PROSPECTS FOR THE USE OF MULTIPHASE INVERTER-FED STATORS IN THE FIELD OF MOLTEN METAL ELECTROMAGNETIC STIRRING SYSTEMS

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It is common knowledge that at present linear stators are in considerable use for the electromagnetic stirring of molten metals in melting furnaces, ladles, castings, etc. [1, 2].

The use of multiphase (i.e. having phase number M more than five) inverter-fed linear or bow-shaped stators has an advantage over three and four phase ones, especially when phase-pole control method (PPM) is used during inverter operation.

The description of PPM is presented in [3-8]. This control method may be used both for multiphase AC inverter drives and multiphase inverter-fed linear or bow-shaped stators that are intended for application in the molten metal electromagnetic stirring systems.

The essence of the control according to PPM is that in this case the electrical angles W between the voltages (or currents) of the nearest phases of inverter are increased by a factor of H (in comparison with any traditional control method) without any change of the inverter voltage (or current) amplitude and frequency, i.e. in this case Wh = H*Wt, where H is some whole number, Wt is the value W when some traditional control method is used (Wt = 2*П/M), Wh is the value W when PPM is used, and П = 3.14159.

H is the major parameter of PPM that characterizes the type of this control method (the value H = 1 corresponds to any traditional control method, and the value H > 1 corresponds to PPM).

The range of the parameter H (including its maximal value), which can be achieved in the given molten metal electromagnetic stirring system, depends on the phase number of the system and on a stator winding type.

The change of the parameter H results in the change of the filtering properties of the multiphase stator.

The application of the phase-pole-controlled (i.e. when PPM is used) multiphase inverter-fed linear (or bow-shaped) stators allow to increase (in comparison with the case when the phase number M is equal to three or four) the intensity of electromagnetic stirring of molten metals by providing with continuous change of the quantity, space location, and configuration of the vortex areas in the metal mass during the process of the above-mentioned stirring. The range of this intensity increase may be wide, and its limit depends on the phase number M.

Besides that the use of PPM allows to prevent the intensity decrease of molten metal electromagnetic stirring when the metal viscosity increases in the consequence of the change in metal temperature or typical composition of alloy.

REFERENCES:

1. Metz, P. Electromagnetic Stirring Process for Continuous Casting / USA Patent № 5,279,351. Date of Patent: January 18, 1994.

2. Steelworks in Hospet to Install Stirring Coils // Met. Plant and Tehn. Int., 1997, vol. 20, № 2, p. 17.

3. Brazhnikov, A.V. Additional Resources of Control of Multiphase Inverter Drives // Proceedings of 7th International Conference on Electrical Machines and Drives “ELMA ‘93”, Varna, Bulgaria, 1993, pp. 325-332.

4. Brazhnikov, A.V., and Dovzhenko, N.N. Beyond Routine Control of Multiphase Inverter Drives // Proceedings of International Conference on Power Electronics, Motion Control and Associated Applications “PEMC ‘94”, Warsaw, Poland, 20-22 September 1994, vol. 1, pp. 99-104.

5. Brazhnikov, A.V., Dovzhenko, N.N., and Izmaylov, E.B. Prospects for the Use of Multiphase Electric Drives in Field of Mining Machines // Proceedings of 3rd International Symposium on Mine Mechanization and Automation “MMA ‘95”, Golden, CO, U.S.A., 1995, vol. 1, pp. 13-13 – 13-23.

6. Brazhnikov, A.V., Dovzhenko, N.N., Gilyov, A.V., and Butkin, V.D. Improvement of Technical-and-Economic Characteristics of Drilling Rigs Owing to the Use of Multiphase Electric Drives", Proceedings of ISDT 16th Annual Technical Conference, Las Vegas, NV, U.S.A., 1996, 8 p.

7. Brazhnikov, A.V., and Dovzhenko, N.N. Advantages of Multiphase Electric Drives – Application in Drilling Rigs // Proceedings of 4th International Symposium on Mine Mechanization and Automation “MMA’ 97”, Brisbane, Queensland, Australia, 6-9 July 1997, vol. 1, pp. B4-37 – B4-42.

8. Brazhnikov, A.V., and Dovzhenko, N.N. Control Potentials and Advantages of Multiphase AC Drives // Proceedings of 29th IEEE Power Electronics Specialists Conference “PESC’ 98”, Fukuoka, Japan, 17-22 May 1998, vol. 2, pp. 2108-2114.