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INCREASED SAFETY RISK DUE TO SEVERE CORROSION RELATED TO BOX COOLER ARRANGEMENTS

Relevant for ship owners and managers as well as design offices, shipyards and suppliers.

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DNV GL has experienced a number of vessels with severe corrosion of the steel structure in way of the box cooler. In the most severe cases, the bolted flange of the top plate of the cooling box was involved. This leads to increased risk of collapse of the top plate. This article provides insights and recommendations on how to avoid this.

Heavy local corrosion of the flange of a box cooler.

Coating failure of the cooling pipes on a box cooler

Extent of damage

A box cooler eliminates the secondary cooling water circuit of sea water inside the engine room (pumps, filters, valves, pipes, etc.). The cooling effect is achieved by natural circulation of the surrounding sea water and is considered to be a cost-effective alternative.

There are two main challenges related to box coolers:

1. Aggressive galvanic corrosion due to more noble material in the box cooler compared with the ship steel

2. Marine growth on the cooler tubes, which can reduce the cooling effect

The most common systems of box coolers are:

1. U-tube bundle made of aluminium brass (CuZn20Al2), coated to prevent harmful galvanic effects on the carbon-steel sea chest

2. U-tube bundle made of copper nickel (CuNi10), uncoated to prevent marine growth on the tubes

3. U-type bundles with an impressed current system to prevent marine growth on the tubes

In a number of cases, severe corrosion damage has been observed in the carbon-steel mounting flange on top of the sea chest, including the bolts and shell plating of a sea chest in way of the box cooler. Considerable sea water leakage in a corroded sea chest may cause a large ingress of water in the engine room if not noticed in time.

Probable causes

The main drivers of corrosion damage are:

- The natural circulation around the cooling elements causes warm sea water to rise towards the top of the sea chest (top plating), creating environmental conditions which increase both corrosion rates and marine growth (barnacles, shells, etc.).
- Exposed noble materials (corrosion resistant) in the box cooler tubes impose galvanic currents between the cooler tubes and the sea chest, causing galvanic corrosion of the adjacent steel structure, if proper electrical insulation is not maintained.
- The corrosion protection systems applied (coating of U-tube bundle, if applicable; coating of the surrounding steel structure, sacrificial anodes and/or impressed current cathodic protection) are not able to suppress the corrosion rate of the sea chest. This can occur due to poor design, damage during installation or in service, or lack of necessary inspection and maintenance.
- Incorrect settings of the impressed current system. This system has been installed to prevent marine growth and maintain the high efficiency of cooler tubes. Possible adverse galvanic corrosion effects on a ship's steel structure may have been given low priority by the manufacturer.

Recommendations

Box coolers are sometimes assumed to be maintenance free. However, DNV GL's experience has shown that the following items should be regularly verified by the crew:

- Look for signs of corrosion and leakage in the mounting frame and the corresponding sea chest.
- The condition of the corrosion protection arrangement of the specific box cooler and sea chest. If new coating is applied, do not coat the tube bundle, anodes or cathodes, as applicable. A small area of damaged coating in the sea chest will concentrate galvanic corrosion to the area of exposed steel.

  Note: The smaller the area, the more aggressive the corrosion.
- Check the correct setting of the impressed current system according to the maker's specifications.
- Keep long-term records of set points of the impressed current system for eventual failure investigations.
- Inspection and replacement of anodes and cathodes. If the anodes are consumed faster than expected, this may be a sign of damage to the corrosion protection system applied. Sacrificial anodes (most often zinc) inside the sea chest to protect the hull may counteract the effect of the tube bundle's anti-fouling and thermal behaviour (Zn deposits on the tubes). Consult the relevant box cooler manufacturer for guidance on the positioning of sacrificial anodes.
- Cleaning of the tube bundle (do not damage the coating or remove the copper-oxide layer).

Due to the severe corrosion issues seen with box cooler arrangements, DNV GL will follow up these details carefully in connection with dry-docking **every five years**. This includes withdrawal of the box cooler.

- Class inspection will focus on: Inspection of the mounting flange, bolts and gasket(s)
- Inspection of the isolation parts (if applicable)
- Inspection of the sea chest inlet and outlet grids (to ensure sufficient free flow area)
- Marine growth (barnacles, shells, etc.) may cover severe local corrosion, especially in the upper part of the sea chest. Thorough cleaning is therefore necessary to check surface condition

References

DNV GL Rules Pt. 7. Ch.1 Sec. 5. 1

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