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Understanding Three-Phase Motor Windings and Rewinding Process Raj here to guide you through the process of rewinding a three-phase electric motor. In this tutorial, we will explore how to set up the coil size of a 1 hp 3 phase motor and discuss the resistance values chart for better understanding. Three-phase motors are widely used due to their good efficacy and cost-effectiveness. They consist of two main sections: rotor and stator. The rotor is typically made as a squirrel-cage, while the stator is an iron core with twisting. The rewinding process involves several steps: 1. Analyzing motor twisting 2. Disassembling the motor 3. Eliminating bearings 4. Calculating fresh winding 5. Rewinding the motor 6. Reassembling it using new bearings Rewinding is a time-consuming procedure, taking about two weeks to complete. If you have any questions or need further clarification, please feel free to message me. A Three-Phase Asynchronous Motor generates a turning magnetic field without the need for a capacitor. The speed of the motor is slightly less than the magnetic field speed due to this effect. The motor's inscription board provides valuable information about the motor's specifications: * Nominal voltage * Nominal current * Power rating * Power factor * Rotation speed * Nominal frequency From the system, inspect each wire individually, including T1, T2, and T3 (three phases), to verify continuity with the ground wire. Readings should indicate infinite resistance; if zero or some continuity is detected, it may indicate a problem with the motor or cable. Check for any potential shorts by disconnecting from the cable and examining the motor and cable separately. Ensure that both ends of each lead are not touching anything else. When using a quality meter, move up to 10 megohms to assess each wire separately (T1 to T2, T2 to T3, and T1 to T3). Typically, readings range from 600-2000 Megohms; however, be cautious of wires touching other components, as this can produce false or unrepeatable readings. For a 230 Vac 3 Phase Motor, readings are often in the range of .3 to 2.0 ohms, with most being approximately .8 ohms. If you read zero, it may indicate a brief between phases; if open, it should be infinite or above 2K ohms. When inspecting cables and plugs, check for signs of coolant intrusion into the connector on the cable to the engine. If present, dry out the connection and retest. In cases where inserts become burnt, they may need replacement. Additionally, look for areas where the cable moves through tracking, as wires can wear over time. For DC Motors, assess the brushes by removing the round caps around the motor, which should reveal springs with square blocks (brushes). Check how much material is left and whether it needs to be replaced. Also, inspect the commutator for wear and wipe down its surface. In some cases, equipment designers may require customized motor windings to match specific applications. This can involve modifying armature winding parameters such as torque constant Kt, voltage constant Ke, armature resistance Ra, and armature inductance La to suit individual servo systems. The process to determine a servomotor's requirements is straightforward once you identify the "load points." These load points are defined by the torque and speed needed for each specific application. Motor power output can be calculated as the product of torque and speed at the motor shaft for a particular load point. This relationship can be expressed as: Pout = Ts where Pout is the output power, T is the torque, and s is the shaft speed in rad/sec or rpm. However, due to inefficiencies, not all input power is converted into useful output power. The difference between input and output power constitutes motor losses. These losses result in heat generation that must be dissipated within the motor's maximum operating temperature limits. When designing a new winding, it's essential to ensure that it doesn't compromise these safety limits. The initial heat rise often comes from armature current, setting a maximum permissible current for a given time and limiting output-shaft torque. Additionally, designers designate a maximum safe speed based on the rotor diameter or number of commutator segments. Motor torque is directly proportional to the developed current in the armature windings: T = KtI where T is the torque, Kt is the motor torque constant, and I is the armature winding current. Sustaining high currents for extended periods can harm the motor by developing excessive temperatures and potentially demagnetizing the motor magnets. Motor speed is directly proportional to the input voltage applied to the motor terminals: s = E/Ke where s is the shaft speed, E is the input voltage, and Ke is the motor voltage constant. The voltage constant is a function of motor structural design and is fully dependent on it. Given article text here they relate thus:Kt = 1.3524Ke (4)whenKt is in oz-in./AandKe is in V/(krpm) Equation (4) shows that the voltage constant is also directly proportional to the effective number of series conductors per coil, the magnetic flux, and the number of poles. Here, we will focus on how to quickly calculate the new Kt and Ke caused by a winding change.Winding constants Besides affecting Kt and Ke, a new winding affects other parameters such as resistance and inductance. Armature resistance changes because it relates to resistivity, length, and area of the wire:R = Qcul/A (5)whereQcu = Resistivity of copper, Ω-ml = Length of wire, mA = Cross-sectional area of wire, m2 A winding change also causes a change in inductance, because inductance depends on total magnetic flux through a coil of a given number of turns, and current linked by the coil:L= NΦ/I (6)whereL = Inductance in henries, HN = Number of turns in coilΦ = Total magnetic flux in webers, wb That value of f in Equation (6) producesL = N2A/l (6a)Equation (6a) shows that armature inductance is proportional to the square of the number of turns. Armature resistance and inductance are figures of merit to servomotor users. The motor's time constants change if the resistance or inductance — or both — change. The electrical time constant is the ratio of the winding's inductance and resistance:te = L/R (7)wherete = Electrical time constant, sec The mechanical time constant istm = RJ/KtKe (8)whereJ = Rotor moment of inertia, kg-m2 and the entire equation is in SI units. Continue on Page 3 The method Equations (2) through (8) show that many motor constants and other figures of merit depend on winding configuration. Consequently, a change in those parameters will affect the user's power supplies and also the servo controls. The servo system designer benefits from finding an accurate value for these constants and motor parameters without having to wait for the motor designer to design the new winding. Two simple, straightforward assumptions follow without loss of generality: • The motor at hand, which will undergo the winding change, performs adequately at a desired full-load point. • The slot fill of that motor winding is adequate.If the first assumption is valid, then the motor operates at acceptable efficiency and the losses in the winding do not compromise the motor's allowable maximum temperature.If the second assumption applies, then the new winding calculations assure adequate slot fill, that is, good copper and iron utilization.Let us assume that the servomotor user wants to change a motor winding so the motor will run at a faster new speed without changing power supply voltage. This immediately calls for a reduction in voltage constant, and consequently, in torque constant.A look at Equations (2) and (3) shows that the new winding requires fewer turns because, as shown before, Ke and Kt are directly proportional to effective number of turns. A straight reduction in the number of turns would leave some empty space in the slots. For the sake of efficiency, A substantial amount of copper is required to fill a specific area, typically around 60% but potentially up to nearly 100%. Large-diameter magnet wire is needed to prevent "low slot fill" and efficiently pack the empty space in the slot. Since magnet wire comes in limited gage sizes or diameters, motor designers have restricted options to work with. In the American Wire Gage system, the area ratio between consecutive wire gauges is consistently about 1.26, while gauge numbers increase as wire diameter decreases. For instance, a change from 20 AWG to 17 AWG results in an area doubling due to the same factor, 1.26. This principle applies across various gage changes, as shown in Table 1. Considering a scenario where a motor requires a significant speed boost without changing input voltage or power output, and maintaining efficiency at previous levels, we can apply equations to determine necessary adjustments. The torque requirement would decrease by 2.5 times, while the motor voltage constant (Ke) must be reduced by the same factor. To reduce Ke by 2.5, one could simply decrease the number of turns, but this would compromise slot fill. To resolve this issue, we need to solve for the required increase in wire gage size to achieve better slot fill. This involves finding the value of 'r', representing the number of wire gage changes needed: Kt(1.26)^r = Kt/2.5 Solving for 'r' yields a result where 'r' equals -4, indicating a need for four smaller wire gauge numbers or four larger ones. The new winding would then have 18 turns with 21 AWG size wire, resulting in a new armature resistance of Rnew = Rold/6.35 and armature inductance Lnew = Lold/(1.26)^4. The increased wire area can support higher current, which is proportional to the new wire area. This approach simplifies the process of adjusting motor parameters by focusing on changes related to the factor 1.26 and the number of wire-gage step changes. However, it's essential to note that this method assumes brush resistance has been accounted for in the equations, but terminal resistance remains outside these calculations. Brush-type DC motors incorporate armature winding resistance and brush-related resistance.*Some brushes are wound into a field type, which should be distinguished from terminology. The term "armature" denotes the windings that carry load current in this context. It may reside within rotating or stationary elements, depending on motor design.P.Ramon Guitart is Design Manager, DC/Servo Motors at Reliance Motion Control's Gallipolis, Ohio facility.

How to calculate motor winding turns. How is motor winding calculated. Motor winding data formula.