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Technical Requirement and Assessment Method of Energy Saving Products and Technologies for Marine

船舶节能产品使用技术条件及评定方法

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Technical Requirement and Assessment Method of Energy Saving Products and Technologies for Marine

1 Scope

This Document specifies the use technical conditions, assessment items and methods, test methods, verification methods, and evaluation methods for the marine energy-saving products.

This Document is applicable to the assessment of the use effect of energy-saving products aimed at reducing the energy consumption of various types of internal combustion engine-powered marines.

2 Normative References

The provisions in following documents become the essential provisions of this Document through reference in this Document. For the dated documents, only the versions with the dates indicated are applicable to this Document; for the undated documents, only the latest version (including all the amendments) is applicable to this Document.

GB/T 2820.6 Reciprocating internal combustion engine driven alternating current generating sets - Part 6: Test methods

GB/T 3221 Code for dock and sea trials of diesel-driven inland ships

GB/T 3471 General provisions for programming mooring and sea trials of sea going ships

GB/T 6072.3 Reciprocating internal combustion engines – Performance – Part 3: Test measurements

GB/T 14951-2007 Measurement method of fuel saving technology for automobiles

GB 15097 Measure method for emission pollutant of exhaust gas of marine diesel engine

GB/T 25348-2010 Technical specification of fuel saving products for automobiles

GB/T 30009 Calculation method for energy efficiency design index of ships

GB/T 30010 Method for the verification of energy efficiency design index of ships

CB/T 4147 Measurement methods of fuel consumption rate for marine diesel engines

CB/T 4148 Measurement of thermodynamics parameters for marine diesel engines

3 Terms and Definitions

3.1 Energy saving products and technologies for marine

Products, technologies and processes that have no adverse effects on the marine's rapidity, operating safety, engine power and other main performance and the environment while reducing the energy consumption during the marine's operation.

3.2 Rate of fuel saving

After the use of energy-saving products and technologies for marine, the ratio of the magnitude of the decrease in marine energy consumption to the energy consumption before using energy-saving products and technologies for marine.

3.3 Rate of pollution reducing

After the use of energy-saving products and technologies for marine, the ratio of the magnitude of the decrease in the emission of exhaust pollutants from marine to the emission of exhaust pollutants before the use of energy-saving products and technologies for marine.

3.4 Unit fuel consumption

Fuel consumption per unit mileage of marine in operation.

3.5 Energy efficiency design index obtained from sea trial test

The actual energy efficiency index of the marine is calculated by bringing the data obtained from the actual marine test into the calculation formula of the marine energy efficiency design index.

NOTE: The energy efficiency design index obtained from sea trial test reflects the energy efficiency level of the marine in actual operation.

4 Use Technical Conditions

4.1 Energy saving index

4.1.1 When the comparison test is carried out on the engine bench, the rate of fuel saving shall meet any of the following conditions:

a) The energy-saving rate of the engine propulsion characteristics is no less than 1.5%, and the energy-saving rate of the load characteristics is no less than 1.0%;

4.6.1 For marine energy-saving products applied to engines, when the engine bench test is used for verification, the assessment conditions shall meet the requirements of 4.1.1, 4.2.1, 4.4.1 and 4.5 at the same time.

4.6.2 For marine energy-saving products applied to engines, when the propulsion characteristics of the actual marine engine are used for verification, the assessment conditions shall meet the requirements of 4.1.2a), 4.2.2, 4.4.1 and 4.5 at the same time.

4.6.3 For marine energy-saving products applied to engines, when the load characteristics of the actual marine engine are used for verification, and the assessment conditions shall meet the requirements of 4.1.2b), 4.4.1 and 4.5 at the same time.

4.6.4 The assessment conditions of marine energy-saving products applied to the hull structure shall meet the requirements of 4.1.2c), 4.2.2, 4.3 and 4.4.2 at the same time.

5 Assessment Items and Methods

5.1 Assessment items

5.1.1 Energy saving

The energy-saving performance of marine energy-saving products is assessed by the rate of fuel saving; and the assessment of rate of fuel saving can be obtained by selecting the following methods according to the use and characteristics of the energy-saving products:

a) When the actual marine verification method is adopted, it can be calculated based on the difference between the energy efficiency design index obtained from sea trial test ($EEDI_{ATTD}$) before and after the use of marine energy-saving products; or the difference before and after the unit fuel consumption of the marine under common working conditions;

b) When the actual marine engine or laboratory engine bench verification method is used, it can be calculated according to the average energy-saving rate of the engine propulsion characteristic model, or can be calculated according to the average energy-saving rate of the engine load characteristic model.

5.1.2 Power and rapidity

The power is expressed by the maximum torque comparison coefficient of the engine (K_M), which can be obtained by measuring the maximum torque under the set working condition on the bench engine; the rapidity is expressed by the rapidity comparison coefficient of the marine (K_S), which can be obtained by measuring the speed of the marine under the setting working conditions.

5.1.3 Navigation safety

The navigation safety is represented by the main indicators reflecting the maneuverability and mobility of the marine, including gyration performance, braking performance and Z-type mobility. Among them, the gyration performance is expressed by the gyration coefficient; the braking performance is expressed by the braking coefficient; and the Z-type mobility is expressed by the Z-type overrunning angle coefficient.

5.1.4 Environmental impact

The environmental impact is represented by the rate of pollution reducing. The rate of pollution reducing can be obtained by measuring and analyzing the purification effect of the main harmful components in the exhaust pollutants of the engine, specifically including the rate of pollution reducing of carbon monoxide (R_{CO}), the rate of pollution reducing of hydrocarbons (R_{HC}), the rate of pollution reducing of nitrogen oxides (R_{NOx}) and the rate of pollution reducing of exhaust particle (R_S). It can also be reflected by comparing the unit fuel consumptions or the energy efficiency design index obtained from sea trial test ($EEDI_{ATTD}$).

5.1.5 Other special properties

For energy saving products and technologies for marine, it is also necessary to assess the physical and chemical performance indicators of energy-saving products such as fuel and lubricant additives according to their specific physical state and character.

5.2 Assessment method

5.2.1 The assessment methods mainly include the engine bench method and the actual marine method.

5.2.2 When using the engine bench method for verification, the assessments on energy-saving performance, power performance, environmental impact and other special performance shall be carried out according to the requirements of 5.1.1, 5.1.2, 5.1.4 and 5.1.5.

5.2.3 When the actual marine is used for verification, the assessments on energy-saving performance, environmental impact and other special performances shall be carried out according to the requirements of 5.1.1, 5.1.4 and 5.1.5; meanwhile as per the application characteristics of the energy saving products and technologies for marine, add the assessments on power, rapidity and navigation safety according to 5.1.2, 5.1.3.

6 Test Methods and Verification Methods

6.1 Test methods

6.1.1 Engine bench comparison test

The engine bench comparison test shall include the following test items:

technologies for marine aimed at reducing marine running resistance and improving propulsion efficiency, the test items in 6.1.2c) and 6.1.2f) shall be added according to the working principle or usage characteristics of the energy-saving products.

6.2.4 When carrying out the actual marine verification test of the rate of pollution reducing of the energy saving products and technologies for marine aimed at reducing the marine running resistance and improving the propulsion efficiency, it is not necessary to carry out the test item of the engine exhaust emission pollutant. The rate of pollution reducing can be determined by analyzing the changes in unit fuel consumption or energy efficiency design index obtained from sea trial test.

6.2.5 The test results shall eliminate test errors before evaluation and analysis, and the specific test data processing methods shall comply with the provisions of Appendix C.

7 Assessment Methods

7.1 Assessment principles

Use the comparison method under the same conditions to assess the energy-saving performance, the engine power, the marine rapidity, the navigation safety and the environmental impact of the energy saving products and technologies for marine.

7.2 Assessment of energy-saving items

7.2.1 The energy-saving rate of propulsion characteristics of the bench engine is calculated according to Formula (1); and the energy-saving rate of load characteristics is calculated according to Formula (2):

$$\eta_{et} = \frac{\bar{g}_{et0} - \bar{g}_{et1}}{\bar{g}_{et0}} \times 100\% \qquad \cdots\cdots (1)$$

Where:

η_{et} - energy-saving rate of propulsion characteristics of the engine;

$\bar{g}_{et0}$ – before using the energy saving products and technologies for marine, average fuel consumption rate of propulsion characteristics of the engine, in g/(kW•h);

$\bar{g}_{et1}$ – after using the energy saving products and technologies for marine, average fuel consumption rate of propulsion characteristics of the engine, in g/(kW•h).

$$\eta_{ef} = \frac{\bar{g}_{ef0} - \bar{g}_{ef1}}{\bar{g}_{ef0}} \times 100\% \qquad \cdots\cdots (2)$$

(sea boat) or constant turning diameter (river boat) when the marine is turning under rated working conditions or common working conditions, in m.

7.4.2 The braking performance of the marine is expressed by the braking coefficient and calculated according to the Formula (8):

$$K_Z = \frac{d_{Z1}}{d_{Z0}} \qquad \cdots\cdots (8)$$

Where:

K_Z – braking coefficient of the marine;

d_{Z1} - after using the energy saving products and technologies for marine, the course of the marine's full-speed reversing and stopping test, in m;

d_{Z0} – before using the energy saving products and technologies for marine, the course of the marine's full-speed reversing and stopping test, in m.

7.4.3 The Z-type mobility of the marine is expressed by the Z-type overrunning angle coefficient, and is calculated according to the Formula (9):

$$K_C = \frac{r_{C1}}{r_{C0}} \qquad \cdots\cdots (9)$$

Where:

K_C - Z-type overrunning angle coefficient;

r_{C1} - after using the energy saving products and technologies for marine, Z-type first overrunning angle under rated working conditions or common working conditions, in °;

r_{C0} – before using the energy saving products and technologies for marine, Z-type first overrunning angle under rated working conditions or common working conditions, in °.

7.5 Assessment on environmental impact item

7.5.1 When calculating the rate of pollution reducing of the environmental impact items, the unit of the test parameters shall be consistent before and after using the energy saving products and technologies for marine.

7.5.2 The rate of pollution reducing of the carbon monoxide is calculated according to Formula (10):

$$R_{CO} = \frac{O_{CO} - J_{CO}}{O_{CO}} \times 100\% \qquad \cdots\cdots (10)$$

Appendix A

(Normative)

Comparison Test Method of Engine Bench of Marine

A.1 Test conditions and requirements

A.1.1 The engine used for bench comparison test can be two-stroke or four-stroke marine diesel engine or gas fuel engine.

A.1.2 The technical state of the engine during the test shall meet the requirements specified in the instruction manual; and the fuel and lubricant used for the test shall be the product of the same label and the same batch that is applicable to the test engine.

A.1.3 The test shall be carried out after the engine has run stably for 3 min to 5 min, and the cooling water temperature and engine oil temperature have basically stabilized.

A.1.4 During the comparison test, the temperature difference between the cooling water outlets before and after the engine under the same working conditions shall be no greater than 2°C' and the difference in lubricant temperature shall be no greater than 2°C.

A.1.5 During the comparison test, the difference between the intake air temperature before and after the engine (or the intake air temperature after the intercooler) under the same working conditions shall not exceed 2°C; and the difference between the exhaust back pressure shall not exceed 2kPa.

A.1.6 During the comparison test, the difference in fuel inlet temperature under the same working conditions shall be no greater than 2°C.

A.1.7 Bench verification test is carried out by comparison test method, that is, under the same environment, using the same label and the same batch of fuel and lubricant, measure the engine output power, fuel consumption, and power and environmental impact before and after using energy saving products and technologies for marine. The main test parameters include torque, power, speed, fuel consumption, etc., and the components of the specified exhaust pollutants.

A.1.8 Bench test equipment and performance shall meet the following requirements:

a) The bench test system has the functions of automatic collection, storage and processing of measurement parameters;

b) Torque measurement tolerance is ±0.5%; rotational speed measurement tolerance is ±0.2%; fuel consumption measurement tolerance is ±0.5%;

c) The monitoring of environmental parameters complies with the provisions of GB/T

Appendix B

(Normative)

Comparison Test of Actual Marine

B.1 Test conditions

B.1.1 When the sea boat is subjected to the comparison test of actual marine, the test conditions shall comply with the provisions of GB/T 3471.

B.1.2 When the river boat is subjected to the comparison test of actual marine, the test conditions shall comply with the provisions of GB/T 3221.

B.1.3 The comparison test shall be carried out under the condition of the same marine with the same configuration and the same loading state, the front and rear marine's floating states shall be consistent; and the engine shall use the same label and the same batch of fuel and lubricant.

B.1.4 Before and after the comparison test, the water flow conditions and environmental conditions in the test water area shall be basically the same. The engine test conditions shall be kept consistent; and the relevant thermal parameters of the engine under the same condition shall be controlled basically the same.

B.1.5 The main performance of the actual marine test instruments is to meet the following requirements:

a) The test parameters of the actual marine mainly include but not limited to the shaft power of the main engine, the output electric power of the generating set, the fuel consumption (mass or volume) of the main and auxiliary engines, temperature and humidity, atmospheric pressure, fuel density, speed, gyration diameter, braking distance, Z-type overrunning angle, etc.;

b) Torque measurement tolerance is ±1.0%; speed measurement tolerance is ±0.5%; fuel consumption measurement tolerance is ±0.5%;

c) The measuring instruments, equipment and performance of engine exhaust pollutants comply with the provisions of GB 15097;

d) The test of thermal parameters related to engine operation complies with the provisions of CB/T 4148;

e) The electric power test output by the generating set complies with the provisions of GB/T 2820.6;

f) The speed test of sea boat shall be carried out according to the provisions of GB/T 3471,

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