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Washdown Series

Smooth Edges, no build up.

Stainless steel Housing and Shaft.

Synchronous electrical servomotors with 3 winding phases, supplied with sinusoidal current wave forms. The feed-back device is a resolver (BFS Series).



INTRODUCTION

We are pleased to offer our readers a new, streamlined Mavilor Express format this month. We hope that you find it visually attractive and easy to read.

This month's technical article comes from Professor J.Compter, as he compares motors with and without brushes. We also include an article on industrial quality certification, submitted by our Quality Manager, Alfred Domenich. We would like to thank both of our contributors for sharing their knowledge and experience with our readers. Another important

contribution comes from the two Chinese MBA interns that recently spent three months honing their skills with us. It was an enriching experience for all of us. Our monthly product spotlight is on our Washdown series, specially designed to meet the needs of food industry applications.

Please remember that Mavilor Express is a forum for all activities related to Mavilor Motors and we would be delighted to include whatever article, comment or opinion that our readers would care to submit.

Thank you very much, Mavilor Team.

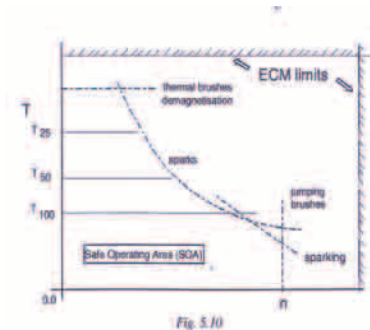
Comparison of motors with and without brushes

by Prof. Dr.J.C Compter

STRENGTHS

The limitations of the electronically commutated motor (ECM) have their roots in the life of the bearings and the load-bearing capacity of the amplifier chosen. There is also a thermal limit and maximum current with a view to demagnetisation.

Fig. 5.10 identifies these limitations compared with the limitations of mechanically commutated motors; the hatching shows the limits for ECM motors; the vertical line is determined by the maximum speed of the bearings and/or the warming up by eddy currents; the horizontal line by the maximum current in relation to demagnetization.



For the motor with brushes the hyperbola in fig. 5.10 is the line of maximum output power. Along this line the shaft power is constant, because it is given by $P_{\text{shaft}} = w \cdot T$. For the ECM the load point with maximum output power P_{shaft} is the point extreme top right. The conclusion is that in the absence of commutation limitations ECMs can be loaded more heavily than motors with brushes.

The advent of power electronics and the development of new magnetic materials such as SmCo and NdFeB ran in parallel and both are used in ECMs. The use of these magnetic materials means that ECMs have smaller volumes than mechanically commutated motors, which generally use AlNiCo

magnets. The strengths of these electronically commutated motors compared with mechanically commutated motors are:

1. Life greater than 30,000 hours
2. May be excited for a prolonged period in the same rotor position (positional servo!)
3. Substantially higher predictability of operational reliability
4. With an appropriate winding suitable for 300 V, making a mains transformer unnecessary
5. No carbon contamination and sparks
6. Not sensitive to impurities in the ambient air
7. Simple mechanical structure

8. Measurable winding temperature so that, with a temperature cut-out, the motors can be loaded to the thermal limit
9. The dissipation in the windings can be found in the stator, so the thermal resistance from source to cooling environment is significantly lower. This means that more dissipation in the coils is permissible and the motor has a higher power density.
10. The thermal capacity of the stator is high, so power peaks lead less quickly to the maximum permissible temperature
11. Smaller construction volume due to the absence of brush / commutator combination.

Points to consider

IRON LOSSES

Both versions of the electronically commutated motor have a rotating permanent magnet inside the iron stator, the choice usually falling on SmCo or NdFeB. These strong magnetic materials are responsible for high magnetic inductions in the stator. As a test the stator temperature of an EC motor has been measured at 5,000 rpm. In this case the EC motor was driven by another motor using the shaft. The EC motor was disconnected from its power supply. This showed that the motor temperature rose 50°C simply because of eddy current losses resulting from the rotating rotor field.

Another approach to this phenomenon is the plotting of the current required for a particular torque as a function of the speed.

Fig. 5.11 shows an increase of 50%; the iron losses are the cause. In contrast to the situation with mechanically commutated motors, here these losses are a significant factor for the load-bearing capacity of the motor.

The T10, T30, T50, T80 and T100 lines in Fig. 5.12 are given for an ECM as an indication. The message below is that in the case of the ECM the maximum permissible copper dissipation falls with speed, because the increasing iron losses use a substantial part of the permissible dissipation.

At the same time the motor torque is used in part to overcome the iron losses, so that there is less available to the shaft.

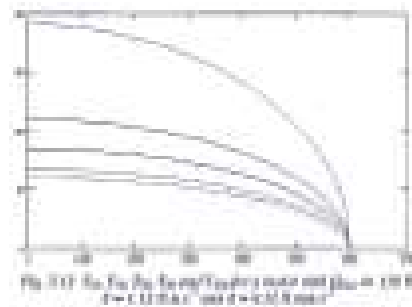
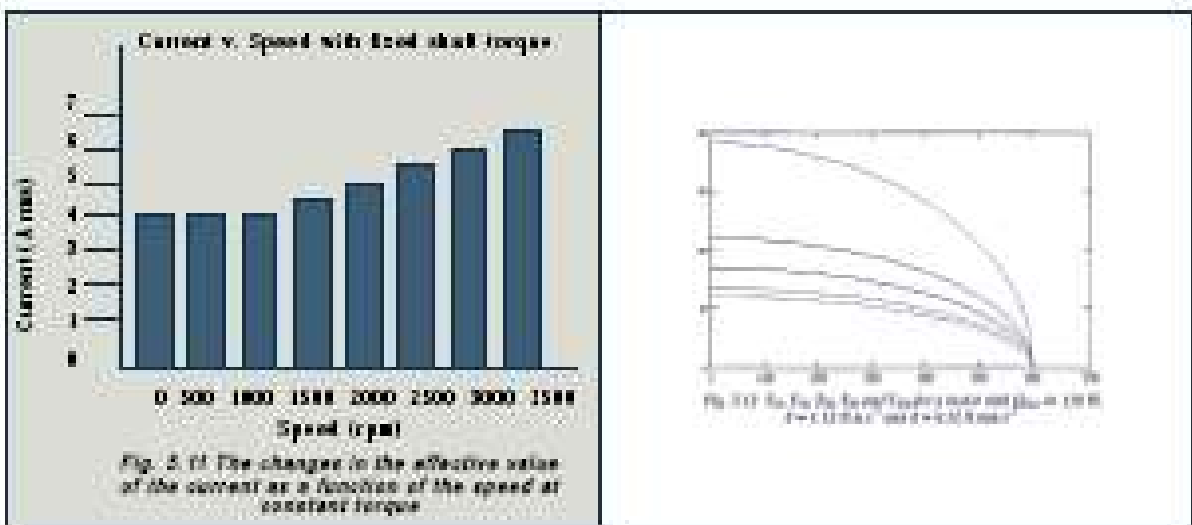
We can regard eddy current losses as a viscous friction; a good approach is to say that: $P_{eddy} = d \cdot \omega^2$, so that the total losses are:

$$P_{diss} + P_{eddy} = \delta / \sigma (T\delta + \omega \cdot d)^2 + (1 - \delta) \cdot (\omega \cdot d)^2 / S + \omega^2 \cdot d \leq Q_{max}$$

$P_{loss} = P_{eddy} + P_{diss} \leq Q_{max}$. If we employ a duty cycle δ , then $T\delta$ is related to the duty cycle δ and the rotational speed ω as follows:

$$T\delta(\omega, \delta) = \sqrt{S / \delta \cdot (Q_{max} - \omega^2 \cdot d) - \omega^2 \cdot d^2 \cdot (1 - 1/\delta) - \omega \cdot d}$$

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Mavilor MSS series with brushless



Mavilor BL series without brushless

The value of the damping d is most easily determined by measuring the current as a function of the speed in the case of an unloaded motor: $d = K.I(w)/w$.

But these high losses are not fundamental to electronically commutated motors! If we want a brushless motor with a speed greater than around 5,000 rpm, we can have one by using lower strength magnets; we can do this by reducing the magnet volume or by using ferroxdure magnets. But we will then have to accept that the steepness of the motor (the factor S) will be lower.

We have already discussed the fact that the current form of Pulse Width modulation (PWM) amplifiers leads to iron losses and additional ohmic losses. It is certainly the case with ECMs that the motor specification goes with a particular amplifier. Current ripple reduction leads to better performance.

Summarizing, the following are the causes of the motor constant falling with increasing speed:

1. The increasing iron losses resulting from the rotor rotating faster, so that there is less torque available at the end of the shaft;
2. The lagging of the current in a stator coil in relation to the EMF because of self-inductance. With the EC-DC motor this effect is related to the finite supply voltage; with the AC synchronous motor there is additionally the phase shift with increasing frequency of the current amplifier.

Remark: when a PWM-amplifier is used and a considerable ripple on the current remains present because of lack of sufficient inductance, one will notice a further performance reduction as discussed in 3.6.3.

Sinusoidal or trapezoidal EMF and the amplifier

Depending on the type of brushless motor, the EMF is sinusoidal or trapezoidal. If these motors are operated with a square-wave or sinusoidal current, there will be a torque ripple of not less than 13%! This can be demonstrated (numerically, for example) by calculating the torque of a DC brushless motor, with the EMFs from Fig. 5.4 that is fed with three sinusoidal currents.

Student's Internship

China Europe International Business School, CEIBS in Shanghai

The Mavilor Motors Internship Program has brought us a better understanding of China, its market, and most importantly, its culture.

Kenny and David, both CEIBS' students, have had the opportunity to travel to Spain and to get to know Mavilor, working and sharing experiences with all of us.



David Meng

"... The experience of working in Mavilor has been wonderful. We have learned a lot about servo motors and drives from our colleagues, including basic theories, applications, and marketing strategies. We have also gathered a lot of information on the Chinese market. I hope that this information will benefit the company in the future.

I would like to thank all my colleagues. The people at Mavilor are very nice. They have told me many things about Barcelona, Catalunya and Spain. They have made my stay here interesting..."



Kenny Wong

"... My MBA internship at Mavilor Motors S.A. has provided me with a solid foundation for my future career. The real-life business experience with the management, customers, distributors and especially all the energetic and passionate staff has been simply fantastic and eye-opening.

Mavilor Motors S.A. has shown not only its leading position in servo motor technology, but also its enthusiasm to provide the best values for all its customers. I truly believe these unique factors will bring Mavilor Motors S.A. even more success in its future. ..."

ATEX in Mavilor Motors S.A.

All the Eexd motors we produce are covered by the ATEX directive, the Notified Body is BASEEFA 2001

Control of Production

It is an essential part of many Product Certification Schemes that type examination and control of production are integrated to give assurance that manufactured products (as well as the design) comply with the requirements of the specified standard.

Under the requirements of the ATEX Directive (as well as many other EU Directives) the proper integration of the two aspects is broken and they are treated separately, possibly even involving different Notified Bodies.

The document issued covering the production phase is called a "Quality Assurance Notification" ("QA Notification") because the directive requires that the body performing the assessment should "notify" the manufacturer of the result of the assessment. Although most of the requirements of the ATEX Directive can be related to the ISO 9000 series of standards, there are some additional requirements, and some that are

omitted.

For this reason, the existence of a Quality Management System Certificate (QMSC) from an accredited certification body cannot be accepted alone as confirming compliance with the ATEX requirements. Neither can an ATEX Quality Assurance Notification be considered as evidence of compliance with all the system requirements of the ISO 9000 series standard.

However, it is a requirement of the ATEX Directive that the Notified Body issuing the QA Notification should take account of any existing QMSC.

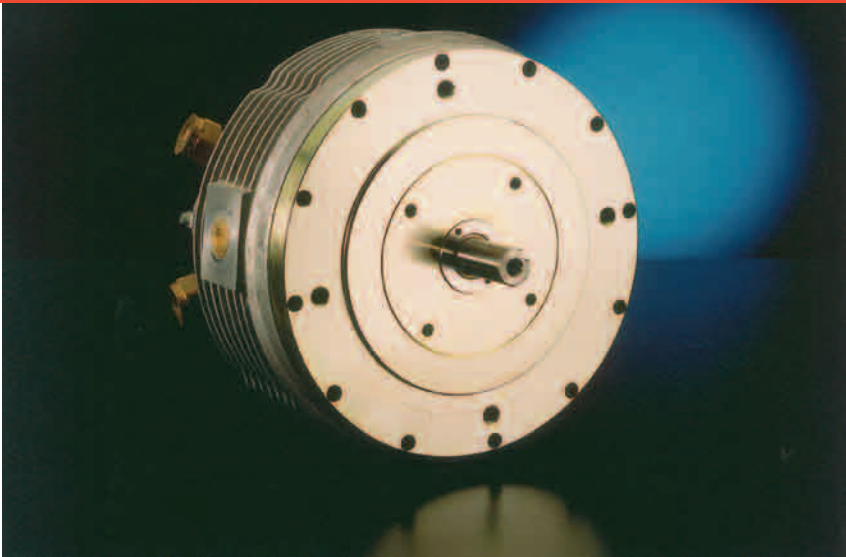
An EC-Type Examination Certificate is a specific form of Type Examination Certificate, given legal status within the framework of one or more EU Directives. Such a certificate does not necessarily provide evidence of compliance with all statutory or other requirements. However, a certificate does signify conformity with a particular standard or set of requirements, and may be used as evidence towards the meeting of relevant legal requirements

The prime activity of type examination is the collection of evidence confirming compliance with the specified standard(s). The evidence will often include the results of tests performed in our own laboratory or in another laboratory which can, probably through accreditation, demonstrate equivalent traceability, along with data sheets for material and components.

Drawings, often prepared specifically for the certification exercise, are the primary source of information.

The output is a report, confirming the evidence of compliance, and a certificate, defining what has been certified. The certificate will normally be a "public domain" document, but the report is a confidential document between our customer and us. There will, however, be the possibility that we are required to reveal the contents of the report, and the drawings, to appropriate legal bodies (such as the European Commission in connection with EU Directives) and to our accreditors.

The ATEX EC-Type Examination Certificate is issued against the Essential Health and Safety Requirements (EHSRs) given in Annex II of the directive. However, compliance with those EHSRs is normally assured by compliance with one or more standards which have been published by the European Standards making bodies, CEN and CENELEC. Once such a standard has been listed in the Official Journal of the European Communities (OJEC) as a "Harmonised Standard", compliance with the standard may be presumed to give compliance with the EHSRs.



DC servomotors EExdII C Series

Mavilor EExdII C Series are axial air-gap servomotors housed in a flame-proof gas accessible enclosure; gas can be ignited within the enclosure without the explosion damaging it or being transmitted to any external flammable atmosphere.

DC and DC "brushless" motors are included in the EExdII C series with options of internally-fitted tachometer, resolver and brakes.

Tips about ATEX

The directive 94/9/EC is a "New Approach" directive laying down Essential Health and Safety Requirements and leaving it to standards, primarily European harmonised standards, to give technical expression of the relevant requirements contained in the directive.

Directive 94/9/EC is a total harmonisation directive, i.e. its provisions will replace existing divergent national and European legislation which cover the same subjects as now stipulated by directive 94/9/EC. Directive 94/9/EC had to be transposed into national law by 1 September 1995. Its provisions have applied (on a voluntary basis only) since 1 March 1996.

However, the broad scope of directive 94/9/EC demonstrated the overriding need to provide for a transitional period, so as to ensure a smooth changeover to a New Approach Community-wide system

The Council adopted directive 94/9/EC with a view to allowing a transitional period until 30 June 2003.

The objective of directive 94/9/EC is to ensure free movement for the products to which it applies in the EU territory. Therefore the directive, based on Article 95 of the EC Treaty, provides for harmonised requirements and procedures to establish compliance.

The directive notes that to remove barriers to trade via the New Approach, provided for in the Council Resolution of 7 May 1985(17), essential requirements regarding safety and other relevant attributes need to be defined by which a high level of protection will be ensured. These Essential Health and Safety Requirements (EHSRs) are listed in directive 94/9/EC at Annex II. After 30 June 2003 products may be placed on the market in the EU territory, freely moved and operated as designed and intended in the expected environment only if they comply with directive 94/9/EC (and other relevant legislation).

Mavilor across the world



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