Analytical sizing of a heat exchanger for a FSAE combustion car

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Abstract: First, the ideal engine operating temperature was defined through studies by Savonen, Chiang and Johnson (1984), which relate the thermodynamics involved in the internal combustion process of an engine with its volumetric efficiency. Afterwards, the necessary thermal rejection at different engine speeds was defined, using the empirical method developed by Heywood (1988), this method relates the engine power to the required thermal rejection performance of the cooling system for certain speed ranges.

The analytical method chosen to dimension the heat exchanger was the NUT-effectiveness, developed by Keys and London in 1984. For this purpose, a dimensioning tool developed in Excel software was developed in order to obtain the amount of heat dissipated by the system cooling in a range of engine operating regimes. This dimensioning tool had as main objective to be able to simulate the heat exchange of radiators with different dimensions, but only with brazed hives. It also considers the conditions of the air and water flow contour of the system.

Also, simulations were developed in Ansys Fluent and Optimum Lap to predict the behavior of air flow through the radiator, as well as validations in specific operating regimes of the engine itself to obtain the mass flow of water flow in the cooling system.

Among all the possibilities of heat exchangers analyzed, the cross-flow radiator with a brazed core of 260x263x62mm was chosen, as it fits within our size restrictions imposed by the rules of the Formula SAE International competition, and also proved to be the best heat exchanger, according to our analytical method.