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Components of diesel engine for locomotive and DMU - Part 8: Turbocharger

机车、动车组柴油机零部件 第 8 部分：增压器

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Components of diesel engine for locomotive and DMU - Part 8: Turbocharger

1 Scope

This Part of TB/T 3475 specifies the terms and definitions, technical requirements, inspection methods, inspection rules, marking, packaging, transport, storage of the axial-flow turbocharger, which is used in the diesel engine for locomotive and DMU (hereinafter referred to as turbocharger).

This Part applies to turbochargers, which is used in the diesel engine for locomotive and DMU.

2 Normative references

The following documents are essential to the application of 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 standard.

GB/T 191 Packaging - Pictorial marking for handling of goods (GB/T 191-2008, ISO 780: 1997, MOD)

GB 253-2008 Kerosene

GB/T 1786 Forging tortillas ultrasonic testing method

GB/T 4118-2008 Trichloromethane for industrial use

GB/T 6402-2008 Steel forgings - Method for ultrasonic testing

GB/T 6519 Ultrasonic inspection of wrought aluminium and magnesium alloy products

GB/T 13306 Plate

GB/T 21563-2018 Railway applications - Rolling stock equipment - Shock and vibration tests (IEC 61373:2010, MOD)

HB/Z 60 Radiographic inspection

HB/Z 61 Penetrant inspection

The speed of turbocharger, which is greater than or equal to 110% of the rated speed, AND at which the turbocharger can safely run continuously for more than 24 hours.

3.7

Maximum gas inlet temperature

The maximum temperature, at which the turbine can work safely for a long time.

4 Technical requirements

4.1 Requirements for working environment

4.1.1 The diesel engine power, which is matched by the turbocharger, under the following environmental conditions, does not need to be corrected:

a) The altitude is not higher than 1500 m;

b) Atmospheric ambient temperature: -40 °C ~ +40 °C.

4.1.2 When the turbocharger is used in an area above 1500 m above sea level OR the atmospheric temperature is greater than +40 °C, the influence of atmospheric pressure and ambient temperature in the area shall be considered.

4.1.3 When it exceeds the scope specified in 4.1.1 and 4.1.2, it shall be determined, through negotiation between the supplier and the buyer.

4.1.4 The maximum intake vacuum of the turbocharger shall be less than or equal to 4 kPa; the maximum exhaust back pressure of the turbocharger shall be less than or equal to 3 kPa (except for those with exhaust gas aftertreatment system).

4.2 Basic requirements

4.2.1 The turbocharger shall be manufactured, in accordance with the product drawings and technical documents, which are approved by the prescribed procedures. It shall comply with the provisions of this Part.

4.2.2 The main parts of the turbocharger (main shaft, turbine disc, turbine blade, integral casting turbine, wind guide wheel, compressor impeller) shall be subject to non-destructive testing; the results shall comply with the provisions of the technical documents.

4.2.3 The shell, which is equipped with cooling water cavity, shall not leak; repair is not allowed.

4.2.4 The outlet area or code of the nozzle ring of the turbocharger, AND the area or code of the inlet throat of the diffuser shall comply with the provisions of the relevant

technical documents. Such information shall be engraved in the designated position AND recorded in the exit-factory documents.

4.2.5 The assembly clearance of the turbocharger and its main components shall comply with the provisions of the product drawings or technical documents.

4.2.6 After the initial operation test of the turbocharger, there shall be no abnormality.

4.3 Performance requirements

4.3.1 After carrying out the vacuum prestressing overspeed test at room temperature for the center perforated compressor impeller and turbine disc, the deformation of the inner hole shall meet the requirements of the technical documents.

4.3.2 The cleanliness of the turbocharger is the total weight of impurities, which are contained in the lubricating oil passages in and out of each turbocharger AND the surfaces of the parts in contact with the lubricating oil; the cleanliness limit is 400 mg/set.

4.3.3 The dynamic balance accuracy of the guide wheel, compressor impeller, bladed shaft, rotor assembly of the turbocharger shall comply with the provisions of the product drawing.

4.3.4 The oil inlet temperature of the turbocharger is related to the quality of the oil used by the diesel engine. It shall be adapted to the requirements of the matching diesel engine.

4.3.5 Performance requirements of the turbocharger's calibration operating point:

a) When the rotational speed is less than 20000 r/min, the rotational speed deviation shall be controlled within the range of ±100 r/min. When the rotational speed is greater than or equal to 20000 r/min, the rotational speed deviation shall be controlled within the range of ±0.5% of the specified value.

b) The pressure ratio deviation shall be controlled within the range of ±1.5% of the specified value.

c) The air flow deviation shall be controlled within ±2% of the specified value.

d) The total efficiency of the turbocharger shall be greater than or equal to the specified value; the specified value shall not be lower than 58%.

4.3.6 After the turbocharger is tested at the highest speed, there shall be no damage to parts or appearance deformation; there shall be no looseness, air leakage, oil leakage or water leakage at the connection.

4.3.7 When the turbocharger is running under the calibration condition, the ratio -- of the calibration flow TO the air flow value at the surge point at the equal pressure ratio

5.1.5 Ultrasonic inspection of turbine disc blanks shall be carried out, in accordance with GB/T 1786.

5.1.6 The X-ray inspection of turbine blade blanks and integrally cast turbine blanks shall be performed, according to HB/Z 60.

5.2 Vacuum prestressing overspeed test at room temperature

The compressor impeller and turbine disc, which have central perforation, shall be subjected to the vacuum prestressing overspeed test at room temperature. The overspeed speed shall be greater than or equal to 110% of the maximum speed; the test time shall not be less than 3 minutes.

5.3 Cleanliness inspection

Carry out cleanliness inspection, according to Appendix A.

5.4 Rotor dynamic balance inspection

Carry out the rotor dynamic balance inspection, according to the provisions of Chapter 9 in JB/T 9752.3-2014.

5.5 Housing tightness inspection

The housing, which is equipped with cooling water cavity, can be subject to tightness test by hydraulic or pneumatic pressure. During the tightness inspection by hydraulic pressure, the hydraulic pressure shall not be lower than 700 kPa; the pressure shall be maintained for 5 minutes. During the tightness inspection by pneumatic pressure, the air pressure shall be 1.5 times the working pressure; the pressure shall be maintained for 15 minutes.

5.6 Initial running test

The turbocharger uses the external air source cold-blowing or self-circulation mode, for running-in operation; the test speed is 25% ~ 30% of the calibration speed; the duration shall be greater than or equal to 10 minutes. Check the operation of the turbocharger and the sealing state of each flange connection. The operation of the turbocharger shall be normal; there shall be no leakage at the connection.

5.7 Calibration point test

After the cold blowing, the hot air test is carried out. The self-circulation method is used, to increase the speed of the turbocharger. When the speed reaches the calibration speed, let it run stably for 10 minutes; record the performance parameters of the turbocharger. There shall be no abnormal phenomenon during operation.

5.8 Maximum speed test

The turbocharger shall be tested according to the maximum speed; the running time shall be greater than or equal to 10 min.

5.9 Idling test

When the speed of the turbocharger is 60% of the rated speed, gradually reduce the oil pressure to the minimum oil pressure; the deviation is ±50 kPa. Cut off the fuel supply, to carry out the idling test; measure the idling time.

5.10 Compressor characteristic test

5.10.1 The test shall be carried out on the compressor test bench or the turbocharger test bench, by the external air source; OR the self-circulation method can also be used for the test. Test various parameters, according to Table B.2 of Appendix B. Calculate the main performance parameters of the compressor, according to the calculation formula in B.5. Draw the compressor performance curve, according to Figure B.1 of Appendix B.

5.10.2 The speed and flow division methods are as follows:

a) Carry out division according to the iso-speed line: The minimum starting speed shall not be higher than 40% of the calibrated speed; then make an iso-speed line every 1000 r/min ~ 3000 r/min, until the maximum speed. There shall be no less than 6 iso-speed lines;

b) Carry out division according to flow measuring points: Starting from the surge point, divide by flow on each iso-speed line; there shall be not less than 5 measuring points.

5.11 Turbine characteristic test

The external air source method can be used on the turbocharger test bench or combined with the performance test of the compressor. The compressor can be used as a dynamometer, to measure various parameters of the compressor and turbine ends. Test various parameters, according to Table B.2 of Appendix B. Calculate the main performance parameters of the turbine, according to the calculation formula in B.5. Draw the turbine performance curve, according to Figure B.2 of Appendix B.

5.12 Lubricating oil seal test

Use external air source for blowing; the test speed is 3000 r/min (the inlet oil temperature is 55 °C ± 5 °C; the oil pressure is the upper limit of the design value). Shut down after running for 10 minutes. Check whether there are oil traces on the compressor end and the turbine end.

5.13 100-h test

6.3.2 Inspection sequence: Initial running test, calibration operating point test, maximum speed test, idling test, lubricating oil seal test.

6.3.3 The exit-factory inspection can be carried out again, in the following cases:

a) If a certain inspection item is found to be unqualified during the inspection, after debugging or repairing;

b) If the parts are found to have defects such as cracks and serious scratches during the inspection, after the damaged parts are replaced.

6.4 Type inspection

6.4.1 Scope of inspection

If it falls under any of the following circumstances, type inspection shall be carried out:

a) When the new product is finished of trial production;

b) When the trial production of the products, after trans-plant production, is completed;

c) When there are major changes in product structure, process or materials, that affect performance and safety;

d) When the continuous production is more than 5 years (or the production volume is 1000 sets);

e) When production resumes, after 2 years of shutdown.

6.4.2 Inspection procedure

6.4.2.1 The following inspection record documents shall be provided, for the turbocharger subject to type inspection:

a) Rotor's dynamic balance inspection record;

b) Inspection and inspection records of the main shaft, turbine disc, turbine blade or integrally cast turbine, air guide wheel, compressor impeller;

c) Inspection records of the rotor's axial movement, the clearance between the air guide wheel and the compressor impeller and the casing, the clearance between the turbine blade and the insert;

d) Inspection report on material chemical composition and mechanical properties of main shaft, turbine disc, turbine blade or integrally cast turbine, air guide wheel, compressor impeller;

e) Inspection records of the dimensions of the main shaft, turbine disc, turbine blade or integrally cast turbine, air guide wheel, compressor impeller;

f) Process inspection record of turbocharger;

g) Exit-factory inspection records of turbocharger.

6.4.2.2 Inspection sequence: Initial operation test, compressor characteristic test, turbine characteristic test, calibration operating point test, 100 h test, structural verification test, calibration operating point test (verification), dismantling inspection, vibration test, dismantling inspection.

6.4.3 Sampling

During the type inspection, a turbocharger that has passed the exit-factory inspection shall be randomly selected. The turbocharger for vibration test may not be the same as the turbocharger for other items of type inspection.

6.4.4 Judgment rules

6.4.4.1 During the type inspection, the number of test suspensions, due to non-turbocharger failure (air leakage, oil leakage or water leakage), shall not exceed one; the suspension time shall not exceed 60 min. At the same time, the test time of the turbocharger shall be extended, according to the suspension time accordingly. If the suspension time exceeds 60 minutes, the type inspection will be deemed invalid.

6.4.4.2 In the process of type inspection, if one of the following situations occurs, the product is judged to be unqualified:

a) The performance index of the calibration operating point does not meet the requirements of the specified index;

b) During the 100-h test and the structural verification test, the main components are damaged, so that the test cannot be continued;

c) During the test, there is oil, gas, water leakage, which cannot be recovered after treatment;

d) During the dismantling inspection, it is found that the main parts have cracks or serious abrasions, OR there are oil stains on the outside of the oil seal disc.

7 Marking, packaging, transport, storage

7.1 Marking

Each turbocharger shall be provided with a sign. The type and size of the sign shall comply with the provisions of GB/T 13306. Its contents shall at least include:

A.1.2.4 Clean containers, such as cups, plates, pots, buckets with lids.

A.1.2.5 Magnets, magnifying glasses, tweezers (flat ends without teeth).

A.1.3 Filter elements

A special white microporous filter membrane, which has a size of 5 μm and a diameter of 50 mm.

A.1.4 Cleaning solution

Use kerosene in compliance with GB 253-2008 or chloroform specified in GB/T 4118-2008.

A.2 Sampling

A.2.1 Randomly select the cleaned parts and carry out the sampling work, for cleanliness determination. The sampling can be carried out, on the production site.

A.2.2 The cleaning solution, which is used for sampling, shall be pre-filtered; the containers and tools shall be clean.

A.2.3 The sampling method shall use the following two:

a) Sampling by rinsing method: It is suitable for oil channel sampling. It should carry out repeated rinsing, along the actual working flow of the oil or fuel; use a container, such as a funnel, to collect the cleaning fluid with impurities, after flushing.

b) Sampling by scrubbing: It is applicable to other parts, except oil passages. Center the finished product into the bucket, so that it does not touch the sides of the bucket. Use the cleaning solution to flush the outer surface and inner holes of the part, whilst using the nylon brush to repeatedly scrub it.

A.2.4 When sampling, the cleaning solution with impurities shall be prevented from splashing out of the container.

A.2.5 At the end of sampling, collect all the cleaning solutions with impurities separately; mark them, including the sampling date, part number, sampling location.

A.3 Preparations for determination

A.3.1 The cleanliness measurement shall be carried out, in a dedicated cleanliness testing room. The room shall be clean (the amount of dust falling within 24 hours is not more than 60 mg/m^2); it is well ventilated and has reliable safety facilities.

A.3.2 Operators shall wear clean clothes, hats, shoes; wash hands before operation.

A.3.3 All measuring instruments and work surfaces shall be clean.

A.3.4 The sampling container shall be cleaned, to ensure that there is no dust and debris.

A.3.5 The cleaning solution, which is used for testing, shall be filtered through a 5 μm membrane.

A.3.6 The constant weight treatment of the filter element is as follows:

a) Use tweezers, to put the filter membrane into the weighing bottle with the cap open. Place the cap together with the bottle cap in an electric heating constant temperature oven, that has been heated to 90 °C ± 5 °C, for 10 min ~ 15 min;

b) Close the weighing bottle cap. Take it out and put it in a desiccator for 10 minutes, to cool down to room temperature;

c) Weigh on an analytical balance. Record the weight of the filter membrane;

d) Repeat the whole process, until the weighing difference between the two drying operations, is not more than 0.4 mg;

e) The average value of the two weighing is the constant weight value of the filter membrane.

A.3.7 Weigh the constant weight G_1 of 5 μm clean filter membranes, according to the method in A.3.6.

A.4 Determination method

A.4.1 Filtration of impurities

Filter the cleaning solution with impurities, which is collected in the process of A.2, as follows:

a) Use tweezers, to take the clean filter membrane that has been weighed in A.3.7 out of the weighing bottle. Wet it in the filtered cleaning solution. Then place it tightly on the glass sand core of the M50 type glass sand core filter device. Use a metal clip, to clamp the butt of the sand core. Place it on the suction filter bottle (see Figure A.1). Connect the vacuum pump;

b) Pour the cleaning solution with impurities into the funnel, for vacuum filtration;

c) After the suction filtration of all the dirty liquid is completed, use the cleaning solution to rinse the inner wall of the funnel and the filter membrane several times, to ensure that all impurities are filtered;

d) After the cleaning solution evaporates, use tweezers, to put the filter membrane with impurities into the original weighing bottle, to prepare for weighing.

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