Comparison of Engine Performance and Pollutant Emission for Marine Diesel Engines of Fishing Boats Among Three Detergents of Scrubbers

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Abstract:

Marine diesel engines use heavy fuel oil which properties are much inferior to those of vehicle fuels. The emissions from burning such degraded fuel oil that contains high sulfur, asphalt, metallic impurities and high viscosity are one of major sources of pollutants. The amended Annex VI of International Convention for the Marine Prevention of Pollution from Ships, briefly termed as MARPOL approved by International Maritime Organization (IMO) that enforced all ocean-going vessels powered by fuel oil with sulfur content lower than 0.5 wt. % since 2020. Among those vessels, the impact of emission of fishing vessels sailing near resident or urban areas on the human health and eco-environment is even more direct and severe. In addition, the current sulfur content of fishing fuel oil A is 0.5 wt. %, which is still 500 times of that of diesel fuel for road vehicles. The installation of scrubber at the tail pipe of diesel engines can curtail SOx emission in compliance with low-sulfur regulation of MARPOL. However, the scrubber cost is still too expensive and previously only installed to large-sized container vessels. Therefore, small-scale economical scrubber for fishing vessels is purported to be designed, constructed, and tested in this study. Except for SOx and PM reduction, NOx reduction is incorporated in the scrubber design. An engine dynamometer was used to test the performance of the scrubber and the back pressure increase. Three kinds of detergents for the scrubber were used, including sea water, fresh water, and carbamide. The experimental results show that the installation of a scrubber at the tail pipe of the diesel engine causes significant increase of the exhaust back pressure, fuel consumption rate, brake specific fuel consumption (bsfc), excess air ratio, and CO emission concentration while considerable decrease of exhaust gas temperature, NOx, SOx and CO2 emission concentrations, and amount of particulate matter emission. In comparison of the effects of chemical agents injected into the scrubber to mix with exhaust gas from the diesel engine, the experimental results show that less excess inlet air required for the case of sea water agent, no obvious difference of exhaust gas temperature among those three injected agents although slightly higher exhaust gas temperature for the fresh water case. Injected carbamide into the scrubber caused the largest reduction of NOx and