

# **INFLUENCE OF THE MIG PROCESS WITH DYNAMIC FEEDING ON THE MICROSTRUCTURE OF PARTS MADE OF AISI 420 STAINLESS STEEL BY WIRE + ARC ADDITIVE MANUFACTURING TECHNIQUE**

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## **ABSTRACT**

Martensitic stainless steel alloys, such as AISI 420, are used to manufacture parts that demand mechanical strength allied to ductility and corrosion resistance, such as injection moulds, surgical instruments, turbine components, among others. This material justifies the use of additive manufacturing (AM) due to its high processing cost with conventional manufacturing processes (subtractive manufacturing). Thus, processes with high deposition efficiency (Buy-to-Fly ratio close to 1) stand out. In this context, the MIG process variants with dynamic feed like CMT (cold metal transfer), CMT Advanced and CMT Pulsed, in addition to the high aggregate technology, are excellent candidates for processes with high BTF ratio due to the stability, geometry of the deposits and high control capacity. This work aims to verify the results obtained in the use of CMT variants applied to parts built by additive manufacturing (AM), comparing them with those of a conventional MIG process, analyzed under the aspects of heat input, hardness, morphology, in addition to macro and microstructures of the parts. Walls of 50 mm high were built by AM, with monitoring of electrical parameters (voltage and current), thermal cycles of the parts and their physical characteristics, these tests were performed with the same deposition rate (2.5 m/min) and weld speed (30 cm/min) for all CMT variants, using 1.2 mm stainless steel AISI 420 wire and shielding gas with 92% Air and 8% CO<sub>2</sub>. Substrate

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was a A36 steel plate with 1/2" thickness, 50 mm width and 250 mm length. In the end, CMT Advanced and CMT Pulsed stood out as opposite ends, where the CMT Pulsed for being a warmer process than the others, generated higher cooling rates, resulting in microstructures of higher hardness. As the cooling speed increases, there is an increase in the magnitude of thermal subcooling that can be achieved. This increases the nucleation rate of the solid and, as a result, grain refining. This is verified for the CMT Advanced process, which presented smaller grains compared to the others. Conversely, the CMT Pulsed showed larger grains. Its consequence of the temperature reached, above A1, where microstructural modifications were possible, i.e., grain growth, seen in the CMT Pulsed process. Among the processes, the CMT Pulse showed higher hardness values, with an average of 506 HV, this result was expected, since its cooling rate was higher, as well as its thermal input. In the wall built from the CMT process the average was 420 HV; for the Conventional 428 HV and for the CMT Advanced 438 HV. The observation of the micro structures showed the prominence of dendritic columnar grains, and their morphology was quite homogeneous for each sample. In the comparison between samples, the CMT Advanced presented smaller grains, the Pulse presented slightly larger grains than the others, and the CMT and Conventional produced results too similar.

**Key-words:** Additive Manufacturing; GMAW; Stainless Steel; WAAM; Welding.