Automated Map Optimization of a Large-Bore Diesel Engine

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ABSTRACT

Increasing oil prices combined with gradually more stringent regulations for the sulfur content of heavy fuel oil as well as more stringent emission legislations lead to rising costs of ownership for large-bore marine diesel engines in the recent past. This trend is expected to continue in the future. Due to the given high throughput rate of large-bore diesel engines already a minor reduction of the fuel oil consumption will result in significant cost savings. One promising way to max the potential of fuel reduction of internal engine measures out is an automated map optimization during normal engine operation. The adjustment might be necessary due to the influence of aging and wear or changed operating conditions, e.g. varying fuel quality, on the combustion process. In this paper a prototype-software is presented that was developed to perform an automated map optimization of stationary large-bore engines. The software works in the way that successively new values for manipulable variables, e.g. start of injection, are calculated and transmitted to the engine control system. The impact on the engine behavior is measured and evaluated in form of an objective function. The calculation of the new values is based on the solution of an optimization problem. With this system a very precise recalibration of the electronically controllable variables at the current engine operating point can be achieved. The prototype-software is flexible with regard to the optimization algorithm as well as with the number of manipulated variables. In addition to the optimization algorithm a safety-concept is implemented to observe the technical limits. The system was successfully tested on a steady-state model of a diesel engine. The simulation shows, that the prototype-software is capable to reduce the specific fuel consumption of a large-bore diesel engine by at the same time meeting the constraints such as the emission limits.

INTRODUCTION

The maritime antipollution convention, the "International Convention for the Prevention of Pollution from Ships", known as MARPOL 73/78 is promulgated by the International Maritime Organization (IMO). More specific the current exhaust emission regulations are named in the Annex VI of the MARPOL 73/78 convention and the NO_x Technical Code [1] which entered into force 2005. The limits on NO_x emission are laid out in a three-tier structure commonly referred to as IMO Tier I to III standards. The regulations for marine diesel engines according to Annex VI are illustrated in Figure 1.



Figure 1 - MARPOL 73/78 Annex VI regulations for NO_x emissions of marine diesel engines [1].

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