Modeling the Distribution of Sulfur Compounds in a Large Two Stroke Diesel Engine

In many years large low speed marine diesel engines have consumed heavy fuel oils with sulfur contents in the order of 2.5 - 4.5wt%. Present legislations require that the fuel sulfur is reduced and in near future the limit will be 0.5wt% globally. During combustion most of the sulfur is oxidized to SO2 from which a fraction is further oxidized to SO3. SO3 may combine with H2O and condense as liquid sulfuric acid that promotes corrosive wear on e.g. cylinder liners. To extend engine lifetime and reduce costs for lubrication it is pivotal to identify formation of SO3 with respect to operational conditions and sulfur feed. This work presents a computational model of a large low speed two-stroke diesel engine where a 0D multi-zone approach including a detailed reaction mechanism is employed in order to investigate in cylinder formation of gaseous SO3 where fuel injection rates are determined using experimental pressure traces. Similarly to NO the SO3 is very sensitive to the rate that fresh air mixes with hot combustion products. Therefore a simple mixing rate is proposed and calibrated in order to meet experimental results of NO. Generally 3 - 5 % of the injected sulfur is oxidized to SO3 that is formed primarily in the temperature range from 2000-1300K. In addition the model is used to reduce the full reaction mechanism from 96 elementary sulfur reactions to only 7 reactions without compromising the SO3 to SO2 ratio.