Economizer problems LNG Carriers

• A case study
• Confidentiality
Overview

• A fleet of Korean built LNG Carriers 2003-2008
• Kawasaki turbine type
• MHI boiler plants type MB-4E-NS
  • About 7 with steam/air heater(Design A)
    Economizers generally subjected to corrosion damages

• About 4 cases with rotating gas/air heater(Design B)
  No damages to economizer, rotating gas/air heaters corroded
Boiler design A

- Steam / Air Heater design
- 3 burners in furnace roof
- HFO Mode/BGO Mode/ Dual mode
Boiler design B

• Gas / Air Heater design
• 3 burners in furnace roof
• HFO Mode/BGO Mode/ Dual mode
Economizer (Boiler design B)

- Three banks
- Helical finned tubes
- Each bank 10 vertical and 16 horizontal tubes
- S-Ten1
- One soot blower on top, one at the bottom, one between 1st and 2nd block and one between 2nd and 3rd block
- Third (bottom bank) made of different material-no condens
The individual economiser tubes are equipped with fins in order to increase the surface area for convection of the heat from the exhaust gases.
Sequence of events-Economizer no.2-ps

- 2006- Vessel delivered
- 2011- February- leakage
- 2011-March-12 tubes replaced
- 2011-new leaks, blind two full vertical lines
- 2011-June- 89 tubes replaced
- 2011- further leakages, blind vertical line
- 2013- Intermediate survey, further leakages
- 2013- top bank replaced
- 2013-middle bank confirmed corroded
- 2015-middle bank replaced
Sequence of events – Economizer no. 1-stb

- 2011- August- damage ascertained, four tubes replaced
- 2012-February- one tube replaced and some welding conducted
- 2012-February-March- Upper bank replaced
- 2013-August- tube leak from weld
- 2015-October-upper and middle bank replaced
Hard ash sticking on the economiser tube surface.
Sister vessels

- About seven vessels with similar boiler/economizer solution - two different series.
- One series built between 2004-06 traded in similar area, extensive use of HFO in general.
- The series built between 2003-04 did not use HFO and different trading area.
Sister vessels
Damage description

• Where on the tubes?
• Which banks?
• Which rows?
• Why?
Photo 7: Damages in the tubes. The previous repairs can be seen as well as the damage caused by the sulphur on the deflectors.

Photo 8: See the high level of corrosion for the sulphuric acid as well as the sulphur deposits on the deflectors’ surface.
Photo 9: See the high level of corrosion for the sulphuric acid as well as the sulphur deposits on the deflectors’ surface.

Photo 10: Tubes with the highest degree of deterioration located in the central area of the boiler.
Causes

• Main cause is;
  • CORROSION-Sulphuric corrosion-cold end corrosion

• -Heavy fuel oil (HFO) will form sulphuric oxides (SOx) in the combustion process. Related to the actual content of Sulphur (%) an amount will be SO2 , of which a small portion again transforms into SO3. When SO3 is contained in the exhaust gases being cooled and reaching the dew point - or the gasses touch a cooler surface (here the economizer tubes) the SO3 and the water (H2O) in the gasses will combine and form concentrated sulphuric acid (H2SO4).

• This type of corrosion, known as cold end corrosion, is mainly encountered in relatively low temperature boiler components such as economizer, air preheater, stack, etc.

• Temperature of metal is critical, not temperature of flue gas. Metal temperature less than dew point.
Contributing cause/how to avoid sulphric acid

- Construction
  - Only one blower per section
- Soot blowing procedures
  - Poor cleaning procedure
- Leaking soot blowers
- Funnel drain
  - Drain system clogged
  - Insufficient drainage during tropical rainshowers
- Funnel opening
  - Heavy rain entering funnel
Photo 25: Drainage from the exhaust manifold

Photo 26: Drain pipe with bends
Contributing cause

- Running/Trading pattern of the vessels
  - Boiler load, slow steaming due to waiting period
- Exhaust gas
  - HFO vs BGO vs combination
- Material, S-Ten vs CR-1A
- Feed water temperature
- Insufficient repairs/Commercial obligations
Consequential damages

• Leakages
• Bank no. 2

• Further, the experience shows that leaking tubes in the economizer top bank have an adverse effect of the service life also in the middle banks - generally not affected at all by the traditional corrosion related to the sulphuric dew point.
Claims Handlers’ challenges

• Normal or extraordinary corrosion
  • Lifetime, what is lifetime?
• If extraordinary, deductibles
  • One per boiler
  • One per contributory cause
  • One in total
• How much influence has the various contributing causes
• Not similar damage to the various economizers
• Which policy year(s)
Claims Handlers’ challenges

- On pressure testing the economizer found again tubes leaking at the area near to the plugged tube. Due to shortage of time it was decided no to plug more tubes. Then by-passed the economizer. Decided to operate the two boilers at reduced load.
Surveyors’ challenges

• Detailed reporting
  • The devil is in the details
  • What where when
  • What does “middle” mean
• Also describe what is not damaged
• Important parameter
  • Temperatures-Exhaust gas inn/out economizer
  • Feedwater-Inn/out