"Guidance for Measures to Cope with Degraded Marine Heavy Fuels, Version II −Taking into Account the Poor Combustibility of Fuels -" Published

Research Institute

Nippon Kaiji Kyokai (ClassNK) published a Japanese version of the new "Guidance for measures to cope with degraded marine heavy fuels Version II" in June 2008, and published an English version of the new guidance in September of the same year.

ClassNK first published the "Guidance for measures to cope with degraded marine heavy fuels Version I" in 1996. Although 12 years have passed since the guidance was published, it continues to be used by a large number of shipowners, managers and others throughout the world. However, when the guidance was first published, the process for manufacturing marine heavy fuel oil mainly yielded conventional distilled residual oil. In the intervening years, fuel oil has been desulfurized to enhance gasoline recovery rates, and the refining process has been changed. Residual oil is now produced from catalyst refining, to create so-called FCC oil. Additionally, amid rising concern about the environment throughout the world, the emission regulations of SOLAS Annex VI have also been extended to fuel oils. One of these issues is low-sulfur fuels issue, the properties of marine fuel oils, and the problems associated with the, are changing.

Changes in fuel oil properties have been recognized as a real and serious issue by a number of experts engaged in the analysis of fuel oils. Some ship owners have learned of these changes, however many engaged in the operation of ships are not aware of this issue.

The change in fuel oil properties can be seen in factors related to fuel problem occurrences from 1996 to 2008 as below:

- 1996: " Era of problems due to four high factors " - High density, high viscosity, high sulfur, and high catalytic fines
- 2008: " Era of problems due to one high and three low factors " - High density, low viscosity, low sulfur, low catalytic fines

These changes can be easily understood by comparing similar problems from both eras. For example, twelve years ago, the cause of abnormal wear of cylinder liner surface was attributed to low temperature corrosion due to sulfur content or FCC catalytic fines, and hard particles such as aluminum and silica. However, in recent years, fluid catalytic cracking residual oil is processed through a desulfurizing unit. Moreover, problems have reduced since the recovery rate of the valuable catalytic fines has been enhanced. However, abnormal wear on the cylinder liner is still being reported, and in recent years, different causes have been pointed out. One such cause is poor combustion. Flames grow longer because of poor combustion, and as a result the film of lubricating oil on the cylinder liner wall face burns. Also, deposit of unburned substances destroys the lubricating oil film, causing abnormal wear of the liner wall.

It has been not determined that problems caused by poor combustion in recent years can be traced back to general properties of the fuel oil, such as specific gravity and viscosity. Combustion tests are normally performed using the constant volume combustion analyzer FIA100 (Fuel Ignition Analyzer-100), the combustion period and the ignition delay time are measured, and the combustion characteristics are compared to determine if there are combustion problems. As a result of such analyses, reports of fuel oil with poor combustibility leading to engine troubles are becoming increasingly common.

In light of these circumstances, ClassNK set up a committee to develop a guidance for measures to cope with the poor combustibility of fuels in June 2007, and with the cooperation of various personnel from shipping companies, engine and equipment manufacturers, petroleum refining companies and experts on fuel oil, proceeded to conduct studies and develop methods to deal with the issue.

Shipowners provided the Committee with reports of a variety of actual problem occurrences. Experts examined each of these reports and created a short-list of the main

factors associated with the problem occurrence. As a result of these examinations, it was determined that these problems were, as previously mentioned, "Problems due to one high and three low factors."

In addition to this, here have a growing number of reports of problems believed to have resulted from the mixing of used lubricating oil such as from on-shore sources (automobiles, etc.) in marine heavy fuel oil. In recent years, this theory has been verified. For example, calcium carbonate ($CaCO_3$) has been determined to be one of the hardened particles that cause abnormal wear of the cylinder liner/piston ring. It has been conclusively determined that the source of the calcium carbonate was calcium (Ca) from lubricating oil additives. It has also been reported that used LO had been mixed with fuel oil in many regions in spite of the prohibition specified in ISO 8217.

Reports of problems estimated to have occurred due to the mixing of sea water in fuel oil, have also been received as in the past. Under such circumstances, the use of low-sulfur fuel oil is also an area of interest.

Many engine components are dependent on the sulfur and its lubricating characteristics and for many years, it has been generally understood that that some amount of sulfur in marine heavy fuel oil is necessary. When system oils compatible with the regular amount of sulfur have been used, problems arising from low sulfur content have been reported.

Based on studies conducted by fuel oil experts, the Committee has identified and compiled technical information on these issues, as well as information on as-of-yet unimplemented technologies, and included them in the Guidance. However, at this point in time, the majority of the reports on problems related to low sulfur are only preliminary reports, and much of the technical information available is based on the premise that adequate studies need to be carried out in order to substantiate the results.

The properties of fuel oil after bunkering mainly depend on processing on the ship side. In principle, there have been no major changes to shipboard fuel oil systems since 1996. However, appropriate operating methods for oil purifiers suited to the various properties of fuel oil have been clearly defined. Based on consultations with manufacturers, information on purifier operations such as three-phase separation of oil, water, sludge; efficient oil purification by two-phase separation of high viscosity oil-water and sludge; and differences in operating efficiency of series and parallel operations of two purifiers, and so on, are also included in the new Guidance.

Among all the issues related to fuel oil, treatment after bunkering, which is often problematic, is of the utmost interest to all concerned. Measures to be adopted by the ship based on studies by engine manufacturers on the Committee, have been also been included in the Guidance,

Recent trends in emission regulations, covering in detail the latest trends of regulations in the USA and Europe, have also been included in the Guidance for easy reference.

The contents of the Guidance this time are as follows:

(1) Changes in problem factors
(2) Increase in fuel oils with poor combustibility
(3) Problem related to low-sulfur fuel oil
(4) Problem points related to ISO standards
(5) Impact of emission regulations
(6)Treatments possible with shipboard fuel oil treatment systems
(7) Measures for machinery systems

The above and as well as many other reference items for the design and safe operation of ships have been also been included. A number of helpful information on measures that can be adopted to address various kinds of problems have also been provided, including measures for dealing with fuel oil with poor combustibility at the ship management site. We are grateful to the members of the Committee for their active participation in studies for this Guidance, and hope that owners, managers, and other related personnel will find the Guidance to be beneficial to their work.