Selecting the welding process.
Since stainless steel is more expensive than regular steel, it is important to choose a process that provides the best results, avoiding such common problems as melt-through (especially when welding thin sections). Following are different processes recommended for welding stainless steel. Process selection is to be made on a case-by-case basis depending on the particular application and availability of equipment.

MMA Manual metal arc welding (ASME: SMAW)
MMA, using covered electrodes, is still the most widely used welding process when it comes to welding stainless steel. The process is suited to all weldable grades, in thickness of 1 mm. and upward. In principle there is no upper limit of thickness. However, for heavier material, the automatic welding processes are often more economical. Although there is a trend towards these wire-processes, manual welding still represents the major proportion of total welding operations.

Factors to consider when choosing an electrode.
The electrode should be of the same basic analysis as the parent metal. This gives the weld its optimum corrosion resistance. However, certain exceptions are permissible. For example a high-alloy electrode may sometime be used for welding a low alloy parent metal. The reason for doing so is weldability and mechanical strength. In all cases the corrosion conditions must be considered. In citric acid, grade 18-10L is more resistant than 17-12-2,5L. In such applications, grade 18-10L should be welded with HILCHROME 308R electrodes and not with a higher alloyed type.

There are basically four different types of covered electrodes for stainless applications: lime or basic (-15), titania or rutile-basic (-16), silica-titania or rutile (-17) and heavy coated for flat and horizontal welding (-26). Electrode selection will be based mainly on the welding position.

Basic coated **(-15)**	DC only	1. Vertical and overhead welding and all-positions applications such as pipe-welding 2. Root passes on heavy plate 3. Fully austenitic high alloyed stainless steels subject to weld-centreline cracking
Rutile-basic coated **(-16)**	AC / DC, DC preferred	1. Applications in the flat position 2. Uphill and overhead welding when lime covered electrodes are not available
Rutile coated **(-17)**	AC / DC, DC preferred	1. Flat- and horizontal position welding when minimum cleanup is desired 2. When a concave bead appearance is desired
Heavy coated **(-26)**	AC / DC, DC preferred	1. Recommended for flat position, horizontal fillet is possible 2. High-current, high-deposition rate welding

Gas Metal Arc Welding (MAG Welding)
The main advantage of MIG welding is its speed. Using a spool of solid wire, an operator can produce high deposition rates. Solid wire can be used in short-circuiting, globular and spray modes of arc transfer, giving GMAW a wide range of deposition rates and heat inputs. While pulsed GMAW can be used on thinner sections or for out-of-position welding, conventional spray transfer is used to join thicker sections because of its high deposition rates. Short-circuiting transfer is extensively used for stainless steel sheet and thin tubing.
MIG welding requires a shielding gas to prevent oxidation of the stainless steel alloys in the welding arc. Depending on the location and regional tendencies, mixtures of argon, helium and CO_2 are used.
The MIG process is either semi-automatic or fully automatic. It is a more economical process than welding with covered electrodes. However, all gas-shielded processes are sensitive to draughts meaning they are not suitable for outdoor work or for welding in open vessels in which a chimney effect may easily occur.

Flux Cored Arc Welding (ASME: FCAW)
Traditionally, the most frequently used processes for welding stainless steels were MMA followed by MIG, TIG and SAW. The fifth process FCAW is developed more recently and offers fabricators a genuine opportunity to increase productivity. Nowadays FCAW is the most used process for welding stainless steel.
FCAW is commonly used for welding stainless steel in the flat position as well as out of position. Cored Wires uses basically the same wire feed equipment and power supply as the MIG process. Unlike MIG wires, however, some Cored Wires contain a very fast freezing flux to form a slag shelf, which allows out of position welding without a special power supply.
Like MIG welding FCAW requires a shielding gas. We recommend either a mixed gas 75%Ar-25%CO_2 or pure CO_2. The difference between these concerns mainly the weldability and possibility to weld vertical upwards.

Gas Tungsten Arc Welding (TIG Welding)
Although slower than MIG and FCAW, TIG Welding can produce high quality, clean welds with minimal defects. Able to weld thin sheets without melt-through, manual and automatic TIG Welding are used for joining conventional and PH stainless steel – particularly in thicknesses op to 5 mm. To avoid contaminating the stainless steel with tungsten, the tungsten electrode should never touch the workpiece.
TIG Welding is typically used for critical welds where strict conformance to code is mandatory, such as in the food service and nuclear industries. In pipe and pressure-vessel welding, TIG is often used for root passes before switching to other processes for the fill passes.
Normally, DC electrode negative (DCEN) is used with a power supply having a constant current output. Alternating Current (AC) is sometimes used for more cleaning action while welding stainless steels containing aluminium. Shielding gas is normally argon, though helium or an argon-helium mixture might be used for greater penetration. The tungsten electrode should be alloyed with thorium when welding stainless steel.

Submerged Arc Welding (ASME: SAW)
Submerged Arc Welding is used for heavy workpieces. Usually, one or two bottom weld beads are deposited first by some other welding process. The joint is then filled by SAW. In certain cases, the bottom bead may also be submerged-arc welded. In such case we use root-backing tapes.
The flux is supplied through a funnel located ahead of the filler wire, which is fed continuously. The flux exercises a shielding function. During welding, part of it is converted into a readily removable slag. Welding is generally performed using DC electrode positive (DCEP). During SAW, extensive interaction occurs between the welding wire and the flux. Chemical elements can be exchanged.

POINTS TO REMEMBER WHEN WELDING STAINLESS STEEL

Before welding
Adjust the root gap and joint angle in a way securing good penetration, for duplex types a wider root gap is recommended
1. Clean the joint and base metal thoroughly
2. Use only stainless brushes for cleaning
3. Preheating is normally not recommended
4. Always use dry electrodes, if necessary redry covered electrodes at 250-350ºC for 2 hours

During welding
1. The heat input should be related to the plate thickness and welding method
2. Avoid striking the arc outside the joint. Arc strikes can act a initiation points for pitting corrosion and cracks
3. A correct root gas shielding is important. Suitable backing gas are high purity Ar or mixtures containing N_2 and H_2
4. Excessive weaving should be avoided. This can result in an overly high heat input

After welding
1. Thorough cleaning after welding is essential to obtain good corrosion resistance. All slag and oxide on and around the weld must be removed
2. Brushing should be done manually and only with stainless brushes
3. Rotating brushes can result in micro-crevices in the weld metal
4. Subsequent heat treatment is normally not necessary
5. Stress relieving should be avoided since this can cause embrittlement of the steel and weld metal
6. When polishing, use a new grinding stone. Small iron particles in a grinding stone might get pushed into the steel, in this way initiating corrosion.