Model Based Controllers for a Solar Power Plant

Manuel Gálvez-Carrillo*, R. De Keyser, C. Ionescu
*Department of Control Engineering and System Analysis
*Université Libre de Bruxelles, Av. F. D. Roosevelt 50 - CP165/55, B1050 Brussels, Belgium
*Email: mgalvezc@ulb.ac.be
Department Electrical energy, Systems and Automation
Ghent University, Technologiepark 913, B9052 Gent-Zwijnaarde, Belgium
Email: rdk@autoctrl.UGent.be

The concern about renewable energies is growing around the world due to their economical and environmental impact. Converting these clean sources of energy in other types that can account for human and industrial use is now of global interest [1]. Therefore, it is necessary not only to adequately design the conversion processes, but also to ensure their optimal technical and economical operation by means of good control strategies. The present work studies the distributed solar collector field ACUREX of the *Plataforma Solar de Almería*, located in the southern Spain. The parabolic-through technology of this plant is the only type of solar plant with existing commercial operating systems [2]. In such a system, a fluid (oil) is heated while travelling in the field, using the energy of the solar radiation concentrated by parabolic mirrors.

Our control objective is that the fluid outlet temperature follows the reference signal, by varying the inlet oil-flow. Notice that the main source of energy, the solar irradiation, cannot be manipulated [3] and constitute the main disturbance of the process. The process is also challenging because of the presence of variable time delay. A schematic of the process can be seen in Figure 1.

In this work, nonlinear and linear models have been obtained in order to replicate the process and disturbances, with emphasis of the adequate election of the variable time delay model. A nonlinear model based predictive control (MPC), the Nonlinear EPSAC (Extended Prediction Self-Adaptive Controller) [4], has been implemented with a modified Smith Predictor in order to overcome the fact of the presence of the variable time delay. This control strategy has been tested and compared with other two strategies: a linear MPC, the EPSAC; and a modified PI controller (Filtered Predictive PI, FPPI), that is designed based on a model of the plant. Both strategies are also combined with a Smith Predictor algorithm. The results are presented in Figure 2 for the output (outlet oil temperature). The nonlinear EPSAC controller behaves better than the other two linear ones, the linear EPSAC reacts faster the FPPI, but the latter is more robust when high changes in reference occur.

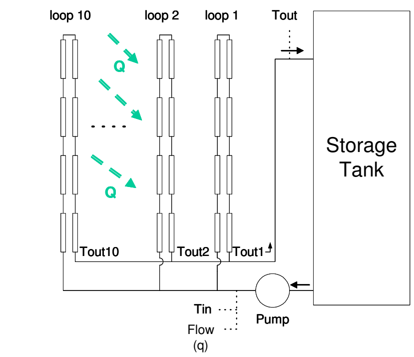

Figure 1: Schematic representation of the solar power plant.

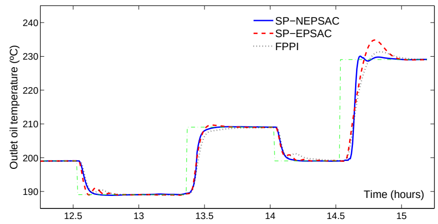

Figure 2: Comparison of Output Temperature for the designed controllers.

References

[1] A. Woloski, ”Fuel of the Future: A Global Push Toward New Energy”. *Harvard International Review*, vol.27, no.4, 40-43, (2006)

[2] V. Quaschning, M. Blanco, ”Solar Power - Photovoltaics or Solar Thermal Power Plants?”, *VGB Congress Power Plants*, Brussels, (2001)

[3] E. F. Camacho, M. Berenguel, F. Rubio, ”Advanced Control of Solar Power Plants”, *Springer-Verlag*, (1997)

[4] R. De Keyser,”Model Based Predictive Control”, *Invited Chapter in UNESCO Encyclopedia of Life Support Systems (EoLSS)*, article 6.43.16.1, Eolss Publishers Co Ltd, 30p, ISBN 0 9542 989 18-26-34 (2003)