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农业装备中三电平二极管箝位式逆变器拓扑结构的改进

Improved neutral point clamped three-level VSI topology construction in agricultural device

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中文摘要:

传统的二极管箝位式(NPC)三电平逆变器结构中，中点电压波动过大将导致输出电压的谐波总畸变率（total harmonic distortion,THD）增大及开关器件损坏，影响了该结构在农业机电中的应用。该文提出了一种带中点电压自平衡的NPC三电平逆变器拓扑结构，通过在传统NPC三电平逆变器结构中加入一套由单相全桥逆变电路组成的电压主动补偿装置，对三相桥臂中点电压的波动进行主动补偿。实时检测三相桥臂中点电压，与给定值比较后，控制补偿装置实时产生补偿电压。不需要坐标变换，控制方案简单。同时对系统的稳定性进行了理论分析。仿真结果表明提出的拓扑结构能够将三相桥臂中点电压的波动控制在3%以下，并且在负载突变时，仍然能快速的平衡中点电压的波动，具有良好的动态性能。

英文摘要:

Abstract: A NPC three-level inverter is suitable to be used in the field of high power, high voltage. A DC side neutral-point N and three-phase bridge arm neutral-point O of a traditional NPC three-level inverter were linked together. The voltage of the three-phase bridge arm neutral-point would fluctuate, because of the DC side neutral-point voltage fluctuation. It would influence the efficiency of the NPC three-level inverter's work. The neutral-point voltage excessive fluctuation of the traditional neutral point clamped (NPC) three-level inverter would cause the total harmonic distortion (THD) of output voltage increase and switch devices damage. This problem limits its engineering applications in the field of agriculture. A NPC three-level inverter topology with a neutral-point voltage self-balancing function was proposed. It consisted of two parts. Part 1 was the traditional NPC three-level inverter. Part 2 was the active compensation voltage device, and was composed of a single-phase full-bridge inverter circuit, which was used to compensate for the voltage fluctuation of a three-phase bridge arm neutral-point in a traditional NPC three-level inverter. The active compensation voltage device is similar to a controllable voltage source. It was used in a series between point O and point N in a traditional NPC three-level inverter. The three-phase bridge arm neutral-point real-time voltage value was detected and compared with a given value. Then, a real-time compensation voltage was generated by the active compensation voltage device. The voltage of the three-phase bridge arm neutral-point was uo, the voltage of the DC side neutral-point was un, and the voltage of the DC side was us. The real-time compensation voltage was ub, . When the neutral-point voltage of part 1 fluctuates excessively, the active compensation voltage device would generate a real-time compensation voltage to keep neutral-point voltage stability, . Because coordinate transformation is not required, the control scheme is simple. Further, a theoretical analysis of the system stability was achieved. In order to verify the proposed control method, the system was simulated by using the "Power system Blockset" in the Matlab/Simulink environment. The parameters used for simulation are defined as follows: us=3000 V，udc=500 V, dc link capacitor, C=1000 uF, L=0.4 mH, the switching frequency of the NPC three-level inverter was 3kHz, and the switching frequency of the active compensation voltage device was 10 kHz. After the compensation, a voltage fluctuation value of the three-phase bridge arm neutral-point in the traditional NPC three-level inverter was limited under 3%. In addition, simulation results showed that the proposed topology has good dynamic performance. In conclusion, a NPC three-level inverter with a neutral-point voltage self-balancing function was proposed due to the problem of neutral-point voltage excessive fluctuation of a traditional neutral point clamped (NPC) three-level inverter. This structure consisted of an active compensation voltage device to eliminate the neutral-point voltage excessive fluctuation. Simulation results have shown that no matter how the load varies, the presented circuit structure can eliminate the three-phase bridge arm neutral-point voltage fluctuation effectively with quick response and good dynamic performance.