International Journal of Research and Review
www.ijrrjournal.com E-ISSN: 2349-9788; P-ISSN: 2454-2237

Review Article

An Insight into Research and Studies on Control Systems in Chemical Industries

Sunil J. Kulkarni

Datta Meghe College of Engineering, Airoli, Navi Mumbai, Maharashtra, India.

Received: 21/08/2016 *Revised: 15/09/2016* *Accepted: 15/09/2016*

ABSTRACT

Chemical process industry is evolving day by day. One of the key aspects of processes is optimization and process control. Various control objectives such as optimizing temperature, pressure, conversion, flow, level are met by using different types of control systems. Feedback, feed forward and combination act as a control strategy. Various control systems such as proportional (P), proportional integral (PI), and proportional integral derivative control systems can be used according to requirements. Nowadays Fuzzy logic control system is considered promising in many applications because of its advantages. The current review summarizes research and studies on control systems in chemical industries.

Key words: Control objectives, response, algorithm, strategy, variables.

INTRODUCTION

Synthesis of various compounds and products from raw material in economical way is main objective of chemical processes. Various optimization techniques are used to maximize the profit. Many times advanced methods are used and compared with old techniques. The production of many compounds can be carried out by new cost effective methods such as reactive chromatography, reactive adsorption, reactive extraction etc. [1-6] These methods also work as a separating unit for the products. The optimization of temperature and heat integration is also important aspect of process optimization. [7,8] Effective use of available resources and waste heat recovery can make the process more economical. [9,10]

Reuse and recycle of the material used in the process can add economical and environmental value of the process. [11-14] Reuse of waste water from the process can minimize water requirement of the process. [15-17] For fulfilling various process objectives, it is important to properly identify measured, controlled and manipulated variables. Also modeling the process is important part of process control. Feedback, feed forward and combination of these two can be used as per requirement. The combined feedback-feed forwards control system is many time more effective. Conventional controllers (P, PI, PID), when chosen sensibly, many times yield proper and fast response. Nowadays fuzzy logic control method is being explored in many applications. The current review summarizes research and studies on control systems in chemical industries.

CONTROL SYSTEMS IN CHEMICAL INDUSTRIES: AN INSIGHT INTO RESEARCH AND STUDIES

Musmade et.al presented the sliding mode controller for chemical processes. [18] In this control system, according to system status, the structure of the control input is changed. They designed a strategy based on

linearization of non linear models. They applied this sliding mode controller strategy for continuous yeast fermentation process. They observed that compared to conventional processes, this strategy yielded better dynamic response.

Ansari et.al carried out studies on modeling and controlling the level of nonlinear process. [19] They reiterated the fact that controlling a non-linear process is a highly complicated and complex process. Many time the level control strategy needed to be studied carefully as the tanks are of different sizes. They proposed different control schemes such as conventional PID controllers based on Ziegler-Nicholas (ZN-PID) method, Chien, Hrones and Reswich (CHR-PID) method, Tyres-Luyben (T-L-PID) method, Internal Model Control (IMC-PID) and Model Predictive Controller (MPC) method. They defined control objectives such as a minimum settling time, peak overshoot and rise time.

Rukkumani et.al carried out studies on process control in sugar industries. [20] They studied control aspects of neutralization of sugar cane juice. According to them, this is complicated process since it exhibits non linearity. They used PID control and fuzzy logic control. As the process was non linear, they found that PID controller was ineffective. They used Fuzzy logic control for this purpose. They found that this method was effective. They used pH as measured variable. They found that Fuzzy logic controller was better option for higher value while for lower value, PID controller can be used. Topolska presented the role of quality control operations in such a complex manufacturing process. [21] They presented the case of plastic forming. They presented quality operation analysis of three main types. First was general one conducted by quality controllers. The second and third operations were ones conducted by process operators and client quality operation.

Rajinikanth and Latha used evolutionary algorithm for unstable systems in tuning and retuning of PID controller. [22] They presented particle swarm optimization (PSO) algorithm to tune and retune the PID controller parameter. They explained development of particle swarm optimization. They concluded that this method improves the performance of the process in terms of time domain specification, set point tracking, disturbance rejection, error minimization, and measurement noise attenuation. Amrit carried out studies on process economics in model predictive control. [23] For the automatic feedback controller, according to him, most important aspect is, maximizing the profit for the system with external disturbances. Most of the times set point/target terminology is the means by which we set desired condition. According to him because of this, many economical considerations are lost. So it happens that the dynamic regulation layer has no information about original plant economics. He developed a model that maximizes plant economy in dynamic regulation model.

Bharti carried out studies on direct digital control (DDC). [24] He reviewed the structure of DDC as well as its working with illustration. He explained benefits of DDC. According to these studies, by using DDC, more complex control schemes, energy and optimization strategies can be implemented. Also operational efficiency and energy efficiency is increased. Last but not the least; DDC is economically more viable considering initial equipment cost, operational cost and savings from performance improvement and modifications.

Afonso et.al carried out investigation on experimental evaluation of an automatic procedure for sensor fault detection. [25] Also they identified faults in a real process under closed-loop control. They used a moving window statistical analysis method for fault detection of the estimated model parameters. They carried out experiments in an industrial-scale pilot plant. They found that the system exhibited a good performance, despite the large number of uncertainties and nonlinearities. In their investigation Chandan and Agnihotri

compared Fuzzy Logic controller and conventional PID controller for flowing fluids. [26] They used MATLAB software for implementing these controllers. Fuzzy logic control can work with less precise input. Also it can do without fast processor. Also its robustness makes it more effective. They found that response of the PID controller is oscillatory. On the contrary, it was observed that the fuzzy logic controller was free from these dangerous oscillations in the transient period.

Shakya et.al carried out comparative studies for the proportional derivative controller, conventional PID controller and fuzzy logic controller for flowing fluids. [27] They used MATLAB and Simulink tools. Their study also found that the fuzzy logic controller has small overshoot and fast response. They concluded that Fuzzy logic controller is better than the conventionally used PID controller. Kala et.al studied performance of different types of controllers for industrial processes. [28] According to them, first order plus dead time (FOPDT) process are predominant in industries. They applied FOPDT model for the blending process. They used modern predictive controller (MPC) for predicting the future evolution of the process to optimize the control signal.

Application of fuzzy control for flow system was studied by Rajguru et.al. [29] According to him, in various areas such as flow process plants, power plants, thermal process plants, oil refineries, diagnosing medical problems, fuzzy logic control system finds application because of its decision making ability. They highlighted the important characteristics in design of fuzzy logic controller for chemical industrial applications.

Performance of different control architectures for reactor system was studied by G.Kaur and R. Kaur. [30] They also carried out Time domain and frequency domain analysis of different controllers. They used Feedback controller and feedback plus feed-forward controller for controlling temperature of the continuous stirred tank reactor (CSTR). In their studies, they found that the feedback plus feed forward controller is best as compared to feedback controller.

CONCLUSION

Investigation by various investigators suggests that compared to conventional processes, sliding mode controller yielded better dynamic response. Controlling a non-linear process is a highly complicated and complex process. According to various studies, fuzzy logic controller was better option for higher value of variables while for lower value, PID controller can be used. Also the study on particle swarm optimization (PSO) algorithm method revealed that PSO improves the performance of the process in terms of time domain specification, set point tracking, disturbance rejection, error minimization, and measurement noise attenuation. It was also observed in few studies that DDC is economically more viable considering initial equipment cost, operational cost and savings from performance improvement and modifications. The feedback plus feed forward controller is better as compared to feedback controller.

REFERENCES

1. Sunil Jayant Kulkarni, “A Review on Research and Advancements in Extractive Distillation”, International Journal of Research, 2015, 2(1), 306-309.
2. Sunil Jayant Kulkarni, “Advancements, Research and Challenges in Reactive Adsorption: A Review”, International Journal of Research, 2015, 2(1), 310-313.
3. Rashmi Vinod Dahake, A.K.Goswami, Dr. V. Kalyanraman, S.J. Kulkarni, “Performance Evaluation of Hybrid Membrane Bioreactor for Low Strength Wastewater Treatment”, International Journal of Science, Engineering and Technology Research, 2013, 2(12), 2167-2169.
4. Manisha Sharma, Raj Vyas, Kailash Singh, “A Review on Reactive

Adsorption for Potential Environmental Applications", Adsorption, 2013, 19(1), 161-188.
5. Sunil J. Kulkarni, Ajaygiri K. Goswami, "Applications and Advancements in Treatment of Waste Water by Membrane Technology- a Review", International Journal of Engineering Sciences & Research Technology, 2014, 3(9), 446,450.
6. R.P.Bhatt, Prof. S.B. Thakore, "Extractive Distillation of Acetic Acid from its Dilute Solution using Lithium Bromide", International Journal Of Scientific Engineering And Technology, 2012, 1(2), 46-50.
7. Y. P. Bhalerao, S. V. Patil, P. V. Vijay Babu, And S. J. Kulkarni, "Energy Retrofit Studies in Diethyl Thiophosphoryl Chloride (DETC) Plant", International Journal of Chemical Engineering and Applications, 2011, 2(6), 439-443.
8. Sunil J Kulkarni, "A Review on Studies and Research on Insulation", International Journal of Science & Healthcare Research. 2016; 1(1):66-69.
9. Sunil J. Kulkarni, Pallavi M. Kherde, "Review on Studies and Research on Heat Recovery, Regeneration and Cogeneration", Int. J Res Rev., 2015, 2(9), 584-589.
10. Murugesan M.P. And Balasubramani R., "The Experimental Study on Enhanced Heat Transfer Performance in Plate Type Heat Exchanger", Research Journal of Engineering Sciences, 2013, 2(2), 16-22.
11. Sunil Kulkarni, Dr Jayant Kaware, "Regeneration and Recovery in Adsorption- A Review", International Journal of Innovative Science Engineering and Technology, 2014, 1(8), 61-64.
12. Sunil J. Kulkarni, Dr. Jayant P. Kaware, "Phenol Desorption From Adsorbent - A Review", International Journal of Engineering Sciences & Management Research, 2015, 2(6), 6 -8.
13. Sunil J. Kulkarni, Dr. Jayant P. Kaware, "A Review On Desorption Of Cadmium from Adsorbent", International Journal of Engineering Sciences and Management Research, 2015, 2(6), 1-4.
14. Sunil Jayant Kulkarni, "Recycle And Reuse of Water- A Review", International Journal of Research, 2014, 1(11), 602-805.
15. Y.H. Yang, H.H. Lou, Y.L. Hueng, "Synthesis of Optimal Wastewater Reuse Network", Wastewater Management, 2011, 20, 311-319.
16. Vasileios Tsiridis, Athanasios Ougolos, Angelos Kotios, Panagiotis Plageras, Yiannis Saratsis, "Wastewater Reclamation and Reuse", Discussion Paper Series, 2009, 15(7), 139-148.
17. Pallavi Amale, Sunil Kulkarni, Kavita Kulkarni, "A Review on Research for Industrial Wastewater Treatment with Special Emphasis on Distillery Effluent", International Journal of Ethics in Engineering and Management Education, 2014, 1(9), 1-4.
18. B. B. Musmade, R. K. Munje, B. M. Patre, "Design Of Sliding Mode Controller To Chemical Processes for Improved Performance", International Journal Of Control And Automation, 2011, 4(1), 15-18.
19. A. Thamemul Ansari, K. Thivakaran, K. Tharani Raja, H. Kala, S. Abirami, "Modelling and Controlling the Level Of Nonlinear Process Via Diverse Control Strategies", International Journal Of Advanced Research In Electrical, Electronics And Instrumentation Engineering, 2014, 3(9), 11755-11763.
20. Rukkumani V., Khavya S., Madhumithra S., Nandhini Devi B., "Chemical Process Control In Sugar Manufacturing Unit", International Journal Of Advances In Engineering & Technology, 2014., 6(6), 2732-2738.
21. S. Topolska, "The Role Of Quality Control Operations In A Process Of Plastic Forming", Journal Of Achievements In Materials And Manufacturing Engineering, 2007, 23(2), 95-98.
22. V. Rajinikanth and K. Latha, "Tuning and Retuning of PID Controller For unstable Systems Using Evolutionary Algorithm", International Scholarly Research Network, Chemical Engineering, 2012, volume 2012, Article Id 693545, and 10 Pagesdoi: 10. 5402/2012/693545.

23. Rishi Amrit, "Optimizing Process Economics In Model Predictive Control", Dissertation Submitted In Partial Fulfillment of The Requirements For The Degree Of Doctor Of Philosophy (Chemical Engineering), University Of Wisconsin-Madison 2011,1-193.
24. Om Prakash Bharti, "Direct Digital Control", IOSR Journal of Electrical and Electronics Engineering, 2013, 7(4), 06-10.
25. P. A. F. N. A. Afonso, J. M. L. Ferreira And J. A. A. M. Castro, "Sensor Fault Detection And Identification In A Pilot Plant Under Process Control", Institution Of Chemical Engineers Trans ICHEME, 1998, 76(A), 490-498.
26. Sahil Chandan, Rahul Agnihotri, "Fuzzy Logic Controller for Flowing Fluids", International Journal of Advanced Research in Computer Engineering and Technology, 2012, 1(4), 98-101.
27. Ritu Shakya, Kritika Rajanwal, Sanskriti Patel and Smita Dinkar, "Design and Simulation of Pd, PID and Fuzzy Logic Controller for Industrial Application", International Journal of Information and Computation Technology, 2014, 4(4), 363-368.
28. H. Kala, P. Sathiya, G. Vijayalakshmi, "Performance Estimation of Different Controller for the Industrial Based Process", International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering, 2016, 4(1), 112-114.
29. Snehal N. Rajguru, Pritesh Shah, Neelarayavarapu And Priyanka Tupe, "Application Of Fuzzy Controllers For Flow Control Processes In chemical Industries", Journal Of Chemical And Pharmaceutical Research, 2014, 6(12), 403-410.
30. Gagandeep Kaur Rupinder Kaur A., "Comparative Study of Performance of Different Control Architectures for Reactor System", International Journal of Computer Applications, 2012, 41(11), 36-39.

How to cite this article: Kulkarni SJ. An insight in to research and studies on control systems in chemical industries. Int J Res Rev. 2016; 3(9):16-20.

******