

Document Title: Procedure for Manufacture of Mandrel Elbows (Cold Formed)

1.0 SCOPE

This procedure outlines the process to manufacture Stainless Steel (SS) Mandrel Elbows (Cold Formed, 4" NPS to 12" NPS) from Seamless Pipe Lengths and ensure that all the manufactured fittings comply with stated requirements and are manufactured under controlled conditions. SAME size pipes are used to manufacture SAME size fittings.

2.0 POLICY

In small and medium-sized businesses, in particular, considerable potential exists for increasing productivity and efficiency in economic and ecological terms, because current production is often based on empirical experience and manual skills.

3.0 METHOD

PRINCIPLE:

Here, pipe sections are pushed over a mandrel, which defines the radius of curvature, into a one-piece and robust fitting.

In the traditional process, forming precision and reliability are low. The Wall Thickness of the convex side is thinned and stressed due to tension and the Wall Thickness on the concave side is thickened and wrinkled due to compression. This Technology aims to avoid uneven thickness, avoid / reduce any human errors and ensure high precision, focused reliability and continuous repeatability.

It brings with it numerous benefits in terms of reduction of processing operations, time and total process costs.

Fittings manufactured by using cold mandrel bending have advantages of small thickness deviation and shorter bending radius than those of any other bending method type.

If all the Technological parameters are set reasonable, this process guarantees all parts of the fittings wall thickness remains UNCHANGED in the forming process and EQUALS to the Pipe Cut Length wall thickness before deformation.

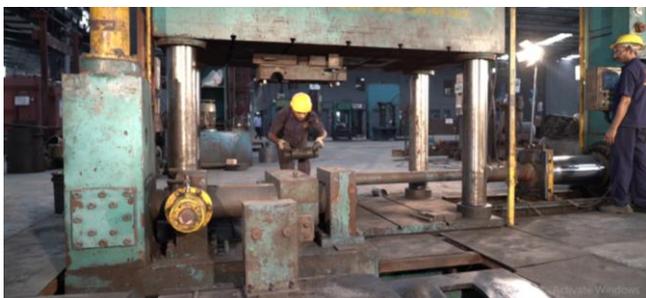
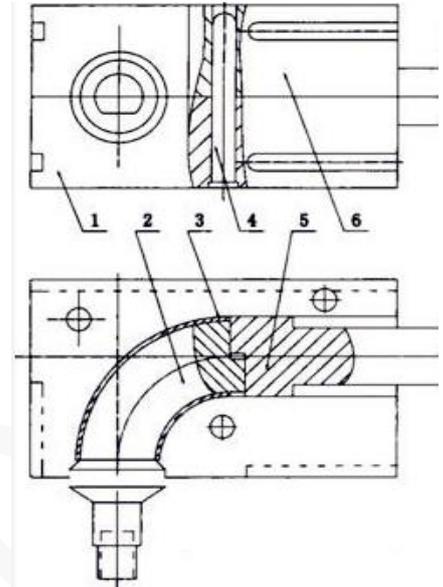
RAW MATERIALS (refer separate procedures for details):

Pipes are selected after Internal Inspections (Visual, Dimensions, Properties, etc) and cut to the required lengths (at 45.5° with 10mm cut off at front and 32.5° at back end , refer Machine Manufacturer's Manual for additional details), on Hacksaw or Plasma Cutting Machines. Starting Materials shall be free from burrs, cracks, nicks, gouges, waves, buckles, or other such surface defects that may impede the successful production of the fitting.

Heat Number punching (preferably low stress) is carried out on each cut length, to ensure traceability is maintained throughout the manufacturing process.

CRITICAL PARAMETERS:

- Formability of the material: it is necessary for the process to work properly and the fitting, does not break during the application of pressure;
- Friction at the interface: the friction between the die and the piece must be properly calibrated / lubricated;
- Machine parameters: these include times, pressures and movements of the axial cylinders that must be set correctly for the effective and efficient production of fittings.



ESSENTIAL VARIABLES:

- Pipe Wall Thickness – same as Fitting Wall Thickness (i.e. within 12.5% fitting tolerance)
- Forming Velocity – set by machine itself, based on 'Pressure of Hydraulic Cylinder'
- Forming Temperature – Room/Ambient Temperature
- Pressurizing Component – Hydraulic Cylinder
- Pressure of Hydraulic Cylinder – 8 to 10 MPa, but never above 20 MPa; Final Pressures are decided by Machine Operator(s) based on Material, Hardness, Diameter & Thickness.

**MANUFACTURING:**

Job Card is received from the Production Engineer. This details the fittings to be manufactured.

The Cold Mandrel Plant is primed to start manufacturing.

Machine Operator to ensure proper Machine conditions are set (Essential Variables) to avoid Over Thinning, Wrinkles, etc.

The Pipe Cut lengths are loaded in the machine on the Die, after application of Lubricant (mixture of Graphite Powder [40%] & Oil [60%]) on its inner and outer surface.

The Limit Switches (at the side of the machine) are set to the desired Final Size. This is to ensure that the Axial Cylinders stop at the required height.

The Machine is then closed from top and locked. The Push Bar (the front end of the Push Bar is welded to the Hydraulic Cylinder Side of the Machine, with locks) pushes the Pipe over the Same-Size-Bent Mandrel.

Finally, the Push Bar is released and the Die is opened and the Same-Size-Bent Mandrel (with the Formed Elbow) rotates around 180° and a tool slides along the Same-Size-Bent Mandrel to release the elbow.

At the end of the process, the semi-finished fittings can be extracted and directed, if necessary, to the subsequent processing phases.

SAFETY:

All required safety precautions shall be ensured (Safety Shoes, Safety Gloves, Safety Goggles, Safety Helmet, etc).

Specific care to be taken since High Forces are involved. Avoid standing directly in front OR back of the machine, you can stand at the sides.

SEMI-FINISHED INSPECTION:

The QC Engineer ensures that the first piece meets the Visual and Dimensional requirements of Semi-Finished products. He signs the Job Card (which is used for manufacturing details and clearance) as evidence of this inspection and manufacturing continues. More fittings may be inspected in case of large quantities at regular intervals, to ensure control on the process. Eventually the Job Card is signed off by the Machine Operator, after completion of all activities.



Manufacturer of Carbon Steel, Alloy Steel and Stainless Steel, Butt Weld & Socket Weld, Pipe Fittings and Flanges

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PAN No. : AABCF3645C
CIN No. : U74900MH2009PTC192904

FINAL PROCESSES:

The semi-finished fittings are then forwarded to the Cutting / Machine Shop / Heat Treatment Section / NDT Section / Shot Blasting Section / Rust Preventive application Section / Paint Section, as applicable, for further processing. Final Beveling operations are generally carried out as indicated (ASME B16.25 / ASME B 16.9), but strictly as per the stated Dimensional Standard.

TESTING (refer separate procedures for details): Samples are drawn from the finished product for Laboratory Testing (Chemical, Mechanical, Hardness, as applicable, as per stated Material Standard).

FINAL INSPECTION (refer separate procedures for details):

Final Visual and Dimensional Inspections shall be completed by Inspection Engineer after Final Machining and Finishing Operations, as per the Standard QAP. Tolerances shall be as per the stated Dimensional Standards.

4.0 PROCESS VALIDATION

Visual and Dimensional (including Ovality, Outside Diameter, Wall Thickness [using Ultrasonic Thickness Gauge], Inside Diameter, Off Angle, Off Plane, Length, Height, etc) Inspections have resulted in compliances with the Standards. Material Testing (Chemical, Mechanical [Transverse / Longitudinal], Metallurgical, PMI, etc) have resulted in compliances with the Standards. Since the fittings have been Cold Formed, Heat Treatment (refer separate procedures for details) is MANDATORY to ensure acceptable metallurgy and hardness.

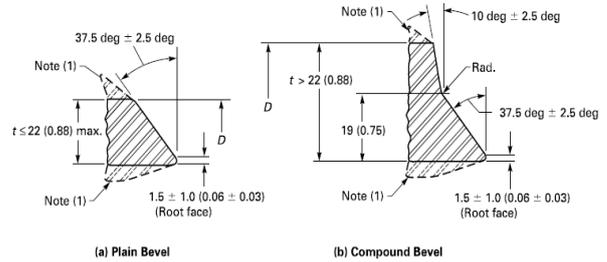
5.0 RESPONSIBILITY

This procedure is the responsibility of the Cold Mandrel Machine Operator and Production Engineer.

6.0 REFERENCES

- Machine Manufacturer's Manual
- Research Paper on Elbow Cold Pushing Mandrel Forming by Hengyuan - 2016
- Research Paper on Seamless Elbow Manufacturing Method: Cold Bending by Haihao Group – 2013
- Research Paper on Elbow Cold Forming by MingHeng - 2017
- Dimensional Standards – ASME, MSS SP
- Material Standards – ASME, ASTM, IS, DIN, EN

Table 8-1 Welding Bevels and Root Face



Nominal Wall Thickness, t, mm (in.)	End Preparation
Less than x [Note (2)]	Cut square or slightly chamfer, at manufacturer's option (not illustrated)
x to 22 (0.88), inclusive [Note (2)]	Plain bevel as in illustration (a) above
More than 22 (0.88)	Compound bevel as in illustration (b) above

GENERAL NOTE: In the illustrations, dimensions in parentheses are in inches; other dimensions are in millimeters.
NOTES:
(1) See section 8 and Figure 8-1 for transition contours.
(2) x = 5 mm (0.19 in.) for carbon steel or ferritic alloy steel and 3 mm (0.12 in.) for austenitic steel or nonferrous alloys.



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