电网技术 2011, 35(1) 26-32 DOI: ISSN: 1000-3673 CN: 11-2410/TM

电力系统

模块化多电平HVDC输电系统子模块电容值的选取和计算

王姗姗1，周孝信1，汤广福1，贺之渊1，滕乐天2，刘隽2

1．中国电力科学研究院，北京市 海淀区 100192；2．上海市电力公司，上海市 浦东区 200122

摘要：

从模块化多电平柔性直流输电系统稳态能量交换过程、有功功率控制动态响应特性、暂态能量交换过程及直流双极短路故障时桥臂保护要求4个方面分析了子模块电容值与直流系统运行特性之间的数学关系。根据理论分析结果，给出了模块化多电平子模块电容的选取原则和计算方法。通常根据稳态子模块电压波动和有功功率控制动态响应特性的要求计算子模块电容值，再根据暂态子模块电压波动和桥臂保护的要求进行校验。利用PSCAD电磁暂态仿真模型对设计实例进行了仿真分析，结果表明该设计方法是合理、可行的。

关键词：

Selection and Calculation for Sub-Module Capacitance in Modular Multi-level Converter HVDC Power Transmission System

WANG Shanshan1, ZHOU Xiaoxin1, TANG Guangfu1, HE Zhiyuan1, TENG Letian2, LIU Jun2

1. China Electric Power Research Institute, Haidian District, Beijing 100192, China;2. Shanghai Municipal Electric Power Company, Pudong District, Shanghai 200122, China

Abstract:

The mathematical relation between the value of sub-module capacitance and operational characteristics of HVDC system is analyzed in four aspects, i.e., the steady-state energy conversion process, dynamic response process of active power control and transient energy conversion process in modular multi-level converter HVDC power transmission system as well as the requirement to bridge arm protection during bipolar short-circuit fault, is researched. Based on the result of theoretical analysis, the principle and calculation method for the selection of modular multi-level sub-module capacitance are given. Usually, the value of the sub-module capacitance is calculated according to the voltage fluctuation and the requirement to dynamic response characteristic of active power control, and the calculation result is verified by transient voltage fluctuation of sub-model and the requirement to the bridge arm protection. Utilizing the model based on electromagnetic transient simulation software PSCAD, a practical design case is simulated, and simulation results show that the proposed selection principle and calculation method are reasonable and feasible.

Keywords:

收稿日期 2010-08-20 **修回日期** 2010-09-19 **网络版发布日期** 2011-01-18

DOI:

基金项目:

国家自然科学基金项目(50777058)。

通讯作者: 王姗姗

作者简介:

作者Email: sswang@epri.sgcc.com.cn

参考文献：

[1] Flourentzou N，Agelidis V G，Demetriades G D．VSC-based HVDC power transmission systems：an overview[J]．IEEE Trans on Power Electronics，2009，24(3)：592-602． [2] ABB AB Grid Systems：HVDC．It's time to connect：technical description of HVDC light technology[R]．Ludvika，Sweden：ABB AB Grid Systems：HVDC，2007． [3] CIGRE B4-37 Working Group．DC transmission using voltage sourced converters[R]．Paris，France：International Council on Large Electric Systems，2004． [4] Lesnicar A，Marquardt R．An innovative modular multilevel converter topology suitable for a wide power range[C]//IEEE Power Technology Conference．Bologna，Italy：Institute of Electrical

and Electronics Engineers，2003：6. [5] Glinka M. Prototype of multiphase modular multilevel converter with 2 MW power rating and 17-level-output-voltage[C]//Power Electronics Specialists Conference. Aachen Germany：Institute of Electrical and Electronics Engineers，2004：2572-2576. [6] Franquelo L G，Rodriguez J，Leon J I，et al. The age of multi-level converters arrives[J]. IEEE Industrial Electronics Magazine，2008，2(2)：28-39. [7] Glinka M，Marquardt R. A new AC/AC multilevel converter family applied to a single-phase converter[C]//The Fifth International Conference on Power Electronics and Drive Systems. Singapore：Institute of Electrical and Electronics Engineers，2004：662-669. [8] Hagiwara M，Nishimura K，Akagi H. A medium-voltage motor drive with a modular multilevel PWM inverter[J]. IEEE Trans on Industrial Electronics，2010，25(7)：1786-1799. [9] Dorn J，Huang H，Retzmann D. A new multilevel voltage-sourced converter topology for HVDC applications[C]//CIGRE Session. Paris，France：International Council on Large Electric Systems，2008：1-8. [10] Pirouz H M，Bina M T，Kanzi K. A new approach to the modulation and dc-link balancing strategy of modular multilevel ac/ac converters[C]//The Sixth International Conference on Power Electronics and Drive Systems (PEDS). Kuala Lumpur，Malaysia：Institute of Electrical and Electronics Engineers，2005：1503-1507. [11] 丁冠军，汤广福，丁明，等. 新型多电平VSC子模块电容参数与均压策略[J]. 中国电机工程学报，2009，29(30)：1-6. Ding Guanjun，Tang Guangfu，Ding Ming，et al. Submodule capacitance parameter and voltage balancing scheme of a new multilevel VSC modular[J]. Proceedings of the CSEE，2009，29(30)：1-6(in Chinese). [12] 管敏渊，徐政，屠卿瑞，等. 模块化多电平换流器型直流输电的调制策略[J]. 电力系统自动化，2010，34(2)：48-52. Guan Minyuan，Xu Zheng，Tu Qingrui，et al. Nearest level modulation for modular multilevel converters in HVDC transmission[J]. Automation of Electric Power Systems，2010，34(2)：48-52(in Chinese). [13] Antonopoulos A，Angquist L，Nee H-P. On dynamics and voltage control of the modular multilevel converter[C]//European Power Electronics and Applications Conference (EPE). Barcelona Spain：Institute of Electrical and Electronics Engineers，2009：1-10. [14] 屠卿瑞，徐政，郑翔，等. 模块化多电平换流器型直流输电内部环流机理分析[J]. 高电压技术，2010，36(2)：547-552. Tu Qingrui，Xu Zheng，Zhen Xiang，et al. Mechanism analysis on the circulating current in modular multilevel converter based HVDC[J]. High Voltage Engineering，2010，36(2)：547-552(in Chinese). [15] Hagiwara M，Akagi H. PWM control and experiment of modular multilevel converters[C]//Proceedings of IEEE Power Electronics Specialists Conference. Rhodes Greece：Institute of Electrical and Electronics Engineers，2008：154-161. [16] Michail V. Analysis，implementation and experimental evaluation of control systems for a modular multilevel converter[D]. Stockholm Sweden：Royal Institute of Technology，2009. [17] 刘钟淇，宋强，刘文华. 基于模块化多电平变流器的轻型直流输电系统[J]. 电力系统自动化，2010，34(2)：53-58. Liu Zhongqi，Song Qiang，Liu Wenhua. VSC-HVDC system based on modular multilevel converters[J]. Automation of Electric Power Systems，2010，34(2)：53-58(in Chinese). [18] Allebrod S，Hamerski R，Marquardt R. New transformerless，scalable modular multilevel converters for HVDC transmission[C]//Power Electronics Specialists Conference. Rhodes Greece：Institute of Electrical and Electronics Engineers，2008：174-179. [19] 魏文辉，刘文华，倪镭，等. 链式STATCOM直流侧电容稳态分析及参数设计[J]. 电力系统自动化，2004，28(4)：28-31. Wei Wenhui，Liu Wenhua，Ni Lei，et al. Steady state mathematical model and DC capacitor parameter design of ?50 Mvar STATCOM with chain-circuit topology[J]. Automation of Electric Power Systems，2004，28(4)：28-31(in Chinese). [20] 马晓军，刘文华，王仲鸿，等. 新型同步补偿器直流侧储能电容值的选取方法[J]. 中国电机工程学报，2000，20(10)：31-35. Ma Xiaojun，Liu Wenhua，Wang Zhonghong，et al. Selecting method of the DC storage capacitor of static synchronous compensator [J]. Proceedings of the CSEE，2000，20(10)：31-35(in Chinese). [21] 殷自力，李庚银，李广凯，等. 柔性直流输电系统运行机理分析及主回路相关参数设计[J]. 电网技术，2007，31(21)：16-21. Yin Zili，Li Gengyin，Li Guangkai，et al. Analysis operational mechanism of VSC-HVDC and relevant parameter design of its main circuit[J]. Power Systems Technology，2007，31(21)：16-21(in Chinese).

本刊中的类似文章
