Numerical simulation of a locomotive engine using detailed chemical kinetics with n-heptane as a diesel surrogate

Javier Antonio Mendoza Corredor

Abstract: Pollution in the world has received significant attention in recent years due to its substantial increase. The causes are multiple, and one of them is the emission of pollutants in the railway transport sector. This is because they have internal combustion engines with high power and torque. These engines consume a large amount of fuel, which is why studies have been conducted in recent years, where emissions are one of the main issues of importance for engineers. Analyzing the behavior of diesel, one of the most widely used fuels in this sector, is necessary to identify optimal operating points that minimize pollution. To accomplish this, a study was conducted on the behavior of a locomotive engine in the present work. The engine model (DASH9-BB40W) is equipped with a GE FDL16 diesel engine, with 16 cylinders, a maximum power of 4100 hp, and a compression ratio of 12.7. A numerical CFRD simulation was performed using detailed chemical kinetics as the combustion model, and n-heptane was used as a substitute for diesel. Four kinetic mechanisms were employed to compare them with experimental values and determine the validity and precision of the models used. This comparison allowed evaluating the effectiveness of the different kinetic mechanisms in predicting the behavior of this type of engine. Each of these mechanisms predicted the formation of soot and NOx. The numerically obtained indicated power from the simulations for each mechanism was compared with the experimental values of the mentioned engine. The simulations were performed using the AVL Fire tool in the ESE Diesel module. The behavior of the average soot fraction and the average NOx fraction for this type of engine is also analyzed.

Keywords: Locomotive engine, Detailed chemical kinetics, AVL-FIRE, Emissions.