A service provided by the
British Stainless Steel Association

Stainless Steel Advisory Service
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Forming and Fabrication Techniques for Stainless Steel

Introduction

Stainless steels can be formed and fabricated in the same way and using the same type of equipment as for most other steels. Some differences in technique apply and the purpose of this information sheet is to draw attention to these. As the most frequently used stainless steels grades are the austenitic '300' types, the information provided here is directed towards these steels.

The steels are considered as being in the fully softened condition.

Work Hardening

In the working of the Austenitic '300' stainless steels it must be remembered that these steels are characterised by high work hardening rates. This feature has a large bearing on many of the forming and fabrication techniques listed below.

Remember also that all machine tools will need to be of added power compared with carbon steel working

Cutting

The first operation undertaken in the fabrication workshop is that of cutting bulk materials into appropriate work pieces. This is readily achieved using existing machinery although in some cases the use of a specialist subcontract facility will be to advantage

Sawing

A power hacksaw operated at nominally 80 strokes per minute with some 0.08 mm feed per stroke will give satisfactory results. At all times ensure a positive feed and avoid rubbing, which will induce glazing and work hardening of the metal.

High-speed band saws work well on stainless steels with a speed of some 18 metres per minute

Shearing

Conventional press/guillotine equipment is used for shearing stainless steels, but should be down-rated by normally 40% compared with their carbon steel rating. Blades and cutters should be well adjusted with edges maintained sharp, thus avoiding the dragging of metal over the blade, with resulting work hardening. The same considerations should apply in working the nibbler to cut out shapes in sheet metal

Plasma Cutting

This process is usually employed to produce shapes from plate material. A clean cut edge and minimum distortion are provided, but it should be noted that a slight taper is provided to the cut edge and due allowance should be made in the design and finishing of the component

Blanking, Punching and Piercing

Each of these processes is mechanically the same in that each is an extension of the shearing operation previously referred to. The machinery used, punches and dies must have strength and rigidity to accommodate the added power used.

In Blanking operations die clearances have to be controlled and a figure of 5% metal thickness per side is quoted for popular gauge thickness. Excessive clearances lead to the metal being dragged with resulting burrs to the blank

In Piercing and Punching hole sizes should not be less than 1.5 times the metal thickness and to avoid excessive distortion the distance between holes should not be less than one half of the hole diameter

Forming

Austenitic stainless steels are readily formed and listed below are several operations in regular use. As in cutting operations machinery power levels have to be increased (or existing power levels down rated) compared with carbon steels

Bending

Flat sheet/plate and bar products can be bent using the press brake or bending machine. The work should be executed as quickly as possible due to work hardening characteristics of stainless steels, and a degree of over bending is necessary to counteract the springback of the bend. Inside radii of bends sharper than a figure equal to the material thickness under consideration should not be attempted.

Drawing

This is the forming operation whereby flat sheet is pressed into cylindrical and rectangular shapes by means of punch and die set up. The work is best carried out in a double action press using a bolster or pressure plate to hold back the material whilst forming is taking place, this avoiding wrinkling of the component flange.

Within the Austenitic ‘300’ series similar materials will give marked differences in their deep drawing characteristics. For example, type 304 will prove to be more readily formed material than type 301, due to its reduced work hardening levels.

Mechanical and hydraulic presses in general use can be used for stainless steel drawing operations, but again the capacity is significantly reduced. For deep drawing work, the hydraulic press is preferred because speed and pressures can be accurately controlled.

Punch and die radii of nominally 5 to 10 times material thickness will allow a smooth draw in of the flat sheet. Too large a radius will cause wrinkling, too small a radius will limit the amount of reduction achieved.

For deep drawing work, several operations are necessary with inter-stage annealing to achieve a high depth to diameter ratio. Where lubricants are used to aid drawing, then these should be removed prior to annealing. Descaling after annealing and prior to further working is essential.

Certain of the plastic protective coatings applied to sheet products can remain in position whilst drawing takes place and will act as an aid to pressing.

For information, annealing of the '300' series of austenitic stainless steels is carried out at a temperature of 1050^{o}C with rapid cooling thereafter.

Spinning

Spinning can form cylindrical and bowl shaped components. This is often a one step operation using a round nose tool working over a rotating mandrel. Manual and power operated tools are used.

Bending of Tubes

Numerous architectural and process applications of tubular pipe work and bends exist. In the bending of tube, guidelines can be set down, but first hand experience has to be gained to achieve regular reliable results.

Tubes can be bent satisfactorily using Rotary Bending machines, where on end of the (straight) tube is clamped and the machine former rotates to pull the tube to the designed radius. Alternatively bending in a hydraulic press will push a radiused head on to the tube to force the tube into roller dies.

In considering either in house or sub-contract tube bending, the quantity involved will have a significant bearing, as will the complexity of the final shapes

Centre-line bend radii of 2 x tube diameter are generally considered to be a minimum for stainless steel materials, duly adjusted where diameter of tube and wall thickness' reach high proportions

Final Considerations

1. Stainless steels are regularly cut and formed and their working should not cause any great problems
2. Remember the high power requirements of stainless steels working compared with carbon steel
3. Be mindful of the high work hardening characteristics of the material
4. Remember that a higher degree of rigidity of tools and machinery is necessary for stainless steels working
5. Always work in a clean and, if possible, a dedicated environment

Before commencing any task ensure that you have received the appropriate health and safety literature from the supplier and fully understand it. If in doubt seek advice.

This Information Sheet is an update of BSSA Information Sheet No.5