for the purpose of welding while forming to pipe.
- Pipe forming- With the help of inclined roller at specific angle, plate/coil is bent to form a pipe.
- Temporary welding- During pipe forming, temporary welding is carried out to avoid it from reopening.

ID OD welding- Where permanent welding on pipe is carried out, inside diameter as well as on outside diameter.

UT test- Ultrasonic testing is performed to check any welding defect on pipe.

Expander- Initial diameter of pipe is maintained at the forming area but sometimes pipe expansion is required to ensure/give required diameter and to reduce/eliminate ovality from pipes. At the time of installation on site, several pipes are joined together to create a line in several meters or kilometers, so it is necessary that each pipe must have equal diameter to avoid any loss and weld them together easily.

Hydro tester- Hydro tester is used to check whether pipe/tube can sustain the required pressure at site or not. It checks each pipe at a particular required pressure and ensures it safety at site.

Edge Milling- It is also called Facing. Face of the pipe is properly milled to facilitate proper welding of two pipes at site.

X-Ray Test- An x-ray test unit is used to find out material defects or welding defects in product (pipe) before dispatching it. Because of material transportation and handling from one machine to another machine, there will be chances of dent or crack. An X-ray machine detects these cracks or dents before dispatching and send it to rework or rejection if found any.

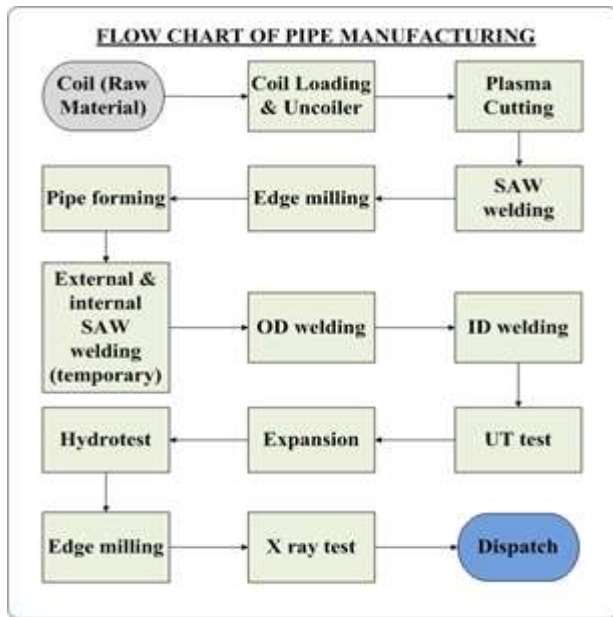


Fig.1. Flow chart of pipe manufacturing

B. MECHANICAL EXPANDER

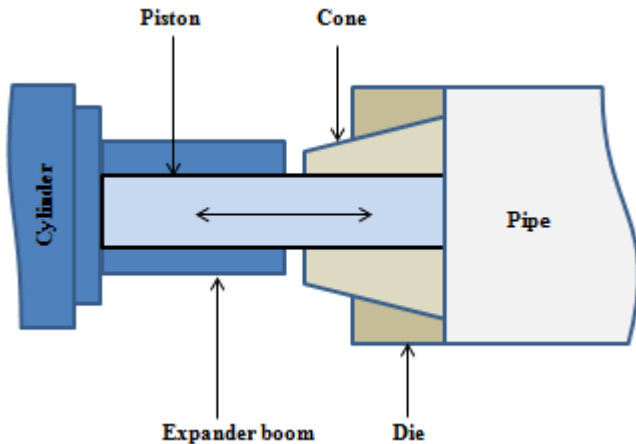


Fig.2. Schematic diagram of Mechanical Expander

Mechanical expander consists of cylinder piston assembly, cone and dies. Casing is provided over the cylinder to protect it from dust and rust. Piston reciprocates in the boom. Boom acts as casing of the piston to protect it. Over the piston on the other side there is an attachment of cone which can easily assemble and dis-assemble from the piston.

Cone is having angular cross-section which is nearer to 4 degree or it can be made according to the requirement. Dies are attached on the cone with the help of liners. Liners facilitate dies to reciprocate inside and outside. Grooves are provided on the cone where liners can be attached easily with the help of bolts. Liners are generally having 'T' cross-section over which dies can easily move forward and backward.

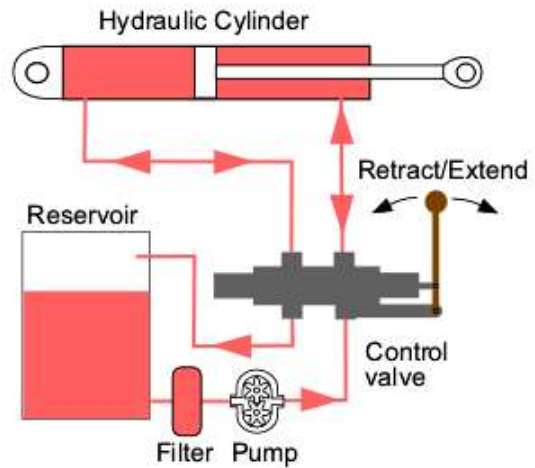


Fig.3. Hydraulic circuit of Mechanical Expander

Hydraulic oil is supplied from the reservoir to pump. Pump supplies hydraulic oil to the cylinder via control valve as shown in figure, by which piston can move forward and backward in the cylinder. Expander can expand the pipe from 1 mm to few centimeters (generally maximum 5 to 6 centimeters). Hydraulic energy is converted to mechanical energy to perform the task in the case of expander.

C. HYDRO TESTER

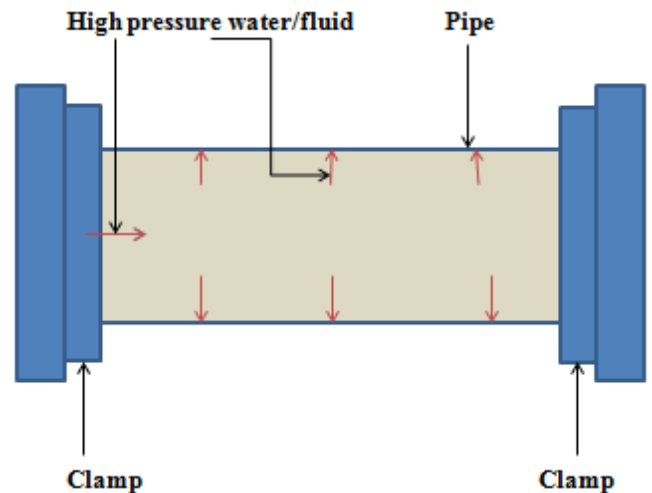


Fig.4. Schematic diagram of Hydro tester

Both faces of the pipe are clamped tightly and hydraulic pressure is applied with the help of hydraulic pump which collects fluid/water from the reservoir and convert into the high pressure. Hydraulic pressure is applied up to the certain limits (bar) according to the requirements to ensure sustainability of pipe while installed on site.

D. HYDRAULIC EXPANDER

Now sometimes pipe unfortunately tears from welding seam on expander while expanding it as well as expands to some millimeters while hydro testing it on hydro tester. High pressure is applied on hydro tester to check any welding defect, so when there is any defect, the pressure can easily tear the welding seam of pipe and sometimes the flow of pipe from the teared welding zone destroy the shade or machine control cabin glass. Because of these reasons the transparent glasses of control cabin are made bullet proof.

Now the 1st idea behind the hydraulic expander is, when we are giving such kind of pressure to check the welding defect, we can also use this phenomenon to expand the pipe which can eliminate the whole expander machine and can save millions of rupees. The only difference is, we have to mention one more criteria on hydro tester that is the final diameter of pipe. And for that purpose may be we have to give somewhat more high pressure to check the welding defects as well as to expand the pipe to certain diameter.

Earlier when already expanded pipe to required diameter from expander is sent to hydro tester, expansion on hydro tester when testing it was not required and treated as rework or rejection (in the case of over diameter). The only change in design of hydro tester is, there should be provision of safety casing over the pipe because of very high pressure is going to apply and it can harm the facility of plant as well as human body.

This casing over the pipe can also be useful in the case of normal hydro tester but anyway because of not that much applicable pressure, many pipe manufacturing plant are not using it.

In expander machine, hydraulic energy is converted to mechanical energy and in hydro tester hydraulic energy is used to perform the task. By hydraulic expansion we need to use only hydraulic energy to perform the tasks, expansion as well as high pressure testing.

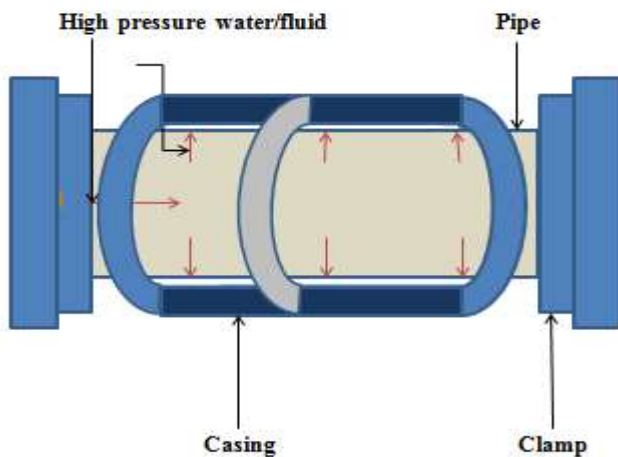


Fig.5. Hydro tester Casing

2nd concept is to perform expansion and hydro testing with the same old procedure but by only one machine which can provide hydraulic energy to test the pipe welding strength and can convert the hydraulic energy into mechanical energy for expansion of pipe.

The change in the design will be provision for pressurized fluid via piston of the mechanical expander and clamp at the both side of the pipe. For the expansion work, provision which is made for hydro testing can be made shut off and hydraulic energy from the pump will move piston, ultimately hydraulic energy is converted to mechanical energy and expansion work is carried out. After expansion, provision for pressurized fluid can be made open and pressurized fluid can store into the pipe at certain bar and hydro testing of pipe can be carried out.

For hydro testing, clamping is must by which there will be no leakage of fluid while testing it. For this, at one end there is expander dies inside which can clamp it from inside and for outer clamping there is provision provided as shown in figure. At the other side arrangement can be made just like hydro tester clamping device which can easily clamp the pipe and eliminate any leakage.

By this concept, expansion as well as hydro testing can be done on single machine, which reduce expenses and of course saves time.

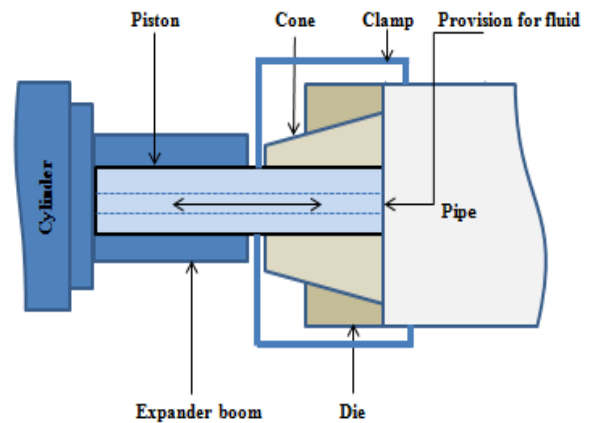


Fig.6. Combination of mechanical expander and hydro tester

E. COMPARISON BETWEEN MECHANICAL AND HYDRAULIC EXPANSION^[4]

Comparison	Mechanical Expansion	Hydraulic Expansion
Expansion medium	Mechanical (cone and dies)	Water under pressure (deionized or distilled water)
Type of expansion	Mechanical dies (8 to 12 normally) contact the workpiece.	Tool with an infinite number of contact points, all pushing the pipe/tube outward at the same time. Uniform pressure expands the pipe, even if the pipe isn't round.

Wall reduction?	Yes (minor)	No
Accuracy & Repeatability	Marginal	Precise
Safety	More	Less (Due to high hydraulic pressure)
Task	Expansion only	Expansion and hydro testing (if needed)

Table 1. Comparison between Mechanical and Hydraulic Expansion

F. ELIMINATION OF HYDRO TESTER ^[2]

According to one study there are several disadvantages of hydro tester. Some of them are mentioned below.

- 1) Since the stresses concentrate in weak sections (with low yield strength), stronger sections will not see the full beneficial effects of the hydro test.
- 2) Leaks are very difficult to detect. If pressure loss is detected during testing it is necessary to check the compressibility and temperature effects, and leakage from mechanical equipment (e.g. valves, flanges, etc.) to be confident that a leak is present. If the leak cannot be seen visibly, then further pipeline sectioning may be necessary.
- 3) If the pipeline ruptures, a repair can be more costly than if a defect was detected through another method (e.g. non-destructive inspection) and repaired.
- 4) Water acquisition can be a problem in offshore, desert, and arctic areas. Water also has to be treated to prevent corrosion being induced (this is a particular problem if seawater is being used).
- 5) Even new pipelines will contain debris, detritus, scale, and oil products, which can pollute the test water. Disposal in an environmentally acceptable way may require on site treatment or tankering to a disposal site.

- 6) Water is generally an unwanted product for gas, liquid and oil lines as it can lead to corrosion during operation. Typically, a pipeline will be de-watered, cleaned, and dried before entering service. This can be a time-consuming and costly exercise.

Also this study clearly mentioned the alternative to replace hydro test which is 'mechanical expander'. According to this study, "A second alternative to the pre-service hydro test would be the use of the mechanical expander. For some types of pipe (e.g. SAW) this is already used to finally size the diameter and produce a round section by plastically deforming the body and weld. The high strains (1-2%) result in plastic deformation that could be used to expose defects in both the weld and pipe body. However, for mechanical expansion, the test would not be a leak test, and defects could be 'opened' during the test but may 'close' afterwards, making them invisible to current NDT techniques. Hydraulic expansion could be used as both sizing and test mechanism". By this study, it is clear that hydraulic expansion has the benefits of both the machine.

II. CONCLUSIONS

It is better to install hydraulic expander instead of installing mechanical expander and hydro tester separately (where both are required). It saves the energy, time, efforts and cost of the company.

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