Austenitic stainless steels are construction materials for a wide range of applications. They are used often because of adequate mechanical properties and excellent corrosion resistance in the chemical, petrochemical and oil industries i.e. on places which are under influence of corrosion medium [1]. Beside acceptably value of yield strength and tensile strength austenitic stainless steels are characterized also clearly high impact energy and relatively low hardness. During welding of austenitic stainless steels in weld metal undesirable phase precipitation can occur, for example $M_23C_6$, $\sigma$-phase, $\chi$-phase. The said phases adverse influence on mechanical and corrosion properties.

In this work the results of fractographic analysis of fracture surfaces of austenitic stainless steel samples after tensile testing and impact energy before and after manual electro arc welding technique are shown. Plate of 15 mm thickness, made from austenitic stainless steel AISI 316L was prepared as V-join. The chemical composition of the base metal was Fe-0,026C-1,49Mn-0,043P-0,003S-0,35Cu-0,060V-16,75Cr-10,80Ni-0,081Ti-0,20Co-0,016Nb (wt.%). Manual electro arc welding was realized with electrodes Böhler FOX SAS-4A. The weld root was obtained by welding using solid electrode 2,5 mm in diameter while fillet welding was carried out by 3,25 mm electrode. The chemical composition of electrode was $\leq$0,03C-0,8Si-0,8Mn-19,0Cr-11,5Ni-2,7Mo (wt.%). Samples for testing mechanical properties and impact tests were cut out from base metal and welded plate. Mechanical properties were tested in accordance with ASTM procedures [2]. After mechanical properties testing fractographic analysis of fracture surfaces using scanning electron microscopy (SEM) was carried out. Fractographic testing was carried out according to the standard conditions on Jeol, JXA-50A device.

Fracture surface testing was carried on standard samples which were thined in weld metal zone. Impact tests were performed on Charpy V-notch (CVN) specimens (10x10x55 mm) at room temperature. V-notch depth 2 mm was machined in the middle of weld metal.

It is well known that fractography directly describes the fracture process and provides valuable evidence for the cause of failure [3,4]. We investigated the fracture surfaces of the austenitic stainless steel using fractured Charpy V-notch impact test specimens.

Distinctly high values of impact energy of base metal (238 J) are obtained which is about 65% more than for weld metal (83 J). Results of impact testing are confirmed with fractographic examination. Figure 1 shows SEM fractographic analysis results for both the base and the weld metals after impact tests. Two distinct fracture modes were observed. The fracture surface of the base metal reveals primarily of cleavage fracture with a small of amount of dimples (Figs. 1a and 1b). In contrast, the impact-fractured surface of weld metal exhibited exclusively ductile fracture (Figs. 1c-f). The ductile fracture characterized by void nucleation, growth and coalescence [5]. On microfractographs some inclusions and particles are observed in a small
holes. Composition and types of these inclusions and particles need to be additionally analysed by energy dispersive X-ray (EDS) spectrometric analysis.

References

Figure 1. SEM microfractographs of base metal (a, b) and weld metal (c-f) of specimens from stainless steel AISI 316L after impact energy testing at different positions and magnifications; a-d - Magn. 500X, e-f - Magn. 1000X