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Coolant Tank Monitoring and Control of Level and Temperature Based on Fuzzy Logic

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ABSTRACT: Tank gauging by fuzzy is much more than just automated inventory management in fuelling operation, collecting accurate information from the site with less effort. The aim of the project is to improve monitoring and control operation in fuzzy based tank farm control system. Here, it is developed to control level and temperature. Automatic fuelling operation is done and accurate information is collected by using fuzzy. It has to be done using a high-performance language used for technical computing (MATLAB).

KEYWORDS: Level Control, Temperature Control, Fuzzy Logic Control, MATLAB

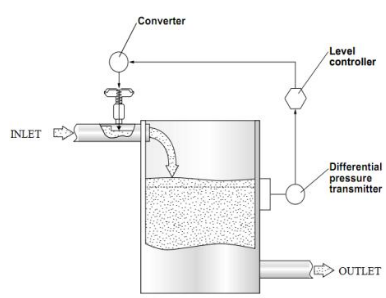
I. INTRODUCTION

Liquid level and temperature, monitoring and control is a typical representation of process control and is widely used in iron and steel, chemicals, petroleum and other industries. The control quality directly affects the quality of products and safety of equipment. The liquid level and temperature, monitoring and control have been an active area in the process control over last decades and various different approaches have been devised. Manual tank dipping is still the most common method used today to obtain liquid levels for inventory management purposes. Tank gauging is much more than just automated inventory management, in fuelling operation, collecting accurate information from the sites with less effort and allows making better decisions. Distributed Control Systems (DCS) are hard to design, debug, test and formally verify.Hence, fuzzy based tank gauging can be implemented.

Fuzzy rule is used here for coolant tank level and temperature monitoring and control purpose. Additional benefits of fuzzy logic include its simplicity and its flexibility. Fuzzy logic can handle problems with imprecise and incomplete data, and it can model nonlinear functions of arbitrary complexity. A linguistic variable is a variable whose values are linguistic terms. The concept of linguistic variable is very useful in dealing with situations which are too complex or too ill-defined to be reasonably described in conventional quantitative expressions. These linguistic variables can also be represented by fuzzy numbers. Accuracy is higher and high effort is not needed. Fast response, small overshoot and good robustness can be obtained through fuzzy.Fuzzy controllers have a relatively small computation cost. They are also very simple to implement in that the user can easily observe and check each step in the workings of the software implementation.Software used here is MAT LAB.

II. Principle of Liquid Level and Temperature Control System

A. Level Control



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The speed of changes in a level control loop largely depends on the size and shape of the process vessel (e.g., larger vessels take longer to fill than smaller ones) and the flow rate of the input and outflow pipes.

Manufacturers may use one of many different measurement technologies to determine level, including radar, ultrasonic, float gauge, and pressure measurement. The final control element in a level control loop is usually a valve on the input and or outflow connections to the tank. Because it is often critical to avoid tank overflow, redundant level control systems are sometimes employed.

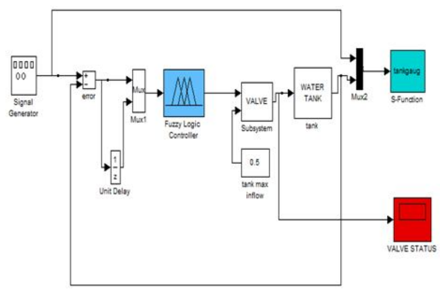

Fig2.Basic control principle of the system

B. Temperature Control

Because of the time required to change the temperature of a process fluid, temperature loops tend to be relatively slow. Feed forward control strategies are often used to increase the speed of the temperature loop response.

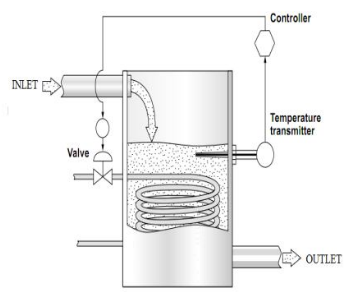

Fig3.Temperature loop

RTDs or thermocouples are typical temperature sensors. Temperature transmitters and controllers are used, although it is not uncommon to see temperature sensors wired directly to the input interface of a controller. The final control element for a temperature loop is usually the fuel valve to a burner or a valve to some kind of heat exchanger.

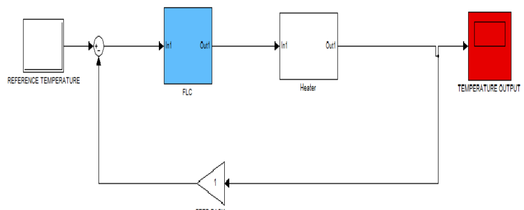

Fig 4.Basic control principle of the system

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III. FUZZY CONTROL OF LIQUID LEVEL CONTROL SYSTEM SIMULATION

The fuzzy rule involves two inputs namely error and change in error(delay) both the errors are connected using a multiplexer. Water tank involves in maintaining the height of the tank. Tank gauging involves in controlling the level of the tank. The inputs involved here are level and rate. The output can be controlled by using the valve.

A. Fuzzification

Set the level range (-1 1) and input rate range as (-0.1 0.1).The corresponding fuzzy sets are (high, medium, low, none, negative, positive).Negative small, positive small, positive large). The both forms of membership function are all gaussmf.

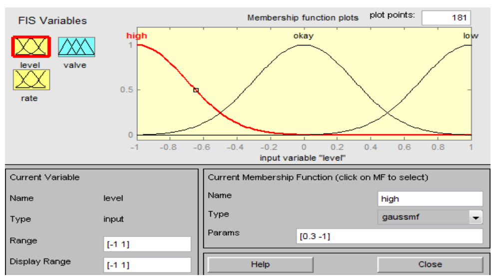

Fig5.Membership function curve

B. Rule Evaluation

1. If the level is accurate, valve does not have any change.
2. If the level is low, the valve is opened faster.
3. If the level is high, the valve is closed faster.
4. If the level is accurate and the rate is positive, valve is closed slowly.
5. If the level is accurate and rate is negative, valve is opened slowly.

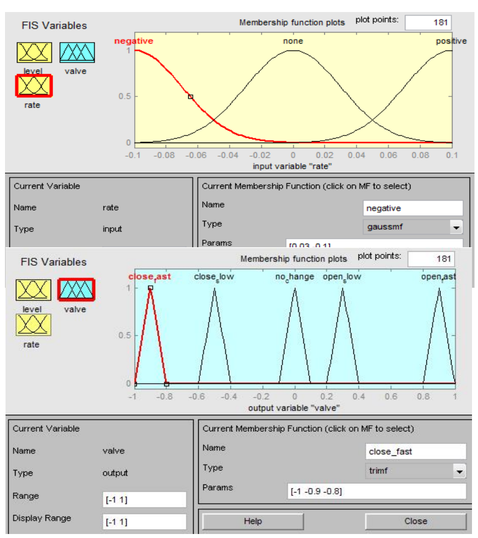

Fig 6.Membership function curve of output

C. **Defuzzification**

Set the valve range (-1,1). The corresponding fuzzy sets are (close fast, close slow, no change, open slow, open fast)The membership function is in the form of trimf (triangle).

IV. Fuzzy Control of Liquid Temperature Control Simulation

Reference temperature is set in the range (0 100). Heater is the final control element of temperature control system. The output is given as the feedback to the input.

A. **Fuzzification**

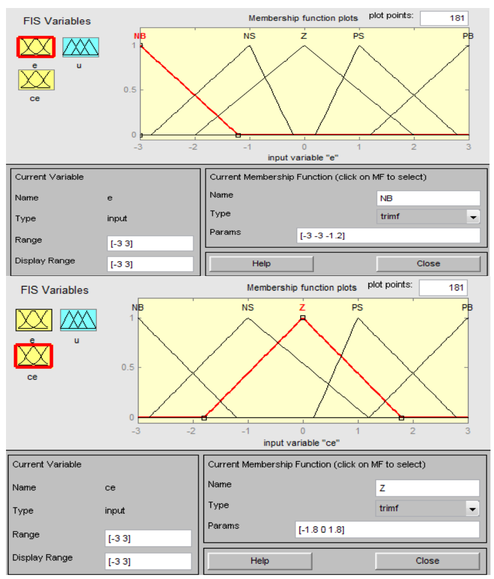

Fig7.Membership function curve

Set the input variable 'e' range (-3 3) and input variable 'ce' range as (-3 3).The corresponding fuzzy sets are (NB, NS, Z, PB, PS). The both forms of membership function are all trimf (triangle).

B. **Rule Evaluation**

1. If (e is NB) and (ce is NB) then (u is NB)
2. If (e is NB) and (ce is NS) then (u is NB)
3. If (e is NB) and (ce is Z) then (u is NB)
4. If (e is NB) and (ce is PS) then (u is NS)
5. If (e is NB) and (ce is PB) then (u is Z)
6. If (e is NS) and (ce is NB) then (u is NB)
7. If (e is NS) and (ce is NS) then (u is NS)
8. If (e is NS) and (ce is Z) then (u is NS)
9. If (e is NS) and (ce is PS) then (u is Z)
10. If (e is NS) and (ce is PB) then (u is PS)
11. If (e is Z) and (ce is NB) then (u is NB)
12. If (e is Z) and (ce is NS) then (u is NS)
13. If (e is Z) and (ce is Z) then (u is Z)
14. If (e is Z) and (ce is PS) then (u is PS)
15. If (e is Z) and (ce is PB) then (u is PB)

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16. If (e is PS) and (ce is NB) then (u is NS)
17. If (e is PS) and (ce is NS) then (u is Z)
18. If (e is PS) and (ce is Z) then (u is PS)
If (e is PS) and (ce is PS) then (u is PS)
20. If (e is PS) and (ce is PB) then (u is PB)
21. If (e is PB) and (ce is NB) then (u is Z)
22. If (e is PB) and (ce is NS) then (u is PS)
23. If (e is PB) and (ce is Z) then (u is PB)
24. If (e is PB) and (ce is PS) then (u is PB)
25. If (e is PB) and (ce is PB) then (u is PB)

C. **Defuzzification**

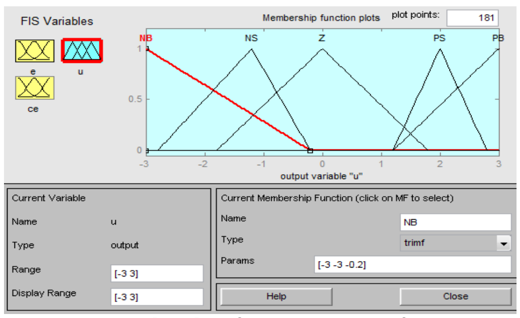

Fig 8.Membership function curve of output

Set the output ‘u’ range (-3 3). The corresponding fuzzy sets are (NB, NS, Z, PB, PS). The membership function is in the form of trimf (triangle).

V. EFFECT OF FUZZY CONTROL

The Level and Temperature control system is built on MATLAB through the fuzzy logic control results are as follows:

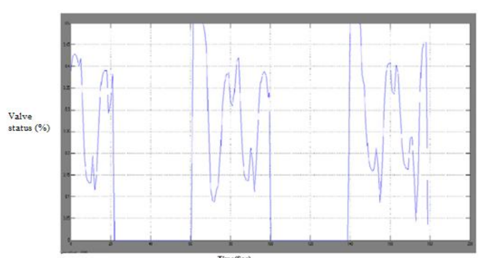

Fig 9.Fuzzy output- Level

Simulation results shows that in Fuzzy control system the outputs can be produced without effort and response can be obtained faster and accurately.

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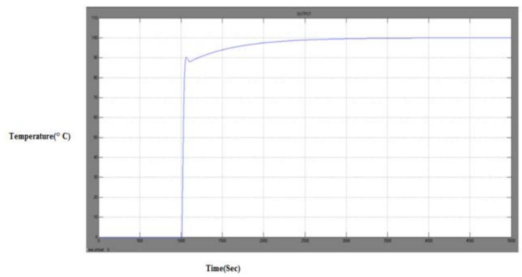

Fig 10.Fuzzy output- Temperature

VI. CONCLUSION

The use of fuzzy systems rather than conventional controllers provides an efficient solution for the control of real problems, the more accurate and stable regulation is provided by the fuzzy controller. The main benefit is that, strict mathematical modelling of the processes concerned is not required. This work has been developed to alleviate the slow response, complexness, more effort and hard verification. The main objective of the proposed method is to have more control over automatic fuelling operation with less effort, fast response, less computation cost. The new proposed control method can be effectively applied for monitoring and controlling the level and temperature of the tank accurately based on fuzzy through matlab simulation.

REFERENCES

[1] J.G.Ziegler and N.B.Nichols, "Optimum settings for automatic controller," ASME Trans. Vol.64, pp.759-768, 1942.
[2] D.A.Coggen,C.L.Alerl,Fundamentals of industrial control, Instrument Society ofAmerica,1992.
[3] G. Klir and B. Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall, Upper Saddle River, NJ, 1995.
[4] WangJian, Zhang Yi and Qin Tinggao, "Application of Self-Adjusting Parameter Fuzzy Controller in the Temperature Control System with Moisture Analyzer", IEEE International Conference on Control and Automation, China, June, 2007, pp.1139-1142.
[5] Yu Dejiang, Mao Zhongyuan, Zhou Qijie and T. P. Leung, "The Optimized Fuzzy Logic in Control Systems", IEEE, Proceedings of the International Conference on Industrial Technology, China, Dec. 1994, pp. 174-178.
[6] Lee C C, "Fuzzy Logic in Control Systems: Fuzzy Logic Control (Part I)", IEEE Trans. on System Man and Cybernetics, vol. 20, pp. 404-418, 1990.
[7] H.M.Chen,Z.Y.Chenand J. P. Suo "Design of a Sliding Mode Controller for a Water Tank Liquid Level Control System," Journal of Innovative Computing, Information and Control vol. 4, no. 12, pp. 3149-3159, 2008.
[8] X.L. Fang, T. Shen and X. S. Feng. "The Bang-Bang Control of Water Tank System Based on Fuzzy Decision," in proceedings of the ninth International Conference on Hybrid Intelligent Systems, IEEE Press, August, 2009,pp.127-131.
[9] M.G.Na. "Design of a Genetic Fuzzy Controller for the Nuclear Steam Generator Water Level Control," Journal of IEEE Transactions on Nuclear Science, Vol. 45, No. 4, pp. 2261-2271.1998.