Enhancing the steam output of exhaust gas boilers/economizers

Traditionally, marine steam systems are designed for a steam pressure of 7 bar(g) in order to provide an adequate steam temperature (170°C) for the heat consumers. HFO, in particular, may require heating to a high temperature to ensure a suitably low fuel viscosity.

Engine exhaust gas heat is used to generate the steam, but the exhaust gas temperature of two-stroke engines is steadily decreasing. This poses a growing challenge when it comes to meeting the required steam flow rate.

Potential to reduce steam pressure

The amount of heat transfer possible depends on the temperature difference between the exhaust gas and the steam. Reducing the steam pressure and thereby the steam temperature might be one way to increase the steam flow rate. (See Fig. 1.)

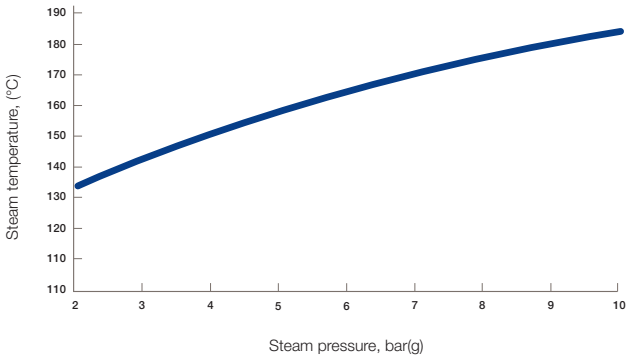

Fig. 1: Saturated steam temperature

For instance, decreasing the pressure from 7 bar(g) to either 5.5 or 4 bar(g) would increase the temperature difference to 8.4 or 18.6°C respectively. The larger difference would benefit heat transfer, creating a significant improvement in steam generation. This is illustrated by the following example. (See Fig. 2.)

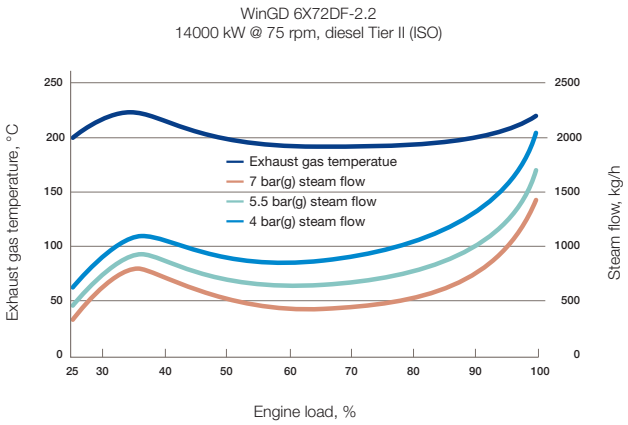

Fig. 2: Example of steam flow at different working pressures

In the example shown, using the same heating surface but reducing the pressure to 5.5 bar(g) would improve the steam flow rate by up to 45% (at 60–75% load). Further reducing the pressure to 4 bar(g) would nearly double the steam flow rate in the same load range.

Naturally, the improvements in steam flow rate would depend on the specifications and tuning of the main engine, which must be evaluated in each case. In general, the relative improvement would depend on the exhaust gas temperature, which will be lower in tropical conditions and higher in winter conditions.

Is reducing steam pressure acceptable?

The acceptability of a lower steam pressure (and a corresponding lower temperature) has to be evaluated from two perspectives: that of the exhaust gas boiler/economizer and that of the heat consumers.

Alfa Laval's experience from large dual-pressure exhaust gas boilers shows that operating the engine on HFO should be possible at steam pressures as low as 3.5–4 bar(g) – without risk of issues like sulphuric acid condensation or excessive fouling. At such pressures, the steam temperature is normally higher than the acid dew point, which is even lower with today's low-sulphur fuels. There should therefore be no concern about acid corrosion in the boiler.

The question then comes down to the heat consumers. It should be possible for them to accept a lower steam/pressure temperature, at least when running on fuel alternatives other than HFO. However, the new parameters must be considered when designing both the steam system and the heat consumers. In this regard, the piping system can be Class III if the normal operating pressure is 5 bar(g) or less and the design pressure is not more than 7 bar(g).

Using enhanced steam output for power generation

Alfa Laval Aalborg boiler systems can be supplied with dual set points. This makes it possible to run at reduced pressure when this sufficient and at ordinary pressure when HFO heating is required.

When running at a lower pressure, the improvement in steam flow rate can help to meet the steam demand as described. In fact, it can often provide even more steam than required. The surplus steam can be used for power generation by means of the Alfa Laval E-PowerPack (www.alfalaval.com/epowerpack), which can help to improve the vessel's Energy Efficiency Index (EEDI/EEXI) and Carbon Intensity Indicator (CII).

In this light, it is worth considering if some of the heat demand might potentially be covered by alternative waste heat sources. If so, even more steam could be used for power generation. As an example, on a vessel with DF engines, forced LNG evaporation could be driven with heat from engine cooling water rather than steam.

To discuss possibilities or request more information, please contact your local Alfa Laval office.

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