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Ships and marine technology — Incinerator sizing and selection — Guidelines

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Foreword

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The committee responsible for this document is ISO/TC 8, *Ships and marine technology*, Subcommittee SC 2, *Marine environment protection*.

INTERNATIONAL STANDARD ISO 18309:2014(E)

Ships and marine technology — Incinerator sizing and selection — Guidelines

1 Scope

This International Standard covers selection criteria to assist procurers in selecting the appropriate incinerator for their needs. This International Standard is a companion document to ISO 13617.

This International Standard does not apply to incinerator systems on special incinerator ships, for example, for burning industrial wastes such as chemicals, manufacturing residues, and so forth.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 13617, *Ships and marine technology — Shipboard incinerators — Requirements*

International Maritime Organization (IMO), *The International Convention for the Prevention of Pollution from Ships (MARPOL)*, Annexes V and VI, as amended

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
batch feeding
non-continuous feeding incinerator where the combustion chamber shall be cooled down between placing solid waste into the combustion chamber

3.2
continuous feeding
pump transfer of sludge oil into the incinerator combustion chamber on a continuous basis; also, the feeding of solid waste into the combustion chamber by a screw conveyor or sluice system

3.3
sludge oil
residual from fuel and lubricating oil separators, oily waste from machinery and hydraulic power units, drip trays and oil-water separators

3.4
sluice system
trap door system, whereby it is possible in a safe manner to feed solid waste into the combustion chamber while the incinerator is operating and is at high temperature

3.5
solid waste
combustible trash, garbage, and rubbish (see also 7.1)

3.6
waste
unneeded or useless matter which is to be discarded

4 Selecting incinerator size and location

A number of factors will govern the selection of the size and type of shipboard incinerator and full consideration shall be given to each. The installed location of the unit is of equal importance to ensure low-cost operation, ease of charging, ease of cleaning, and so forth. Consideration should be given to the following factors:

a) maximum amount of each type of waste that will be incinerated each day (see Clause 5);

b) normal number of hours per day that the incinerator will be in operation;

c) loading procedure (batch/continuous) over operating hours;

d) if wet and dry material can be loaded into the incinerator, so that a large volume of auxiliary fuel is not required

e) if the incinerator can be installed on a ship in a location near the major source of refuse, so as to minimize the manpower requirements for loading operations;

f) if ashes will be removed easily if the incinerator is installed in the machinery space or on a lower deck;

g) if ash removal will be manual (shovelling) or semiautomatic.

5 Estimating daily quantities of solid waste to be incinerated

— Number of the ship's crew:

Galley and crew quarters waste estimate: 1,5 kg per crew member per day

— Number of passengers carried:

Galley and passenger quarters waste estimate: 2,5 kg per passenger per day

— Stores:

Estimated amount of packaging for food and other items that, during the underway period, will become waste in the form of rubbish or trash: 0,5 kg per crew member or passenger per day

— Sludge oil generation (see Clause 8 for estimation)

6 Other factors for selection

a) Type of unit (for example: solid waste only, solid waste and sludge oil)

b) Capacity of unit in kW or BTU/hour (based on waste generation estimate, heat content of waste, and operating hours)

c) Sludge oil capacity

d) Loading considerations (batch loading or continuous feed)

e) Environmental considerations

Incinerators are required to meet the emission limits specified in IMO MARPOL Annex VI or ISO 13617.

f) Heat recovery options (amount of steam or hot water to be generated)

g) Induced draft fan requirements

h) Modular/package

i) Dimensions/weight

7 Classification of shipboard wastes and incinerators

The basis for satisfactory incinerator operation is the correct analysis of the waste to be destroyed and the selection of proper equipment to best destroy that particular waste.

As a guide, mixtures of waste most commonly encountered have been classified into types of waste, together with the heat content (kJ/kg) values and moisture contents of the mixtures. For example, a concentration of one specific waste in the mixture may change the heat value or the moisture content, or both, of the mixture. A concentration of more than 10 % by weight of catalogues, magazines, or packaged paper will change the density of the mixture and affect burning rates.

Similarly, incinerators have been classified by their capacities and by the types of wastes they are capable of incinerating.

7.1 Classification of shipboard wastes

The following classifications of shipboard waste differ from the definition of garbage as found in Annex V of MARPOL, which includes all of the types listed below.

a) Type 0: Trash, a mixture of highly combustible waste, such as paper, cardboard, cartons, wood boxes, and combustible floor sweepings from commercial and industrial activities. The mixtures contain up to 10 % by weight of plastic bags, coated paper, laminated paper, treated corrugated cardboard, oily rags, and plastic or rubber scraps.

   This type of waste contains 10 % moisture, 5 % incombustible solids, and has a heating value of 19 730 kJ/kg as fired.

b) Type 1: Rubbish, a mixture of combustible waste, such as paper, cardboard cartons, wood scrap, foliage, and combustible floor sweepings, from domestic, commercial, and industrial activities. The mixture contains up to 20 % by weight of galley or cafeteria waste, but contains little or no treated papers, plastic, or rubber wastes.

   This type of waste contains 25 % moisture, 10 % incombustible solids, and has a heating value of 15 100 kJ/kg as fired.

c) Type 2: Refuse, consisting of an approximately even mixture of rubbish and garbage by weight.

   This type of waste is common to the occupancy of the passenger ships, consisting of up to 50 % moisture, 7 % incombustible solids, and has a heating value of 10 000 kJ/kg as fired.

d) Type 3: Garbage, consisting of animal and vegetable wastes from restaurants, cafeterias, galleys, sick bays, and like installations.

   This type of waste contains up to 70 % moisture, up to 5 % incombustible solids, and has a heating value of 5 800 kJ/kg as fired.

e) Type 4: Aquatic life forms and animal remains, consisting of carcasses, organs, and solid organic wastes from vessels carrying animal type cargoes.

   This type of waste contains up to 85 % moisture, 5 % incombustible solids, and has a heating value of 2 300 kJ/kg as fired.

f) Type 5: By-product waste, liquid or semi-liquid, such as tar, paints, solvents, sludge oil, and so forth, from shipboard operations.

   BTU values shall be determined by the individual materials to be destroyed.

g) Type 6: Solid by-product waste, such as rubber, plastics, wood waste, and so forth, from industrial operations.

NOTE Energy values (kJ/kg or BTU/lb) has to be determined by the individual materials to be destroyed.

8 Incinerator operations

The normal incineration procedure should be described for a vessel in the technical specification and waste management plan, to define how the incinerator is to be used under normal operating conditions, and to make sure it has enough capacity for the intended use.

Reports from tests performed to meet IMO MARPOL Annex VI or ISO 13617 emission requirements should be considered in capacity calculations.

The sizing of the incinerator should take into consideration the expected daily operational hours, the uncertainty in the calculation of the waste amount and the mixture of the waste. Also, sufficient time for repair and service of the incinerator should be taken into account.

8.1 Solid waste capacity calculation

For solid waste generation, the values in Clause 5 should be considered.

It should be taken into account if the incinerator will be batch fed or has the capability to be sluice fed continuously, or a combination of both. Batch feeding reduces the daily capacity, since the chamber shall be cooled between batches before opening and reloading.

8.2 Machinery sludge oil generation calculation

For engines using heavy fuel oil (HFO), it can be estimated that about 1 % – 2 % of the fuel consumption will end up in the sludge oil tank for incineration, depending on separator capabilities and operational procedures.

The daily generation of sludge oil (SO, in litres) for two-stroke engines can also be estimated by the following formula:

$$SO(daily) = 0{,}182 * kW * (PCT / 100) * 24 \text{ hrs}$$

where

0,182 is a typical constant for two-stroke engines with units of [litres/(kW·hr)];

kW is the ship engine size in brake kW;

PCT is the estimated sludge oil generation.

The formula estimates the amount of sludge generated daily under 24 h transit. If engine size is in horsepower, divide result by 1,36. Suggested minimum PCT value is 1 or 2.

If the main engine runs on MDO, the daily generation of sludge is limited, and sludge oil generation should be positively verified in each case.

Other sources for sludge oil, such as lubricating oil and hydraulic oil, should also be added.

8.3 Capacity calculation when burning both solid waste and sludge oil

The estimated capacity calculation should be the sum of the estimates generated by 8.1 and 8.2 above.

The service tanks for sludge oil should at least have sufficient capacity to hold the daily generation of such waste, as defined by 8.2, received via the sludge oil holding tank.

The flue gas extraction system shall have sufficient capacity to handle stack back pressure under all circumstances, to secure full effect of theoretical incinerator capacity, and to provide personnel and property protection.

Back pressure calculations shall be presented and compared with system abilities.

It is recommended to consult the equipment supplier for advice and verification of calculations.

For optimum efficiency, and to reduce the amount of unburned components in the ashes, it is recommended to incinerate sludge oil first, then all solid waste, and then switch back to sludge oil.

Annex A
(informative)

Alternative disposal of contaminated water

The incinerator(s) can be equipped to utilize heat generated during normal operation to dispose of contaminated water, through injection directly into the combustion chamber.

a) The water can be what normally is destined to end up in the oily water separator or holding tank for sludge oil.

b) The water can be contaminated with the same components as found in sludge oil, mainly oil, and chemicals. No solids.

c) The water is transferred to a water service tank before injection in the combustion process, where levels and consumption can be monitored (for oil record book recording, if necessary) and necessary pre-treatment, if any.

Water injection shall be monitored and controlled by the incinerator controls [e.g. programmable logic controller (PLC)], and not by a separate system.

a) If the system fails to stabilize the chamber temperature at a level where injection can proceed, the water injection should be automatically shut down by the PLC.

b) Injection of water in the combustion chamber should not increase fuel consumption after stabilization.

c) Injection of water should not significantly reduce the incinerator capacity, compared to capacity without this optional equipment.

An incinerator with such optional equipment should be tested and certified according to normal IMO procedures.

It is recommended to seek advice on installation and use of any water injection equipment with the supplier.

Bibliography

[1] ASTM F1322, *Standard Guide for Selection of Shipboard Incinerators*

[2] The Incinerator Institute of America, *Incinerator Institute of America Waste Classification*

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