Numerical Study and Experimental Comparison of Laser Cutting of 1.2MM Thick Austenitic Stainless-steel Using CW ND: YAG Laser

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Stainless steel-304 is the most common steel used for corrosion resistance applications, but higher melting point is a limitation in industrial manufacturing. The non-conventional and subtractive manufacturing technique of laser cutting- a beam directed method, is suitable for these applications. The gaussian laser beam is directed at the material that melts, burns, vaporizes, or blows away by a jet of gas leaving an edge with a good surface finish. In this work, numerical study was performed to study insights into the multi-physical fluid process of laser cutting. To study this, 1.2 mm thick austenitic stainless-steel was cut using a continuous width neodymium-doped yttrium aluminum garnet (CW Nd: YAG) laser and the process was verified with the already published experimental results. The simulation was carried out with TruVOF, FLOW-3D as it has the capabilities for simulating advanced algorithm for free-surface fluid tracking. To evaluate the optimum condition for kerf width, smooth surface cut, roughness, and heat affected zones within limited time, the input parameters: laser power (660-1980 watts), cutting speed (2 - 8 m/min), oxygen gas pressure (9 - 11 bars) and focal distance (-1m - 1.0 m) were varied and analyzed using a full 3D model. The simulation results showed smoother surface cut, little dross formation, lower temperature rise on heat affected zones, and less finished time at cutting speed 8m/min, higher laser power above 1000, gas pressure of 11 bars, and focus distance of -1.0 m. It was noticed that increase in laser power at a faster cutting speed led to an increase in kerf width, reduction in dross formation, lower temperature rises on heat affected zones and a reduced finish time. The simulation led to a good agreement with experimental results within a 15% percentage error.