Preparation, which often constitutes the final stage of the manufacturing process, serves not only a cosmetic purpose, it also produces a finish which will be more acceptable to the buyer. Accurate end preparation of tube ensures that, where lengths of tube are to be joined to each other or to other components, the squareness of the tube end will guarantee proper fit-up and correct alignment on long runs. The many types of preparation vary according to the size of the component, wall thickness and the joining method to be employed. Most welding specifications call for a predetermined end form which will vary according to the subsequent welding method.

Methods of end preparation vary from the simplest, e.g. a hacksaw and file, to high-tech, high-volume CNC production machinery, which can turn out hundreds of finished tubes or pipes per hour.

Hacksaw and file

Although inexpensive in terms of equipment, this process is too slow and inaccurate to be considered as a practical method of preparing weld joints. The high cost of labour also makes the benefits of this method dubious.

Grinding

Grinding is the most common of the low-tech methods employed in the tube and pipe fabrication shops. It is relatively inexpensive, as the initial investment in equipment is considerably less than many of the alternative types of machinery currently available. It can be used on a wide selection of materials and it will, given sufficient time and a good operator, create most of the common weld preps in use at present. However, grinding is of no value where there is risk of fire or explosion. It is also dirty and can be dangerous because of the risk of inhaling airborne particles (though precautions can be taken against this risk). Grinding is also very noisy and can contribute to industrial deafness. Hidden costs can include the grinding discs, especially if they are designed for use on exotic materials, and maintenance. The accuracy of grinding is not optimal under any circumstances, and the more complicated the profile, the harder it is to achieve. Particles of the grinding disc can be deposited on the pipe material, which can result in weld defects in the subsequent joining process.

Flame or plasma cutting

Several methods exist for creating end preparations on tube and pipe using flame or plasma cutting. Many of them provide acceptable surfaces for welding under certain circumstances and depending on the skill of the operator. The cost of manual flame/plasma cutting equipment is not prohibitive, and these methods can be employed in a number of on-site situations, both indoors and out. Mechanised methods of flame and plasma cutting are more accurate than hand-held torches, although there are still limitations to be taken into account. Plasma cutting has the advantage over flame of being able to work on more exotic materials such as stainless steel, but it can be extremely messy and, on heavy materials, the cut tends to dissipate as it advances through the wall, leaving an inaccurate finish. Both flame and plasma cutting induce a certain amount of heat into the material.

Lathe or boring machine

Employing a lathe or boring machine is an accurate and sometimes fast method compared to the others available. It can also produce complex profiles with a high level of repeatability. In a lathe, with the workpiece rotating, there are limitations as to the size and shape of the pieces to be prepared. A 12-metre length of tube spinning at high speed can be very hard to control. A boring machine has far fewer limitations, but there are many disadvantages common to both machines. Using these machines for end preparation ties up the machines and prevents them from being used for the many more complex operations of which they are capable. Handling large or complicated pipes, possibly with bends or fittings welded into them, can be difficult and slow.

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Hand-held milling and nibbling machines

Hand-held milling and nibbling machines vary in size and capacity from a small electric drill for lightweight plates about 3mm thick to free-standing machines that have the workpiece fed through by hand. Some of these machines carry a milling cutter that will remove large amounts of material very quickly. These leave a surface finish that is generally acceptable for most methods of welding. Other machines use a system similar to a miniaturised guillotine that nibbles the material away to a predetermined shape.
products, with largely the same benefits as for tube and pipe. In some instances, for example where plate is being rolled into a tubular section, accurate machining to width is imperative as this will govern the diameter of the finished tube. Machines of this nature are usually built into production lines, together with rolling and welding equipment. For workshop activities, a vast range of both fixed and portable systems is available. The choice of using a fixed system, as opposed to a portable machine, largely depends on the volume of ends to be prepared and the speed at which it is to take place. If there is a large number of similar-sized items to be prepared in a common profile, a fixed system should be preferred. This can be installed on a production line and work in harness with any other process that the components have to pass through. Portable machines also have the advantage that, if the prepared pipes are to be assembled on site, the machinery can be taken to the job location and the same standards of accuracy can be achieved as in the workshop. Machines designed for in-situ use are usually lightweight in relation to the dimensions they are made to work on. They can be supplied with a variety of drive systems. There is a wide choice of methods for attaching the machine to the work, and several different cutting methods can be employed.

Equipment for tube and pipe end preparation can range from a machine as simple as a grinder mounted in a jig which clamps the pipe to faster and more accurate CNC machines. On occasions end preparations have to be created in an environment that precludes normal methods. This may be under water or in an irradiated area, or possibly in a situation where a human operator cannot be employed due to inaccessibility or danger to life. For these applications remote-control machines are needed. In situations where it is not permitted to touch the inside of the tube, for example with an electrochemically polished tube, machines employ special clamping collets to grip the workpiece, while others use a system of jaws similar to a chuck. For smaller sizes the collet system is the optimal solution. Another subcategory of the collet method is the chain fixing, the biggest advantage of which is that it is practically without limit of diameter. The principal disadvantage of the chain method is that it is difficult to set up and, if care is not taken, the cutter may wander, resulting in a spiral instead of a prepped end. Nearly all the users of such chains use a mandrel to facilitate self-centering and self-alignment. Most of the operators employ also form tools to create the desired shape on the pipe end. Many will perform more than one cutting operation simultaneously, i.e. a compound bevel, counter-bore and root face. For thicker wall applications some machines use single-point tooling with articulated tool holders. These types of machines can also be adapted to reinstate a damaged gasket seat on flanges and vessels.

Welding (super) duplex pipes
The advantages of using high-tech portable tools were made evident when Dragados Offshore SA was asked to build an LNG processing plant on Melkøya Island as part of Statoil’s project. In the past, the company had prepared large-diameter hard-alloy Pipes (stainless steel duplex and super duplex, P91, etc.) using several methods, including cutting by flame or band saw, manual bevelling with abrasive discs or, when high quality was important, using a lathe. But these methods proved unproductive, polluting, low quality and inconvenient. So Dragados Offshore asked Kalmia SA and its partner Protem to propose a method of machining pipes that avoided all these problems. Most of the conduction of this plant had to be constructed in duplex and super duplex pipes to handle high pressures in corrosion weather conditions. The weld preps were to be made in different configurations (10°, 37°30’ and “J” shape) and in different sizes, schedules and materials. After studying the problem, Kalmia and Protem decided to offer portable tools for working pipes ranging from 1” to 42”. The toolkit comprised low-speed bevellers and orbital welding equipment, "Due to the high quality of the weld preps we were able to carry out a lot of the welding using newly acquired orbital welding equipment," said José Ramón Damborenea, General Sales Manager of Kalmia SA.

Capital investment
Portable machine tools and sophisticated production systems require a large initial capital investment. This can be a daunting prospect, particularly for small businesses. However, the enhanced accuracy and repeatability of these machines can lead to a reduction in the number of components needing to be scrapped and a reduction in the number of weld defects. Accurate end profiles mean that more advanced welding processes can be employed. Many automated welding systems need very accurate fit-up, and are very unforgiving if there are inaccuracies in the weld preparation. If an estimator can judge more accurately the time taken to perform end profiles, the total time allowed for the operation can be more easily quantified. This makes it easier to calculate labour costs and make a correct price quote. In most cases therefore it is of considerable benefit for companies to invest in the most advanced equipment available to enhance quality and productivity.