Abstract of Ph.D. Thesis

"Power Quality Improvement in Multi-Pulse Converter Fed Multilevel Inverter Based Induction Motor Drives"

Mr. Piyush Kant (2015EEZ8089)

In this research work, various configurations of multi-pulse AC-DC converters fed multilevel inverters (MLIs) based induction motor drive (IMDs) are presented for medium voltage and medium power applications. This research work provides conventional single-stage multi-winding transformer (SS-MWT) based 12-pulse and 18-pulse AC-DC converters at utility end. This single-stage multi-winding transformer (MWT) has phase-shift in secondary windings only. With the help of this convention SS-MWT, one can achieve up to 36-pulse AC-DC converter, which requires very small phase-shift. Due to which, the manufacturing process of this MWT becomes very complex. Therefore, in this research work, new configuration of modular MWT is proposed to achieve 36-pulse AC-DC converter, which has phase-shift in both primary and secondary windings and it does not require small phase-shift. Due to which the manufacturing process of proposed MWT is quite easier than conventional MWT. With the help of modular MWT, a 54-pulse AC-DC converter is utilized in this research work to shape the supply current closer to sinusoidal and to reduce it total harmonic distortion (THD) to a very low value. This modular MWT is more suitable, when more numbers of isolated DC-supplies are required such as cascaded H-bridge (CHB) inverter fed IMD. Therefore, in this research work, a new multiphase MWT is proposed at the utility end, which convert input three-phase AC-supply in to five-phase output AC-supply. With the help of this multiphase MWT, a 20-pulse, 30-pulse, 40-pulse and 60-pulse AC-DC converters are proposed at the utility end, which has good power quality even at light load conditions.

From above discussion, it is observed that different configurations of multi-pulse AC-DC converters are proposed at the utility end. Apart from it, different types of MLIs are utilized at the motor end to drive an induction motor (IM). A 3-level three-leg neutral point clamped (NPC) and 5-level six-leg NPC MLI are utilized at the motor end to drive an IM. The structure of NPC MLI becomes quite complex for more than 5-level. Therefore, in this research work, CHB-inverter is used at the motor end to drive an IM. The 5-level and 7-level symmetrical CHB-inverters are used at the drive end. However, this symmetrical CHB-inverter needs more numbers of DC-supplies and power semiconductors switches (PSSs) to get higher numbers of output voltage levels. Therefore, in this research work, binary (1:2) principle is utilized to get more numbers of output voltage levels. The 7-level and 15-level binary CHB-inverters are utilized at the drive end, which requires same numbers of isolated DC-supplies and power semiconductor switches as 5-level and 7-level symmetrical CHB-inverters needed, respectively. In this research work, ternary (1:3) principle is also utilized to get more numbers of output voltage level with same numbers of isolated DC-supplies and power semiconductor switches. The 9-level and 27-level ternary CHB-inverters are utilized at the motor end to drive an IM, which requires same numbers of isolated DC-supplies and power semiconductor switches as 7-level and 15-level binary CHB-inverters needed, respectively.

Apart from this NPC and CHB-inverters, a new cascaded inverter is also utilized in this research work to drive an IM, which requires less numbers of isolated DC-supplies than CHB-inverters and easy structure than NPC MLI. The 3-level, 5-level and 7-level cascaded MLIs are used, which are cascading two, four and six numbers of three-phase voltage source inverters (VSIs), respectively. Moreover, a 4-level cascaded inverter is also used, which is cascading a 3-level NPC and three-phase VSI in unique manner.

From above discussion, it is observed that different configurations of multi-pulse AC-DC converters at utility end and various configurations of MLIs at drive end are presented in this research work. Apart from it, an indirect vector control with and without speed sensor and direct torque control (DTC) without speed sensor schemes are utilized to control an IM. Moreover, various types of modulations techniques are utilized to control these MLIs. Due to which, these MLIs are operated at quite low switching frequency and fundamental frequency switching, to reduce switching losses in IMDs.