THE ENVIRONMENTAL AWARENESS IN THE ENGINE ROOM SIMULATOR TRAINING

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Abstract: The environmental awareness in the engine room simulator training is the main subject of this paper. The latest legal requirements for the reduced emission of SO_2, NO_x and CO_2 imply not only the new onboard ship technology but also the improved environmental awareness of the ship crew. The problem requires the close co-operation between the navigational and the engineering officers but the engine room simulator is the right place where the available solutions can be compared and evaluated. One the other hand the engineering officers should be aware that technical state of the engine and its tuning has the significant influence of the environment pollution. The paper shows the examples how this problem is implemented in the existing engine room simulators.

Keywords: engine room simulator, environmental awareness.

The advanced mathematical modelling available today, makes possible to extend a scope of the training offered by the engine room simulators by addressing the environmental awareness problems. Virtual Engine Room 6 (VER6) is the first engine room simulator where special ECO Data module has been added. This module uses the exhaust data from the sophisticated combustion process model which are normally available as the exhaust analyser readings (Fig. 1).

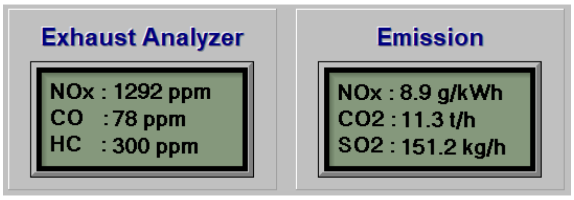

Figure 1.The exhaust analyzer display in VER6 simulator.

The ECO Data should be used in order to see the influence of the selected ME operational parameters and the ambient conditions on the fuels consumption and the environment pollution. In general, this data should awake the economic and ecological awareness of the trainees.

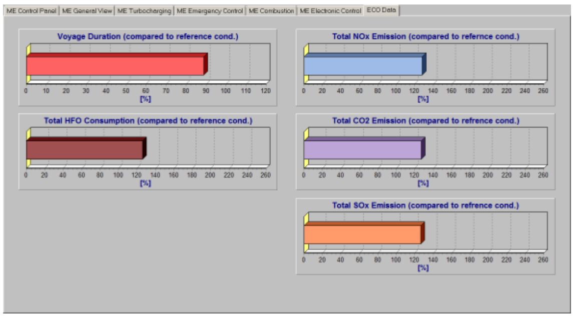

Figure 2. The ECO Data bars in VER6 simulator.

The ME ECO Data System window includes several data bars showing the data which is necessary for the economic and ecologic voyage planning. The presented data includes:

- Estimated voyage duration (without the time in the harbour and during the manoeuvring, canal passage etc.). This estimation is based on the theoretical assumption that the current (observed) ship speed will be maintained as a mean speed during the whole voyage. So, let's assume that one would like to shorten the voyage time by 10% (Fig. 3).

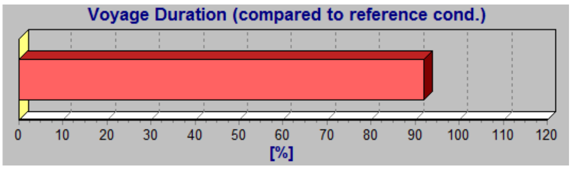

Figure 3. The example of voyage time shorter by 10%.

- Total estimated HFO consumption by ME only (i.e. without the fuel consumption by the main boiler or MDO by the diesel generators, incinerator etc.). In our example the HFO fuel cost will increase by ca. 35% (Fig. 4).

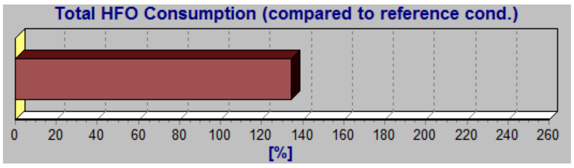

Figure 4. The example of the HFO cost consumption increase by 35%.

- Total NO_x emission by ME only (i.e. without the fuel consumption by the main boiler or MDO by the diesel generators, incinerator etc.). In our example there will be almost no NO_x emission increase (Fig. 5) due to the fact that the engine has an electronic control the injection advance will be delayed at higher loads.

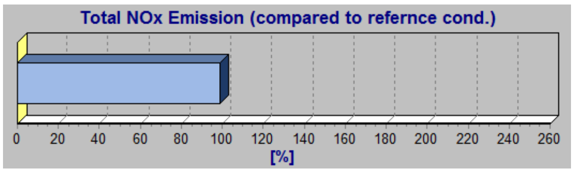

Figure 5. The example of the total NO_x emission estimation.

- Total CO2 emission by ME only (i.e. without the fuel consumption by the main boiler or MDO by the diesel generators, incinerator etc.). For the above given example, the total CO2 will increase by ca. 35% (Fig.5).

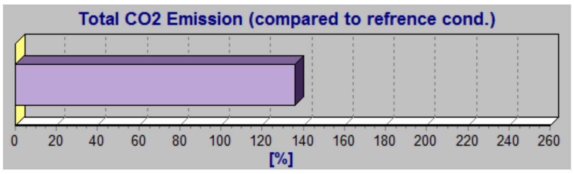

Figure 5. The example of the CO2 emission increase by 35%.

- Total SOx emission by ME only (i.e. without the fuel consumption by the main boiler). This factor depends strongly by sulphur content in the fuel so the very significant change can be observed when switching from HFO to LSF.

All above mentioned data is presented as the relative values (%) in comparison to the reference conditions which are: 70 rpm, 25% of the ship load, calm sea and 3.5% sulphur in the fuel.

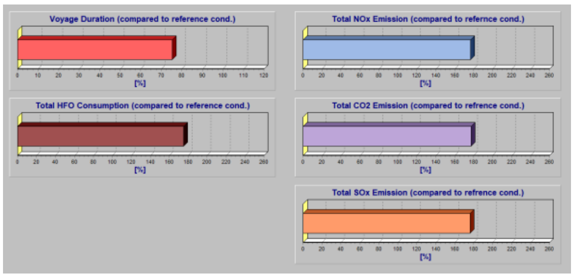

Figure 6. ECO Data in Economy Mode.

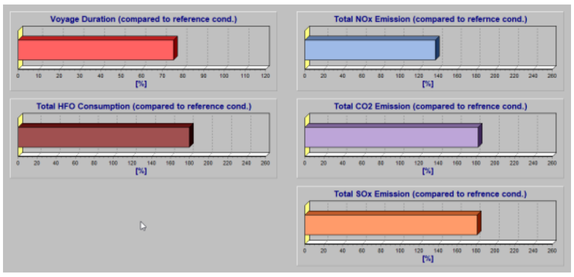

Figure 7. ECO Data in Emission Mode.

The another example (Fig. 6 and Fig. 7) shows that switching the injection timing of the electronically controlled engine from Economy Mode to Emission Mode will cause small increase of the fuel consumption but significant decrease of the NO_x emission.

The environmental awareness is also a part of the maritime training at management level when using Turbo Diesel 5 (TD5) simulator.

Turbo Diesel 5 offers the possibility to observe the influence of mixed engine faults on numerous operational parameters. As an example, the influence of the single and multiple (mixed) engine faults on NO_x emission will be discussed. Fig. 8 shows, how does NO_x emission and concentration in the exhaust gases depend on the injection advance angle. It is easy to conclude that the recommended by an engine producer injection timing (18 deg before TDC) offers the lowest NO_x emission.

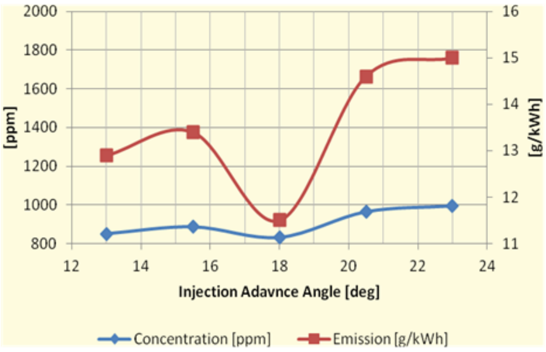

Figure 8. NO_x emission and concentration as a function of an injection advance angle.

On the other hand, the air filter cross section decrease which simulates the dirty air filer and a decreased air flow through the engine, lower air/fuel ratio and the significant increase of NO_x emission (Fig. 9) what it is well known from the literature [1, 2, 3].

The emission is much higher and far above even the MARPOL - Tier I [4] limits when the third fault i.e. dirty air filer simulation is mixed in (Fig. 11).

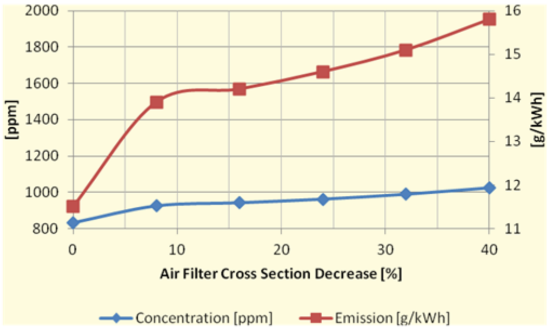

Figure 9. NO_x emission and concentration as a function of an air filter cross section decrease.

When the dirty exhaust duct is simulated and the injection advance angle is changed (Fig. 10) the lack of an air dominates the influence of the optimal injection timing and the total NO_x emission is higher than when both single faults are simulated.

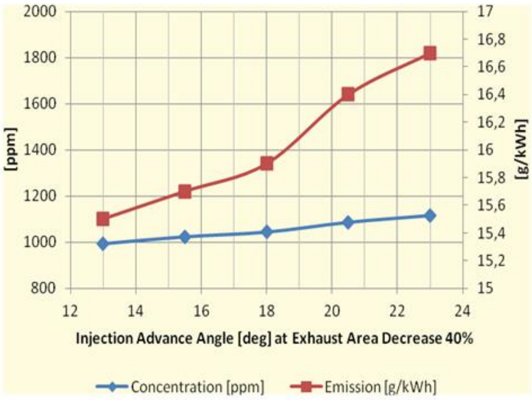

Figure 10. NO_x emission and concentration as a function an injection advance angle and dirty exhaust.

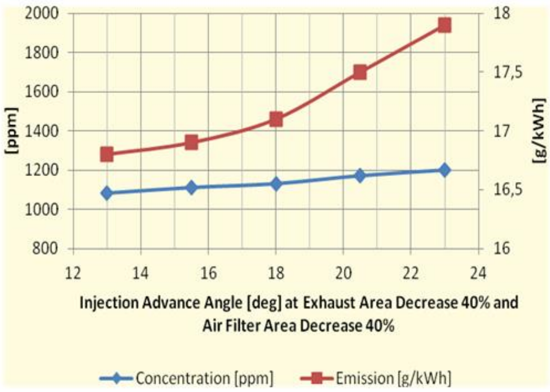

Figure 11. NO_x emission and concentration as a function of an injection advance angle, dirty exhaust and dirty air filter.

The above described observations imply the need to care of the turbocharging system cleanliness as an important measure to prevent the environment pollution by NO_x emission. On the other hand, when the proper flow of the turbocharging air is provided, it is necessary take care about the injection adjustment as an effective measure of the environment protection.

CONCLUSION

The presented examples show that it is possible to extend the functionality of the engine room simulators by including the environmental awareness as well. This may look as a step outside of the today engine room functionality but it is probably the anticipation of the functionality from tomorrow.

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