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Turbochargers - Part 1: General requirements

涡轮增压器 第 1 部分:一般技术条件

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Turbochargers - Part 1: General requirements

1 Scope

This Part of GB/T 23341 specifies the terms and definitions, technical requirements, inspection items, inspection rules, marking, packaging, transportation and storage for the radial and mixed-flow turbochargers (hereinafter referred to as "the supercharger").

This Part applies to the superchargers for internal combustion engines (including diesel engines, gasoline engines, natural gas engines) for vehicles, ships, construction machinery, agricultural and forestry machinery, power generation and other purposes.

This Part does not apply to axial-flow superchargers.

2 Normative references

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

GB/T 727, *Turbocharger nomenclature and code*

GB/T 1804-2000, *General tolerances - Tolerances for linear and angular dimensions without individual tolerance indications*

GB/T 2828.1, *Sampling procedures for inspection by attributes - Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

GB/T 6414, *Castings - Dimensional tolerances and geometrical tolerances and machining allowances*

GB/T 25364.1-2010, *Turbocharger seal rings - Part 1: General specifications*

GB/T 26549-2011, *Turbocharger variable nozzle ring - General specifications*

JB/T 6002-2007, *Turbochargers. Limit values and measurement methods for cleanliness*

JB/T 9752.3, *Turbochargers - Part 3: Balance quality requirements and check methods of rotors*

JB/T 11325-2013, *Internal combustion engines turbochargers actuator. Specifications*

The range of the compressor flow area in the area included in the compressor efficiency $\eta_c \geq 0.60$.

3.15 maximum parameter

The maximum working speed n_{max} and the maximum turbine inlet temperature T_{Tmax} that allow the supercharger to be used for a long time as specified in the supercharger technical documents.

4 Technical requirements

4.1 General

Turbocharger products shall be manufactured according to the product drawings and technical documents approved by the prescribed procedures.

4.2 Matching requirements for supercharger products

4.2.1 The model compilation of supercharger products shall comply with the provisions of GB/T 727.

4.2.2 The supercharger manufacturer shall provide users with the main technical parameters and usage requirements of supercharger products.

The main technical parameters and usage requirements are as follows:

a) Product model;

b) Connection dimension drawing for supercharger outline installation;

c) Supercharger net mass;

d) For superchargers with bypass valves or other adjustment mechanisms, the setting parameters and adjustment methods of the actuator shall be provided;

e) Main performance parameters of the supercharger: compressor pressure ratio, compressor flow range, compressor efficiency range, maximum working speed, maximum turbine inlet temperature, turbine efficiency and total turbocharger efficiency and so on;

f) Lubricating oil designation, lubricating oil inlet pressure range and oil filter requirements;

g) For the superchargers with cooling water system, the requirements for cooling water installation and usage shall be provided;

h) For superchargers with electronic components, the requirements for the use of

electronic components shall be provided;

i) Instruction manual for supercharger products.

4.3 Supercharger manufacturing requirements

4.3.1 The compressor impeller blank of the supercharger shall comply with the provisions of Chapter 3 of JB/T 11786-2014.

4.3.2 The turbine impeller blank of the supercharger shall comply with the provisions of Chapter 3 of JB/T 11787-2014. When newly designed and manufactured, the first-order natural frequency and dispersion limits of turbine (finished) blades:

$$f_{min} > 5n_{max}$$

$$\delta < 8\%$$

$$\delta = \frac{f_{max} - f_{min}}{(f_1 + f_2 + \cdots + f_n)/n} \times 100\% \quad \cdots\cdots (12)$$

Where,

f_{max} - The maximum value of the first-order natural vibration frequency of the turbine blade, in Hertz [Hz] (Hz);

δ - The first-order natural vibration frequency dispersion of the turbine blade;

f_{min} - The minimum value of the first-order natural vibration frequency of the turbine blade, in Hertz [Hz] (Hz);

n_{max} - The maximum speed of the supercharger, in revolution per second (r/s);

f_1, f_2, …, f_n - The first-order natural vibration frequency value of the first blade, the second blade, …, the nth blade of the turbine, in Hertz [Hz] (Hz).

4.3.3 The nozzle ring of the supercharger shall comply with the provisions of Chapter 4 of GB/T 26549-2011.

4.3.4 The actuator of the supercharger shall comply with the provisions of Chapter 3 of JB/T 11325-2013.

4.3.5 The sealing ring of the supercharger shall comply with the provisions of Chapter 5 of GB/T 25364.1-2010.

4.3.6 The flow capacity of the turbine box (shell) of the supercharger shall be based on the sample turbine shell. The allowable deviation shall comply with the provisions of Table 1.

Table 1 -- Deviation of turbine shell flow capacity from prototype turbine shell

Compressor impeller diameter/mm	<70	≥70~100	>100
Turbine shell flow capacity	±3%	±3%	±2.5%

4.3.7 The turbine rotor and compressor impeller of the supercharger shall be tested for single-piece dynamic balance. The rotor assembly shall be tested for combined balance. Balance quality shall meet the requirements of JB/T 9752.3. When the overall dynamic balancing machine or the shell vibration test is used, the rotor assembly may not be tested for combined balance. The overall dynamic balance or casing vibration test requires that the allowable vibration speed value at the rated speed of the turbocharger shall be ≤4.5mm/s.

4.3.8 Before the supercharger is assembled, the parts shall be cleaned. The cleanliness of the whole turbocharger shall comply with the provisions of Chapter 3 of JB/T 6002-2007.

4.3.9 The supercharger assembly shall comply with the regulations of product drawings and technical documents. The rotor shall rotate flexibly. Abnormal noise and jamming are not allowed.

4.3.10 For superchargers with bypass valves or other adjustment mechanisms, the operating parameters of the actuators shall be adjusted to meet the range specified in the technical documents.

4.3.11 The appearance of the supercharger shall be kept clean. The outline shall be complete and beautiful. There are no casting defects such as cracks and slag inclusions on the surface of the casting. If the outer surface is painted, the paint is required to be firm and bright. Peeling, falling-off and paint leakage are not allowed. All oil, gas and water inlets and outlets of the supercharger shall be equipped with effective sealing measures. The packaging shall be complete and firm.

4.3.12 The supercharger dimensions and shape as well as position tolerance requirements shall comply with the scope specified in the technical documents of the drawings. If it is not noted with dimensional tolerances, it is implemented according to level C in GB/T 1804-2000. The casting dimensional tolerance of the unmarked blank surface shall be implemented according to the casting dimensional tolerance CT 10 in GB/T 6414.

4.4 Main performance requirements for the supercharger

4.4.1 Compressor performance of the supercharger

Under the same compressor conversion rotate speed n_{cnp}, the compressor efficiency, compressor pressure ratio and compressor conversion flow shall conform to the compressor performance benchmark curve. The allowable deviation range shall comply with the provisions of Table 2.

Table 2 -- Compressor performance deviation of the supercharger

After 200h reliability and durability thermal cycle test, dismantle and inspect the supercharger. Check the performance changes before and after the reliability test of the supercharger and the wear of key parts:

a) Before and after reliability test, compare compressor performance with turbine performance or self-circulation performance. All performance deviations are allowed to be within ±3%;

b) The turbine rotor shall rotate flexibly without sticking;

c) There is no oil leakage at the compressor end and turbine end;

d) Compressor impeller and turbine blades have no rubbing and flying cracks. Impeller blades are free of cracks and deformations;

e) All outer surfaces of the turbine casing are free of cracks. There shall not be more than 3 cracks on the partition wall of the inner flow channel. Depth is ≤1mm. The length does not penetrate one-third of the wall thickness of the outer wall;

f) The wear of key parts such as floating bearings, thrust bearings, rotor journals, and seals is less than 80% of the design maximum allowable wear.

4.4.9 Supercharger tightness

The tightness of the supercharger shall meet:

a) The static seal shall meet the requirements of 3.5 in JB/T 12335-2015;

b) The turbocharger is not equipped with an air filter at the compressor end. When the total intake pressure p_i^* ≥-8kPa, the compressor end does not leak oil.

5 Inspection items

Turbochargers are manufactured according to approved product drawings and technical documents. Inspect according to the content specified in Table 8.

6.2 Type inspection

6.2.1 Before being put into mass production, the manufacturer's inspection for the manufacturing requirements, performance measurement and reliability test of the supercharger with new design or major changes in the structure or material of the main components is called type inspection.

6.2.2 The items of type inspection shall be as specified in Table 8.

6.2.3 During the type inspection, the number of randomly selected samples is 2. Carry out various tests according to items 1~13 and item 17 in Table 8. Randomly select 1 prototype for the item 14 test in Table 8. Take 3 or more prototypes respectively and carry out the tests according to items 15 and 16 in Table 8.

6.3 Spot inspection

6.3.1 The inspection of the product by the manufacturer, customer or quality inspection agency within the specified time (or batch) according to the technical documents is called spot inspection.

6.3.2 Items for the spot inspection are according to the provisions of Table 8.

6.3.3 The number of prototypes for spot inspection is 1 to 2. When the customer is conducting the spot inspection, if the manufacturer and the customer have reached an agreement, the agreement shall be implemented according to the agreement between the two parties. When the quality inspection agency conducts the spot inspection, it shall be carried out in accordance with the regulations of the quality inspection agency.

6.3.4 Spot inspection for compressor performance and turbine characteristic tests: For mass-produced superchargers (same series models), when the monthly output is not less than 1,000 units, the spot test shall be carried out once every six months. When the monthly output is less than 1000 units, the spot inspection shall be carried out once a year. The performance test curve shall not be less than two isorotation lines, including the product design (highest) parameters and the highest compressor efficiency. The number of inspected prototypes is 1.

6.3.5 Spot inspection for supercharger self-circulation performance test, supercharger noise test, and supercharger cleanliness measurement: For mass-produced superchargers (same series models), when the monthly output is not less than 1000 units, the spot inspection shall be carried out once every month. When the monthly output is less than 1000 units, the spot inspection shall be carried out once every three months. The number of inspected prototypes is 2.

7 Marking, packaging, transportation and storage

7.1 Marking

7.1.1 Product marks

Each supercharger shall have a nameplate or product mark engraved on the obvious part, including:

a) Product name;

b) Product model;

c) Product number, assembly number or customer number;

d) Manufacturer's name, trademark.

7.1.2 Packing box marks

The contents to be marked on the outside of the packing box include:

a) Product name, model, quantity, date of manufacture, and implementation standard number;

b) Product number, assembly number or customer number;

c) Packing box size: length (mm) × width (mm) × height (mm);

d) Total mass, in kg;

e) Manufacturer's name, address, telephone;

f) Rain and moisture proof, sign of putting upward and careful handling.

7.2 Packaging

7.2.1 The oil inlet and outlet, air inlet and outlet, and water inlet and outlet of the supercharger shall be equipped with caps or plugs.

7.2.2 The supercharger is packaged in two layers inside and outside. The inner packing is plastic film bag. The outer packaging shall be firm and can reliably fix the supercharger. Carton packaging shall have reliable sealing measures.

7.2.3 The supercharger shall be accompanied by the product certificate, product instruction manual, exit-factory inspection sheet and warranty card. If there are spare parts or multiple units in one box, a packing list is required, which shall be put into the packing box together.

7.3 Transportation

Superchargers are allowed to be transported by normal vehicles. During transportation, prevent sunlight, rain, violent collision. They shall be lightly placed and unloaded.

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