Set-up and Implementation of a Recuperative Stand for Testing a Filtering and Regeneration System

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Abstract— **The paper presents the methodology and design of testing structure dedicated to one laboratory model of a filtering and regeneration system (SISFREG) developed through the project number 42/2014, type Partnerships - PCCA 2013, which allows the conversion of the dc traction substations in "active substations". The configuration was made based on the actual conditions prevailing in a substation for traction d.c. and given the equipment available in the Laboratory of Power Electronics and Electrical Drives of Department of Electromechanics, Environment and Applied Informatics. The experimental structure contains the equivalent of the transformer-rectifier traction group; the equivalent of the d.c. traction motors; the possibility of system to be connected, on the one hand in the connection point of the traction transformer, and on the other hand with line d.c. (Equivalent catenary). The control and monitoring algorithm was implemented on the 1103 dSpace system. Finally, the paper presents the experiments conducted in accordance with the test protocol, interpretation results and determine the energy performance of the system in the active filtering and regeneration operation mode.**
Keywords— **Active DC Traction Substation; Recovery braking energy; Stand test and verification**

REFERENCES

[1] H. Akagi, H. Watanabe, M. Aredes, Instantaneous power theory and applications to power conditioning, Wiley-IEEE Press, 2007.

[2] M. Muszyński, K. Mikołajuk, A. Toboła, "Control of dc capacitor voltage in active power filters," Przegląd Elektrotechniczny, vol. 89, no. 4, pp. 245-247, 2013.

[3] M.K. Mishra, K. Karthikeyan, "An investigation on design and switching dynamics of a voltage source inverter to compensate unbalanced and nonlinear loads," IEEE Trans.Ind. Electronics, vol.56, no. 8, pp. 2802-2810, Aug. 2009.

[4] A. Bitoleanu, M. Popescu M. Dobriceanu, F. Nastasoiu, "DC-bus voltage optimum control of three-phase shunt active filter system," in Proc. 12th International Conference on Optimization of Electrical and Electronic Equipment, pp. 538 - 543, May 2010.

[5] P.J. Randewijk, J.H.R. Enslin, "Inverting DC traction substation with active power filtering incorporated," in Proc. Power Electronics Specialists Conference, vol.1, 1995, pp. 360-366.

[6] K.-W. Lao, N. Dai, W.-G. Liu, M.-C. Wong, "Hybrid power quality compensator with minimum dc operation voltage design for high-speed traction power systems," IEEE Trans. on Power Electronics, vol. 28 , no. 4, pp. 2024 – 2036, 2013.

[7] A. Gonzalez-Gil, R. Palacin, P. Batty, and J.P. Powell, "Energy-efficient urban rail systems: strategies for an optimal management of regenerative braking energy," Transport Research Arena, Paris 2014.

[8] B. Bahrani, A. Rufer, "Optimization-based voltage support in traction networks using active line-side converters," IEEE Trans. on Power Electronics, vol. 28, no. 2, pp. 673 – 685, 2013.

[9] K. Shishime, "Practical applications of the railway static power conditioner (RPC) for conventional railways," MEIDEN Review, no. 156, pp. 38-41, 2012.

[10] X. Yang, X. Li, B. Ning, and T.Tang, "A survey on energy-efficient train operation for urban rail transit," IEEE Transactions on Intelligent Transportation Systems, vol. 17, issue 1, pp. 2-13, Jan. 2016.

[11] M.C. Falvo, D. Sbordone, A. Fernández-Cardador, A.P. Cucala, R. R Pecharromán, and A. López-López, "Energy savings in metro-transit systems: A comparison between operational Italian and Spanish lines," in Proc. Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit, vol. 230, no. 2, pp. 345-359, Feb. 2016.

[12] Á.J. López-López, R.R. Pecharromán, A. Fernández-Cardador, and A.P. Cucala, "Assessment of energy-saving techniques in direct-currentelectrified mass transit systems," Transportation Research Part C: Emerging Technologies, vol. 38, pp. 85-100, Jan. 2014.

[13] D. Iannuzzi, P. Tricoli, "Speed-based state-of-charge tracking control for metro trains with onboard supercapacitors," IEEE Trans. on Power Electronics, vol. 27, no. 4, pp. 2129–2140, Feb. 2012.

[14] Y. Warin, R. Lanselle, M. Thiounn, "Active substation," World Congress on Railway Research, Lille, France, May 2011.

[15] O. Solis, F. Castro, L. Bukhin, K. Pham, D. Turner, and G. Thompson: "Saving money every day: La metro subway wayside energy storage substation, in Proc. JRC, 2015 Joint Rail Conference, March 23 – 26, San Jose CA., 2015.

[16] M. Shimada, Y. Miyaji, T. Kaneko, and K. Suzuki, "Energy-saving technology for railway traction systems using onboard storage batteries," Hitachi Review, vol. 61, no. 7, pp. 312-318, 2012.

[17] S.S. Fazel, S. Firouzian, and B.K. Shandiz, "Energy-efficient emplacement of reversible DC traction power substations in urban rail transport through regenerative energy recovery," International journal of railway research, Jan. 2016.

[18] Alexandru Bitoleanu; Mihaela Popescu; Constantin Vlad Suru, Configuring and experimental evaluation of a laboratory model for filtering and regeneration in active DC traction substations, 2017 10th International Symposium on Advanced Topics in Electrical Engineering (ATEE), Year: 2017, Pages: 591 - 596, DOI: 10.1109/ATEE.2017.7905168.

[19] Alexandru Bitoleanu; Mihaela Popescu; Constantin Vlad Suru, Theoretical and experimental evaluation of the indirect current control in active filtering and regeneration systems, 2017 International Conference on Optimization of Electrical and Electronic Equipment (OPTIM) & 2017 Intl Aegean Conference on Electrical Machines and Power Electronics (ACEMP), Year: 2017, Pages: 759 - 764, DOI: 10.1109/OPTIM.2017.7975060

[20] Mihaela Popescu, A. Bitoleanu, and V. Suru, "Indirect current control in active DC railway traction substations," in Proc. ACEMP-OPTIMELECTROMOTION 2015 Joint Conference, Turkey, pp. 192-197, Sept. 2015.

[21] A. Bitoleanu, M. Popescu, V. Suru, "Optimal Controllers Design in Indirect Current Control System of Active DC-Traction Substation," PEMC 2016, Varna, Bulgaria, pp. 904-909.

[22] M. Popescu, A. Bitoleanu, and V. Suru, "A DSP_Based Implementation of the p_q Theory in Active Power Filtering Under Nonideal Voltage Conditions," IEEE Transactions on Industrial Informatics, Vol. 9 , Issue 2, pp. 880_889, May 2013.