GB

NATIONAL STANDARD OF THE

PEOPLE'S REPUBLIC OF CHINA

ICS 29.160.30

K 21

GB/T 24625-2009

Guide for the design and application of synchronous motors for converter supply

变频器供电同步电动机设计与应用指南

Issued on: November 30, 2009 **Implemented on: April 01, 2010**

Issued by: General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China;
Standardization Administration of the People's Republic of China.

Table of Contents

Guide for the design and application of synchronous motors for converter supply

1 Scope

This Standard specifies the ratings, structure types, performance requirements, cooling methods, test methods and acceptance rules of three-phase or multi-phase synchronous motors powered by converters, and also includes requirements for converters.

This Standard applies to synchronous motors driven by variable frequency power supplies. Anything not specified in this Standard shall comply with the relevant provisions in GB 755.

2 Normative references

The following documents contain the provisions which, through reference in this Standard, become the provisions of this Standard. For dated references, their subsequent amendments (excluding corrigendum) or revisions do not apply to this Standard. However, the parties who enter into agreement based on this Standard are encouraged to investigate whether the latest versions of these documents are applicable. For undated reference documents, the latest versions apply to this Standard.

GB 755 Rotating electrical machines - Rating and performance (GB 755-2008, IEC 60034-1:2004, IDT)

GB/T997 Rotating electrical machines - Classification of types of construction mounting arrangements and terminal box position (IM Code) (GB/T 997-2008, IEC 60034-7:2001, IDT)

GB/T 1993 Cooling methods for rotating electrical machines (idt GB/T 1993-1993, IEC 60034-6:1991)

GB 1971 Rotating electrical machines - Terminal markings and direction of rotation (GB/T 1971-2006, IEC 60034-8:2002, IDT)

GB/T 4942.1 Degrees of protection provided by the integral design of rotating electrical machines (IP code) - Classification (GB/T 4942.1-2006, IEC 60034-5:2000, IDT)

GB 10068 Mechanical vibration of certain machines with shaft heights 56 mm and higher-measurement evaluation and limits of vibration severity (GB 10068-2008, IEC 60034-14:2007, IDT)

Frequently used short-term overload capability refers to the ability of a motor to repeatedly withstand a load exceeding the rated load, which is regarded as part of a regular duty cycle.

After short-term overload operation, the motor must be operated with light load to ensure that the root-mean-square load value of the motor during the entire load cycle does not exceed the continuous rating. At the same time, the short-term overload operation time shall be limited to a certain range that does not exceed the rated temperature rise to ensure the insulation life.

3.3 Basic operating performance of converter-powered synchronous motors

The corresponding harmonic content in the voltage or current of a converter-powered motor is different from that when running on a sinusoidal power supply, so it is important to analyze the impact of torque reduction and oscillating torque caused by harmonics on the basic operating performance of the drive. Only by understanding the spectrum of the converter's output current and/or voltage can the motor manufacturer calculate the details about the additional torque (especially oscillating torque) and losses generated during operation of the motor and the impact of harmonics on the winding temperature rise. This is so different from the design of the effective part of the motor in the range of GB 755 that each reduction factor must be determined before selection. When intermittent, periodic, or variable-load working systems are adopted, the time rating shall be a continuous rating and be based on a thermal effect close to that encountered in actual use.

3.4 Multi-phase variable frequency synchronous motors

An a.c. motor that uses a multi-phase variable frequency power supply and has a constant ratio between the frequency of its electromotive force and the motor speed. Commonly used phase numbers are 6, 12 and 15.

3.5 Classification of converters

As a power supply, converters can be divided into two types: voltage source type and current source type. For a.c.-d.c.-a.c. converters, if the filter capacitor is connected in parallel with the d.c. intermediate link, it is a voltage source type; if the filter inductor is connected in series with the d.c. intermediate link, it is a current source type. For a.c.-a.c. converters, it does not have an obvious d.c. intermediate link, but it is also divided into voltage source type and current source type to meet the needs of the load. Usually, the internal resistance of a.c.-a.c. converters is very small, and most of them are voltage source types.

3.6 Commutation reactance X_C

Reactive component of commutation impedance. Reactance that effectively prevents current transfer between converter circuit elements of one or a batch of commutation groups. For converter-powered salient-pole synchronous motors:

$$X_C = \frac{X''_d + X''_q}{2}$$

In the formula, X''_d and X''_q are the y-axis and x-axis super-transient reactance (unsaturated value) of each phase corresponding to the rated voltage, rated current and rated frequency, respectively.

4 Matching of motors and converters

4.1 Variable frequency power supplies

When selecting a variable frequency power supply, the following factors shall be considered, and a certain margin shall be left in the capacity of the power supply.

a) Variable frequency power supplies are generally configured according to continuous load current capacity, short-term load current capacity and peak current capacity. In the selection, it shall appropriately control the size of the specification, the peak value and instantaneous value of the current, the root-mean-square value of the motor current and the operation mode of the system.

b) When the motor and its control system are used for loads where sudden changes in torque or frequency may occur, the selection of the current size shall take into account the maximum transient current peak caused by the sudden change.

c) When the required operating speed of the motor changes, and the change in power frequency is greater than the change in motor speed, the effective current or peak current output by the control system may exceed the requirements of the steady state.

d) When the motor is running at low speed or overload, the motor loss increases and the efficiency decreases, so the power supply must ensure the operating requirements of the motor.

e) du/dt of the output power supply of the converter is not greater than 3 kV/μs.

4.2 Converter-powered synchronous motors

When designing and selecting a variable frequency motor, the following factors shall be considered.

a) The insulation of the motor is generally designed according to 2 times the rated voltage, and the motor shall be able to withstand the voltage gradient impact with du/dt of 3 kV/μs caused by the variable frequency power supply. The insulation of motors controlled by pulse width modulation (PWM) shall comply with the requirements of IEC 60034-18-42.

The noise of motors does not exceed the maximum allowable value specified in GB 10069.3.

The allowable vibration value of motors is as follows:

a) For those with the rotation speed of 600 r/min and above, it shall not exceed the maximum allowable value specified in GB 10068.

b) For those with rotation speed below 600 r/min, the double-amplitude vibration value shall not exceed 0.075 mm.

4.4 Commutation reactance X_C limits

The commutation reactance X_C is closely related to the air gap torque, stator current fluctuation, additional loss, vibration and noise, and determines the dynamic response of the motor.

For voltage source type converters, X_C (p.u.) = 0.15 ~ 0.20

For current source type converters, $0.08 \leq X_C$ (p.u.) ≤ 0.1

5 Classification of converter-powered synchronous motors

5.1 Variable frequency synchronous motors for general industrial use

This type of motors is used to adjust the load by adjusting the mechanical speed of the motor to achieve energy saving effects. It is mainly used for loads such as fans and water pumps, generally of S1 working system.

5.2 Variable frequency synchronous motors for loads such as hoists

This type of motors has a continuous cycle S8 working system in which the load and speed change accordingly.

5.3 Synchronous motors for metal rolling mills

5.3.1 Synchronous motors for metal finishing mills

This type of motors generally operates in one direction, but can also be designed to operate in two directions if necessary. This type of motors for rolling mills generally have the following special requirements:

a) There is sufficient margin for temperature rise under rated load: Under the rated working conditions and 100 % of the rated load, the temperature rise of the motor is assessed according to Class 130 (B) insulation;

6 Structure types, degree of protection, cooling methods and lubrication methods of motors

6.1 Motor structure and installation types: According to GB/T 997, most are installed horizontally or vertically, using sliding bearings or rolling bearings.

6.2 Degree of protection: According to GB/T 4942.1, generally IP23, IP44 or IP54, etc.

6.3 Cooling methods: According to GB/T 1993, generally IC86W or IC37.

6.4 Lubrication methods: Sliding bearings are mostly lubricated with hydrostatic oil, and rolling bearings are lubricated with oil or grease.

7 Technical requirements for motors

7.1 The insulation grade is Class 155 (F).

7.2 The rating is a continuous rating based on the S1 work system.

7.3 Normal operating conditions:

7.3.1 The altitude does not exceed 1000 m.

7.3.2 The ambient temperature shall be between 0 °C and 40 °C. The cooling air does not contain acid, alkali and salt harmful gases. The dust content in the air shall not exceed 0.15 mg/m^3.

7.3.3 Rated voltage:

Commonly used rated voltage levels are: 600 V, 690 V, 1200 V, 1650 V, 3300 V, 6600 V, 10000 V.

7.3.4 Overspeed of motors: Motors without special requirements are generally assessed at 1.2 times the maximum speed for 1 minute.

7.3.5 Shaft current: To avoid the generation of shaft current, corresponding measures shall be taken. Since the shaft voltage of the variable frequency motor is larger than that of ordinary power frequency, there shall be a shaft current grounding device on the motor.

7.3.6 Terminal markings and direction of rotation of motors: According to GB 1971.

8 Test methods for converter-powered synchronous motors

8.1 The test shall be carried out in accordance with GB/T 1029 or IEC 60034-2.

This is an excerpt of the PDF (Some pages are marked off intentionally)

------ The End ------