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Sewage treatment control based on adaptive fuzzy algorithm

Weiping Zhang[a,b], Mohit Kumar[b,d], Junfeng Yu[b], Jiangxia Wang[b], Yihua Mao[c,*]

[a]*Department of Electronic Information Engineering, Nanchang University, Nanchang, No. 999 University Avenue Honggutan, China, email: zhangweiping@zjubh.com*
[b]*Binhai Industrial Technology Research Institute of Zhejiang University, Gaoxin 6 Road, Binhai High Tech Zone, Tianjin 300301, China, emails: junfengyu@zjubh.com (J. Yu), jiangxiawang@zjubh.com (J. Wang)*
[c]*Zhejiang University College of Civil Engineering and Architecture, AnZhong Bldg, Zijingang Campus, Hangzhou 310027, China, email: maoyihua@zjubh.com*
[d]*Faculty of Computer Science and Electrical Engineering, University of Rostock, Universitaetsplatz 1, 18055 Rostock, Germany, email: mohitkumar@zjubh.com (M. Kumar)*

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ABSTRACT

China is one of the countries with severe water shortage. Water resource per capita is one quarter of the world average. China's river systems are subject to different degrees of pollution. Waste water is generated in the control design water pH monitoring and acid-base neutralization process. The paper is mainly developed to introduce fuzzy adaptive PID control into S7-300PLC and establish a closed loop PID control system. The simulation results show that the fuzzy control system mentioned in this paper is much better than the conventional PID control system. The study solves key technical problems in the wastewater treatment process so as to create economic benefits.

Keywords: Wastewater treatment; pH value control; Fuzzy adaptive PID; PLC; S7-300

1. Introduction

Water pollution is a major problem in our country. Apart from separating out harmful components in the sewage, the main task of sewage treatment is to convert it into harmless material. The traditional water treatment regulator added is not easy to control. It has high energy consumption and great harm to the human body. The effect of the qualified emission index is not good and the operation cost is high. Therefore, it is the current development trend to replace manual control with pH value automatic control [1].

More and more attention has been paid to environmental problems in China. The research of modern control theory provides a good prospect for the whole industry of water treatment.

The economically developed countries such as the United States, Japan and Western Europe attach importance to the problem of automatic control of sewage treatment. The technology of computer automatic control system has been adopted, and the ideal effect has been obtained [2].

pH value control is mainly used in the process of acid and alkali neutralization in water treatment. The key to this process is to consider the basis of the control theory. The control theory is developed from the traditional control theory to the modern control theory, and then to the present artificial intelligence control theory.

Block fuzzy blur can be established according to the table obtained in the program table array. Because the two input E and EC membership degree of the fuzzy controller in the system are the same, it can be divided into six grades by calculation. E and EC obtain the corresponding membership set XI and X2. The fuzzy adaptive PID control algorithm is applied to the control system of wastewater treatment [3].

* Corresponding author.

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Design process, including the design of PLC control system and PC monitoring system, has put forward the overall design scheme of the pH value control system for wastewater treatment.

The reasoning function can realize the process of fuzzy reasoning. Based on a well-defined control table in a fuzzy block, reasoning operation block adopts the Mamdani reasoning principle. In order to realize the fuzzy self-tuning of PID parameters in PLC, a fuzzy control table must be set up in the data memory of PLC. The error E and the error variation amount EC are combined with MATLAB Toolbox blur. In addition, the control rule of each output fuzzy is used. The fuzzy set of three output parameters in fuzzy adaptive PID control can be obtained.

2. pH of water treatment systems theory and technology

2.1. Process analysis

Industrial wastewater often shows acidic or alkaline property. As direct emissions will cause water pollution, a series of processing is needed. According to Chinese National Standard: Discharge Standard of Pollutants for Municipal Wastewater Treatment Plant [11], predetermined pH value for sewage should be between 6 and 9. The process is to add chemicals to the wastewater so that it reacts with contaminants in the water. After the pH (pH value) of the waste water is adjusted, the waste water will become neutral. The treatment of waste water can be improved through varied acids.

pH was raised in 1907 by the Danish biochemist Soren Peter Lauritz Sorensen. pH value, also known as a hydrogen ion index of solubility, referring to the amount and the total number of H^+ ions of the total mass ratio [4]. It represents the degree of acidic or basic solution. The hydrogen ion solubility negative common logarithm of the expression is:

$$\mathrm{pH} = -\log[\mathrm{H}^+] \text{ or } [\mathrm{H}^+] = 10^{-\mathrm{pH}} \tag{1}$$

pH hydrogen ion concentration index generally ranges 0–14. When the neutral solution is 7, then the acidic is less than 7. The smaller the value is, the stronger the acid is. The basicity is greater than 7. The larger the value is, the stronger the basicity is.

The basic process:

Water molecules dissociation according to the following formula:

$$\mathrm{H_2O} \leftrightarrow \mathrm{H}^+ + \mathrm{OH}^- \tag{2}$$

Water dissociation equilibrium values are:

$$\mathrm{Kw} = [\mathrm{H}^+][\mathrm{OH}^-] = 10^{-14} \tag{3}$$

Eq. (2) can be arbitrarily determined by the formula with a known pH bits hydroxide concentration of the aqueous solution:

$$[\mathrm{OH}^-] = 10^{\mathrm{pH}-14} \tag{4}$$

The solution obtained thereby:

$$\mathrm{Kw} = [\mathrm{H}^+][\mathrm{OH}^-] = 10^{-14} \tag{5}$$

It can be drawn:

$$[\mathrm{H}^+] = \sqrt{\frac{x^2}{4} + \mathrm{Kw}} + \frac{x}{2}$$
$$[\mathrm{OH}^-] = \sqrt{\frac{x^2}{4} + \mathrm{Kw}} - \frac{x}{2} \tag{6}$$

roll out:

$$\mathrm{pH} \approx f(x) = -\log\left(\sqrt{\frac{x^2}{4} + \mathrm{Kw}} + \frac{x}{2}\right) \tag{7}$$

In the reaction, the concentration and pH value shows the correspondence relationship below. As shown in Fig. 1, the function $f(x)$ become a curve, and the abscissa is the concentration difference $x_a - x_b$.

Process can be clearly seen from the graph. In general, acid-base neutralization process is of severe nonlinear characteristics after tested due to excessive acidic substance contained in the wastewater. There is reason manual control manner and it is too backward. If acidic and basic substances are manually added, the pH value will be without warning of low or high, and it is found that the pH hydrogen ion concentration index is generally between 0 and 14. When the neutral solution is 7, then the acidic is less than 7. The smaller the value is, the stronger the acid is. The basicity is greater than 7. The larger the value is, the stronger the basicity is. pH value cannot be sure, and it may be a waste of the drug. The drug costs have increased, prone to make excessive emissions, polluting the environment [5].

Further analysis of the titration curve changes, determined function/expression is the derivative:

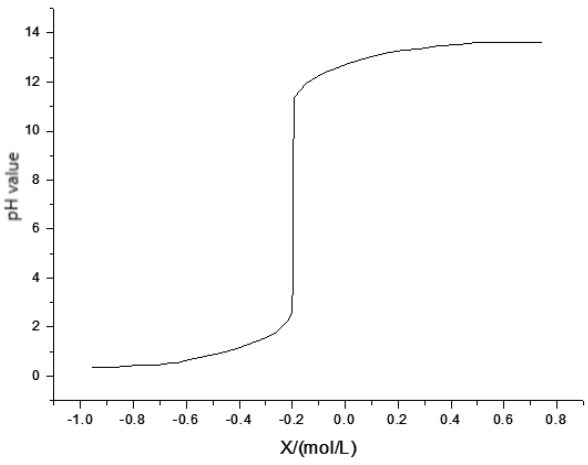

Fig. 1. Acid-base titration curve.

$$f'(x) = \frac{\lg e}{2\sqrt{\frac{x^2}{4} + Kw}} \tag{8}$$

In the formula, $f'(x) = 0$, that is, at pH = 7, $f'(x)\max = 2.2 \times 10^6$. For larger or smaller pH value, $f'(x)$ decreases sharply.

2.2. Waste water treatment and process characteristics and mechanism analysis model

CSTR process system model is shown in Fig. 2. In the state model, the pH and the process can be analyzed.

The parameters in Fig. 2 are as follows: wastewater flow F_1- acid (base); F_2- inlet flow neutralizer base (acid), that is, the control amount $u(t)$; A wastewater C_1 solubility acid (base); C_2- solubility inflow base neutralizer (acid); *xa*A total acid solubility stream (base): *xb*A base stream (acid) is the total solubility; *V*- reactor volume.

Measuring the pH of the waste water effluent outlet of the waste water channel, if the pH value does not meet national emissions requirements, it is returned to the reactor through the return valve; by the addition of an appropriate amount of acid neutralizing agent, alkali waste water pH can eventually reach the outlet value of emission standards.

The entire process is controlled by the model. It is not only static and dynamic models with complete composition. The stability of the chemical constituents is the static model. The mass concentration of the fully dynamic model represents a dynamic change in CSTR [6]. And we are dealing with waste water from a waste liquid that comes Ran exchanger, its acidic and basic positioning is uncertain, the acid can be mutated to mutated alkaline, so in this case we require two neutralizing agents.

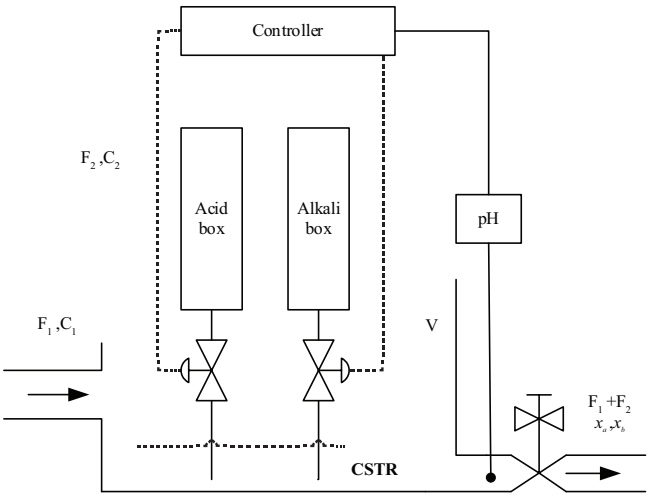

Fig. 2. System of CSTR process schematics.

Expression is as follows:

$$F_1(t)C_1 - [F_1(t) + F_2(t)]x_a = V\frac{dx_a}{dt} \tag{9}$$

Expressed as:

$$F_2(t)C_2 - [F_1(t) + F_2(t)]x_a = V\frac{dx_b}{dt} \tag{10}$$

Dynamic control model by Eqs. (9) and (10) to obtain CSTR system is as follows:

$$\begin{aligned} F_1(t)C_1 - V\frac{dx_a}{dt} &= [F_1(t) + u(t)]x_a \\ F_1(t)C_2 - V\frac{dx_b}{dt} &= [F_1(t) + u(t)]x_b \end{aligned} \tag{11}$$

Make $y = x_a - x_b$ comprehensive Eqs. (9) and (10) can be simplified to:

$$V\frac{dy}{dt} = (C_1 - y)F_1(t) - (C_2 - y)F_2(t) \tag{12}$$

Herein, the non-linear characteristics of pH for the process are described, the main processes for the reaction of HCl and NaOH to pH process are described. By Eqs. (3) and (11), final CSTR acid and alkali to give an overall control system model:

$$\frac{d\mathrm{pH}}{dt} = \frac{(C_1 - 10^{-\mathrm{pH}} + 10^{\mathrm{pH}-14}) \times F_1(t) - (C_2 - 10^{-\mathrm{pH}} - 10^{\mathrm{pH}-14})F_2(t)}{V[\ln 10(-10^{-\mathrm{pH}} - 10^{\mathrm{pH}-14})]} \tag{13}$$

2.3. PID control system overview

PID represents the proportional, integral, differential regulation. When you adjust the shock curve is a curve, *P* is the slope control adjustment, that is, the opening speed, shock adjustable time integral, derivative control deviation, that is, the amplitude of the curve. The basic structure of a general closed-loop control system is shown in Fig. 3, in general by

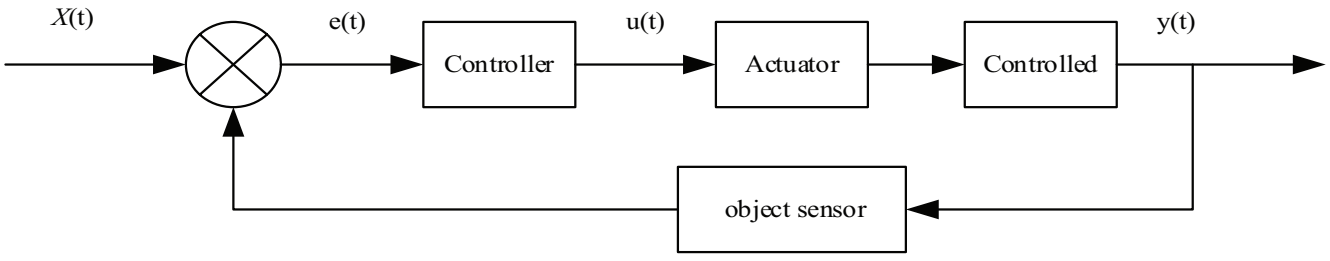

Fig. 3. Basic structure of a conventional closed loop control system 3.

a controller, the actuator, and a feedback controlled object composition [7]. The basic structure of the computer-controlled closed-loop system which includes two basic units (AD and DA) in the circuit is shown in Fig. 4.

PID control is a parallel control, PID control system is a continuous mathematical expression that can be represented by the following formula:

$$u(t) = K_p\left[e(t) + \frac{1}{T_i}\int_0^t e(t)dt + T_d\frac{de(t)}{dt}\right] \quad (14)$$

among them: $u(t)$ is the output controller and $e(t)$ is the controller input. K_p, T_i and T_d, respectively, refers to the proportional coefficient, integral time and derivative time.

Digital PID control algorithm position is the most commonly used PID control algorithm and incremental PID control algorithm. DCS system is a distributed control, analog signal processing, and good PLC logic programming system that can handle digital signals; the PID control loop is adjusted, not the system.

STEP 7 programming software, using standard library and the PID control, the OB35 is executed at fixed time intervals cycle row block of the flowchart of Fig. 6 PID tissue control algorithm [7]. Incremental PID control algorithm shown in Fig. 5 contains a flowchart of an algorithm integral separation HD controller.

Simply put, PID is broad but not exclusive, because the physical meaning is fairly clear that many systems can tune up a few. Now, if there is no model, there is no input and output data.

Once the model is applied, even with the input and output data, in addition to third-order LTI system including the following, for most systems, PID effect can only be considered acceptable. General specifically adapted control algorithms can be found in certain subcategories of the system, the effect is better than PID: but these algorithms are often designed without Bo, which, if changed, could pose a big problem to other systems [8].

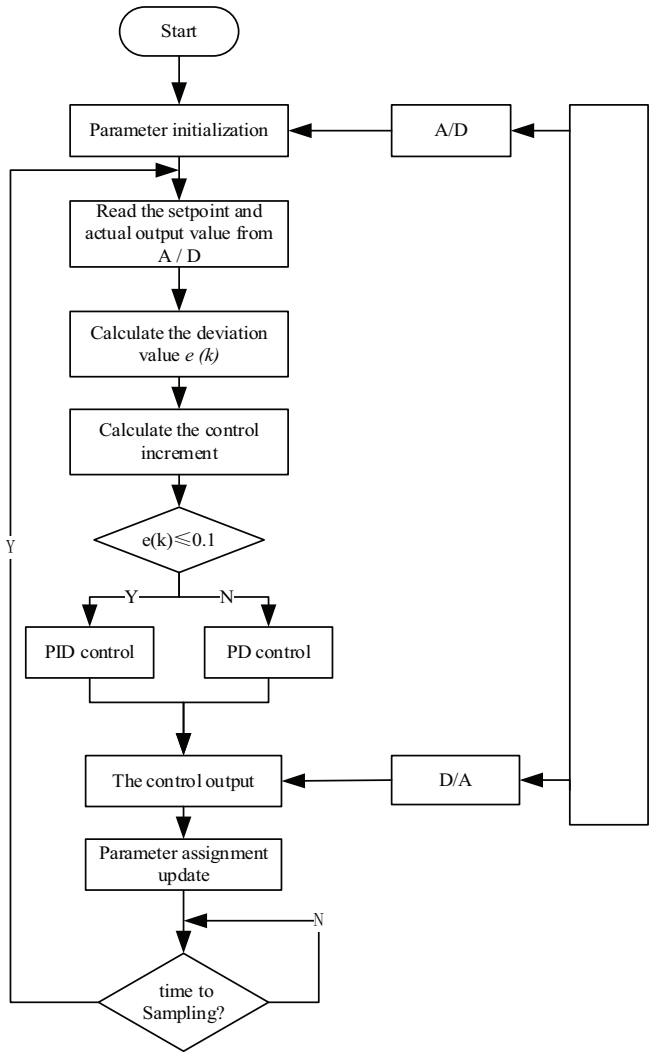

Fig. 6. Flowchart of PID control algorithm.

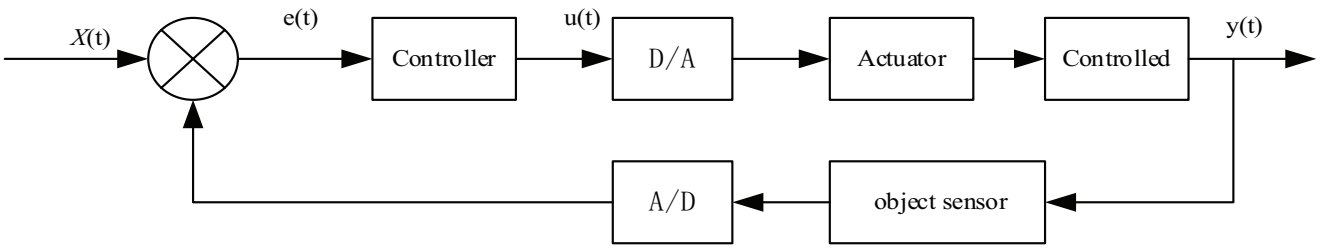

Fig. 4. Basic structure of the closed-loop system controlled by the computer.

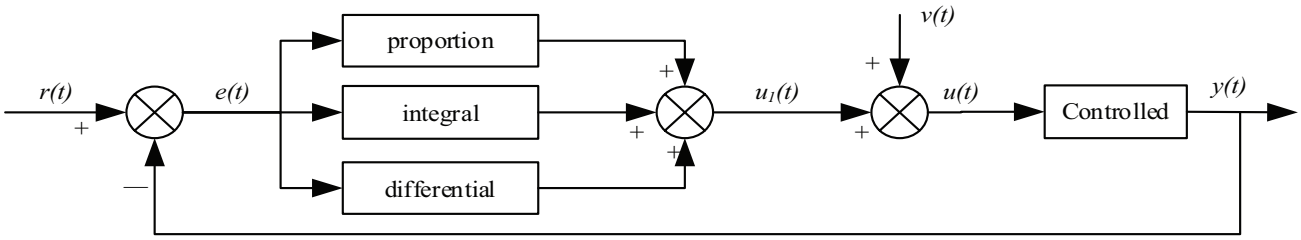

Fig. 5. PID control system block diagram.

In practice, PID fact can add a lot of trick. Consider, for example, to perform dynamic link, prevent super-saturation considered dynamic sensor, etc., in fact, is no longer limited to the three degrees of freedom, it even has a non-linear time. And the easiest Cascade PID is not just the three degrees of freedom [9]. Another aspect of some high-end systems cannot be separated, it cannot use intermediate, then it is difficult to be transferred PID good effects.

2.4. Fuzzy adaptive PID control system theory

Fuzzy control system has the following four components

First, fuzzy controller, the heart of the fuzzy controller system, the core of fuzzy inference system.

Second, this bidirectional digital to analog conversion means that it may rely on digital signal and an analog signal; input/output interface device.

Third, generalized objects refer to especially various controlled objects and reality.

Fourth, sensors mean controllably changing the object into an electric signal that can be identified and treated by the system.

As shown in Fig. 7, wherein the fuzzy controller is the core of the system structure, the structure of the composition of the fuzzy controller is shown in Fig. 8.

As to conventional ordinary PID regulator, the algorithm is very simple, robust, of high security and thus widely used in industrial control engineering, control, but its fixed parameters make it difficult to fit different demands; the latest theory and fuzzy PID control method is composed of a combination of fuzzy PID controller, PID parameters required to make corresponding adjustments according to the different situations in the outside world, in each case using different parameters, and finally come to an adjustable parameter package adapt fuzzy controller design method, and finally its simulation conclusion, adjustable parameters. Fuzzy PID controller in many control systems has very good control effect, far more than the conventional PID controller, the system completely stable performance is improved [10].

Fuzzy adaptive PID control principle system architecture is shown in Fig. 9.

In industrial applications, online processing method must be used, that is, discharge side, while adding acid or alkali in accordance with the detected pH value, standard water became neutral. In water treatment and acid-base reaction in the pool, reaction is relatively slow, and therefore presents a serious non-linearity, hysteresis and uncertainty. Knowing how promptly and effectively control the pH value is the key to solving the problem. Disturbance of the system is caused due to many factors, with the parameters of PID control be difficult to adapt, thus the conventional fuzzy control and PID control theory.

3. pH of water treatment system design

3.1. Water pH control system overall design

In this paper, we developed targeted system solutions to meet the requirements under the control of the system pH control, to achieve high efficiency, high stability of the water treatment process based on characteristics of the system design process and waste water applications.

Water overall block diagram of the pH control system represented in Fig. 10, collection pond and the pH by a pH treatment process transmitter, the present system was developed to control the amount of two channels, if the outlet is an acidic wastewater, the control amount 1 output, valve opening up base; if the UI wastewater treatment wastewater is alkaline, the control amount output from the channel 2, valve opens up acid. After selecting the output channel and the control amount applied to the pump, a return valve, fill valve acid, fill valve base, the acid and the pH constantly. The pH of the collected is transmitted via PROFIBUS-DP IPC bus,

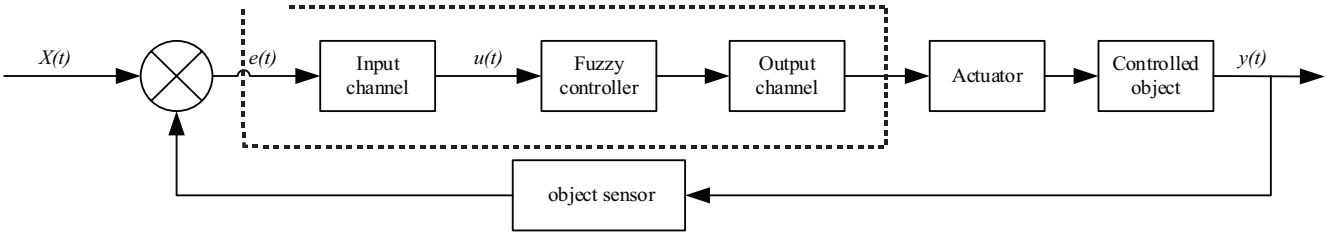

Fig. 7. Basic structure of the fuzzy control system.

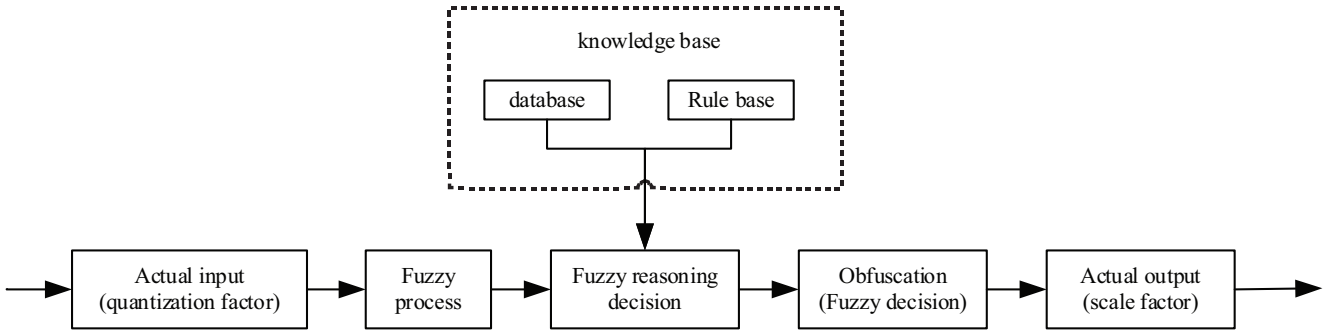

Fig. 8. Fuzzy controller circuit composition.

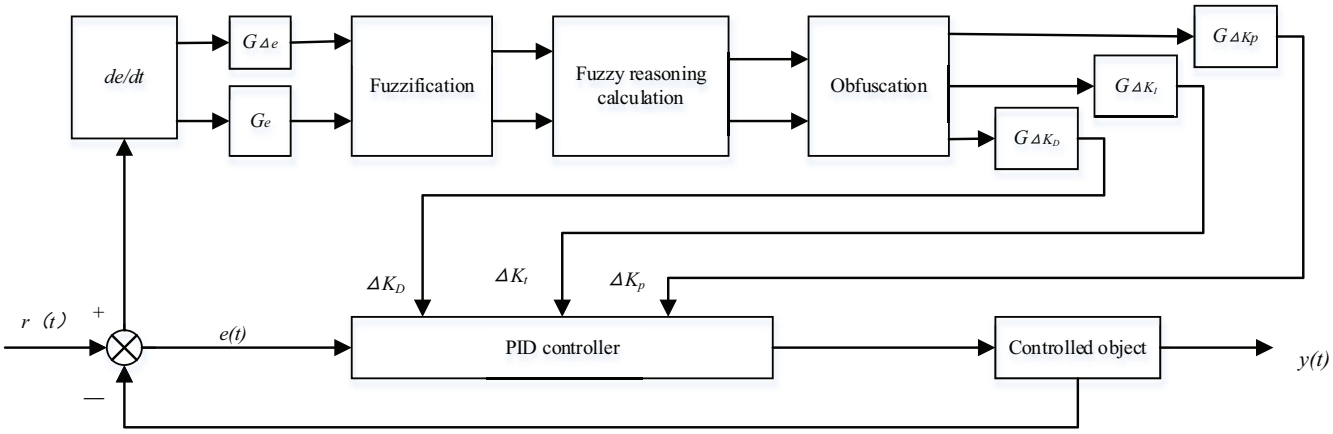

Fig. 9. Principle of fuzzy adaptive PID control system architecture.

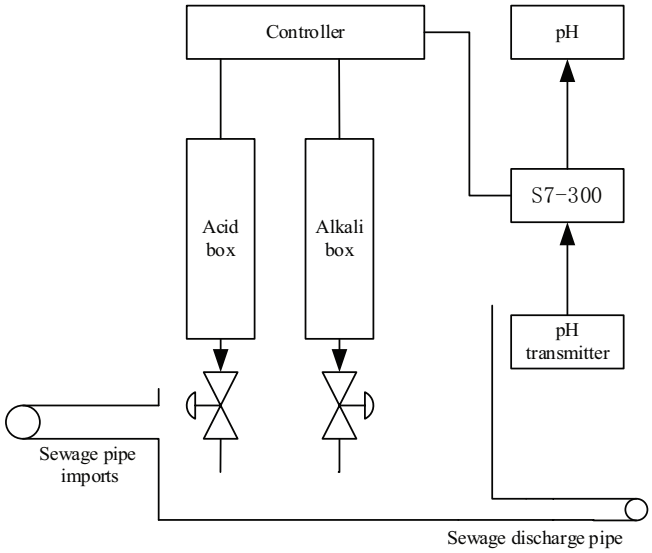

Fig. 10. Overall block diagram of the system.

programming software and monitoring software WINCC STEP7, real-time data display, remote control history data storage systems and status monitoring.

As for conventional ordinary PID regulator, because the algorithm is very simple, robust, and of high security features and thus has been widely used in Sichuan to control industrial engineering and control, but because of its fixed parameters make it difficult for not N demand, the latest theory and fuzzy PID control method composed of a combination of fuzzy PID controller, PID parameters so that the different needs of the outside world corresponding adjustments, in each case using different parameters, and finally come to inch adjustment parameters adaptive fuzzy controller design, and finally subjected to simulation, process design characteristics of the system according to the conclusions and waste water applications, the development of a targeted system solutions, and to follow the relevant standards, specifications and other design requirements, to meet the system the control requirements, to achieve high efficiency, high stability of the pH control in the water treatment process. Fuzzy PID controller adjustable parameters in the control system far more than many of the conventional PID controller, the system is completely stable performance is improved.

The entire control system is based on functional requirements and performance indicators, designed in hardware development platform – water treatment pH control system of Siemens S7-3 (X) series PLC. Hardware modules general structure is shown in Fig. 11.

Programmable logic controllers (Programming Logic Control, PLC) are designed for industrial environments for professional computer system, which can be adapted to the harsh environment of industrial site, for a series of measurements in terms of hardware and software. It has highly reliable resistance, strong anti-interference ability.

Siemens S7-300 PLC series is a medium, modular design, which mainly consists of the rack, the power supply module, signal module (SM), and a communication module (CP) and other components.

3.2. pH treatment adaptive PID fuzzy control system design

Adaptive fuzzy PID water treatment system herein, the two inputs, respectively, of the deviation e and the pH of the pool deviation change rate Ae, are three outputs u PID control parameters Kp, incremental state ΔKp KI, KD of, ΔKI, ΔKD.

Deviation $e = pH_{set} - pH_{sample(n)}$, among them $pH_{sample(n)}$: the pH value of T is the sampling period obtained by sampling; when this program is running, it gives value of a and b and will be assigned to a memory cell. Because the memory cells of each dispensing procedure are random, the value of each output is also random, that is, the value is indeterminate.

Input and output membership function is defined as below:

E assignment is shown in Table 1, EC assignment is shown in Table 2, *u* assignment is shown in Tables 3 and 4. Depending on the position, E and EC take *u* pre-calculated using computer control amount, the control table is made as shown in Table 4.

Depending on the position E and EC takes u pre-calculated using computer control amount, the control table is made as shown in Table 4.

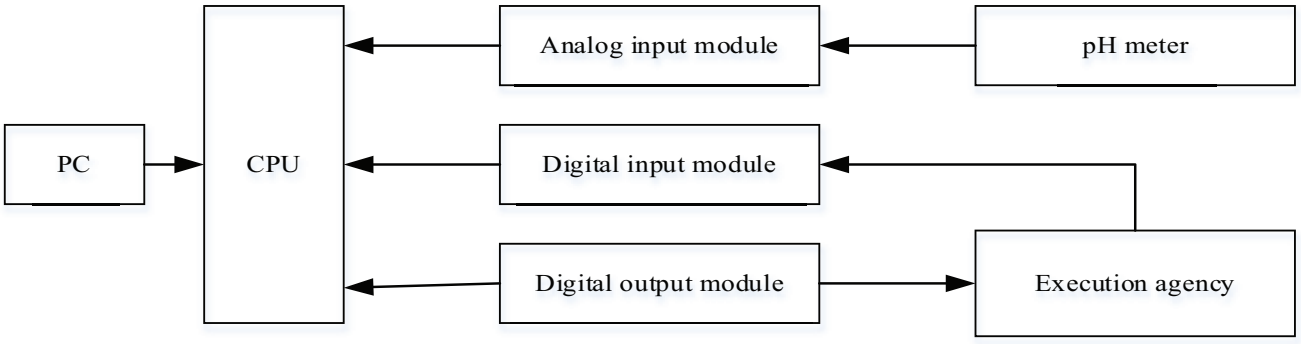

Fig. 11. General structure hardware module.

Table 1
Evaluation of the deviation E function assignment table genus

A	–3	–2.5	–2	–1.5	–1	–0.5	0	0	0.5	1	1.5	2	2.5	3
PB	4	4	4	4	4	4	4	4	4	4	4	4	4	4
PM	4	4	4	4	4	4	4	4	4	4	4	4	4	4
PS	2	2	2	2	2	2	2	2	2	2	2	2	2	2
PO	1	1	1	1	1	1	1	1	1	1	1	1	1	1
NO	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NB	4	4	4	4	4	4	4	4	4	4	4	4	4	4

Table 2
Assignment table error change EC

	–3	–2.5	–2	–1.5	–1	–0.5	0	0.5	1	1.5	2	2.5	3
PB	1	1	1	1	1	1	1	1	1	1	1	1	1
PM	1	1	1	1	1	1	1	1	1	1	1	1	1
PS	0	0	0	0	0	0	0	0	0	0	0	0	0
ZO	0	0	0	0	0	0	0	0	0	0	0	0	0
NS	–3	–3	–3	–3	–3	–3	–3	–3	–3	–3	–3	–3	–3
NM	–4	–4	–4	–4	–4	–4	–4	–4	–4	–4	–4	–4	–4
NB	–4	–4	–4	–4	–4	–4	–4	–4	–4	–4	–4	–4	–4

Table 3
Table assignment process quantity variable *u*

	–7	–6	–5	–4	–3	–2	–1	0	1	2	3	4	5	6	7
PB	4	4	4	4	1	1	0	–1	–1	–1	0	–1	–1	0	–1
PM	4	4	4	4	1	1	0	–1	–1	–1	0	–1	–1	0	–1
PS	2	2	2	2	0	0	–1	–4	–4	–4	–1	–4	–4	–1	–4
ZO	1	1	1	1	0	–3	–4	–4	–4	–4	–4	–4	–4	–4	–4
NS	0	0	0	0	–3	–3	–6	–6	–6	–6	–6	–6	–6	–6	–6
NM	0	0	0	–2	–4	–4	–6	–6	–6	–6	–6	–6	–6	–6	–6
NB	0	0	0	–2	–4	–4	–6	–6	–6	–6	–6	–6	–6	–6	–6

As solid is taken into consideration during calculation of the pH value of the parameter solid, so the value cannot meet different needs, the current on the latest fuzzy and PID control method of combining fuzzy PID controller configuration, so that the corresponding PID parameters can be adjusted according to different needs of the outside world, in each case using different parameters, the conclusion that the design of the adaptive fuzzy controller adjustable parameters, and

Table 4
Fuzzy control rule table

EC / u / E	–3	–2.5	–2	–1.5	–1	–0.5	0	0.5	1	1.5	2	2.5	3
–3	7	7	7	7	7	7	7	4	4	2	0	0	0
–2.5	7	7	7	7	7	7	7	4	4	2	0	0	0
–2	6	6	6	6	6	6	6	4	4	2	0	0	0
–1.5	6	6	6	6	6	6	6	3	2	0	–1	–1	–1
–1	4	4	4	4	4	4	4	1	0	0	–1	–1	–1
–0.5	4	4	4	4	4	4	1	0	0	0	–3	–2	–1
0	4	4	4	4	1	1	0	–1	–1	–1	–4	–4	–4
0	4	4	4	4	1	1	0	–1	–1	–1	–4	–4	–4
0.5	2	2	2	2	0	0	–1	–4	–4	–4	–4	–4	–4
1	1	1	1	1	0	–3	–4	–4	–4	–4	–4	–4	–4
1.5	0	0	0	0	–3	–3	–6	–6	–6	–6	–6	–6	–6
2	0	0	0	–2	–4	–4	–6	–6	–6	–6	–6	–6	–6
2.5	0	0	0	–2	–4	–4	–6	–6	–6	–6	–6	–6	–6
3	0	0	0	–2	–4	–4	–7	–7	–7	–7	–7	–7	–7

finally subjected to simulation, process design characteristics of the system according to the conclusions and waste water applications, the development of a targeted system solutions.

Set A, B are two fuzzy sets on the universe U, for each element of the U, a predetermined "and" operator AUB A and B, "intersection" operation AAB and "fill" calculation of membership functions.

As far as my understanding is concerned, it is still a final IMD controller, but because parameters can be automatically adjusted reasons, so it can solve a lot of general nonlinear problems, but if Chu nonlinear system, uncertainty is very strict East when that fuzzy PID control effect will be unsatisfactory. PID control and fuzzy rules or more complex, selected membership function also relies on the experience.

The results of fuzzy reasoning membership are composed of graphics functions in accordance with the obtained pieces of inference rules output variables, output variables referred to the possibility distribution. Fuzzy inference purpose solution according to this result is to determine a value representative of the distribution of the best, resulting in precisely controlled action. Common methods are ambiguous such as maximum membership average method, centroid method and so, the author decides to take the median and other methods.

This design uses the weighted average method, the exact values were calculated as ΔKp, ΔKI, ΔKD, that is, the PID parameters Kp, delta values KI, KD's. Each fuzzy set ΔKp, ΔKI, ΔKD has been obtained by the foregoing fuzzy inference.

Since the pH of the process is a typical nonlinear system, the control method on the basis of this chapter is recognized, the analysis, and to select from and control method of rational design, that is, fuzzy adaptive PID control.

4. Verification result of the pH control system

The engineering fuzzy self-tunes PID parameters comprehensive verification system to verify the MATLAB language system simulation platform.

4.1. Simulation of fuzzy adaptive PID control

Process mechanism model selection and treatment of wastewater pH control object are identical. Study on setting control target transfers function as described herein: $\frac{1}{10s+1}e^{-3s}$.

Water pH control system herein is selected with adaptive fuzzy PID control algorithm, the adaptive PID controller and the conventional one are used herein, the fuzzy PID control system compares the two simulation systems. In the absence of interference, the conventional PID adaptive fuzzy PID control system simulation results are shown in Fig. 12; in the presence of interference, fuzzy adaptive PID with the conventional PID control system simulation results are shown in Fig. 13.

From Fig. 12, it can be seen by comparing the adaptive fuzzy PID control, since the fuzzy controller is capable of variation and deviation change rate ec e PID of three parameters KP, KI, KD corrected based online system, the phase adjusts up faster than conventional PID control parameters, the overall adjustment of the total time is much lower than traditional PID. After the three traditional PID parameter settings are the same, it does not have adaptive characteristics.

Establishment of a closed loop PID control system (loop): First, it requires to use measuring element to measure the liquid level sensor to control the level value; second, it requires a PID controller; Again, an appropriate actuator output as a control element, such as valves, pumps, and the like inverter; Finally, the above-described three elements of the actual controlled process are combined to form a closed loop PID control system. Closed loop PID feedback control system is built on the basis of the principle, the output of the deviation with using the expected value of the PID control system, in order to obtain better control performance. Fuzzy control is used inside a fuzzy control box design, the preparation of language rules, the form of membership functions, etc., can be modified according to the fuzzy PID fuzzy control rules PID

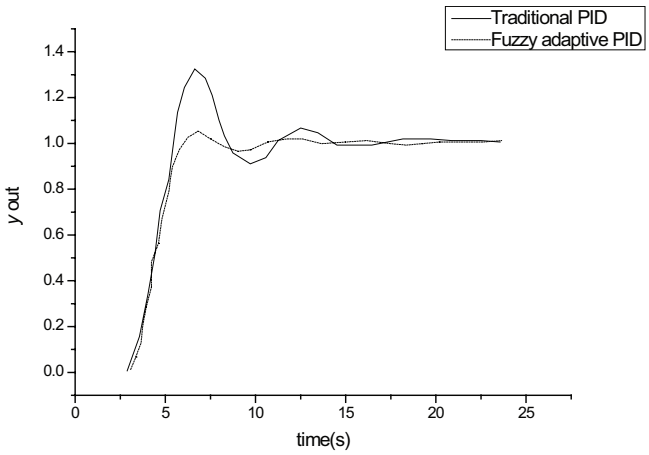

Fig. 12. Conventional PID control system fuzzy adaptive PID simulation results (without interference) system.

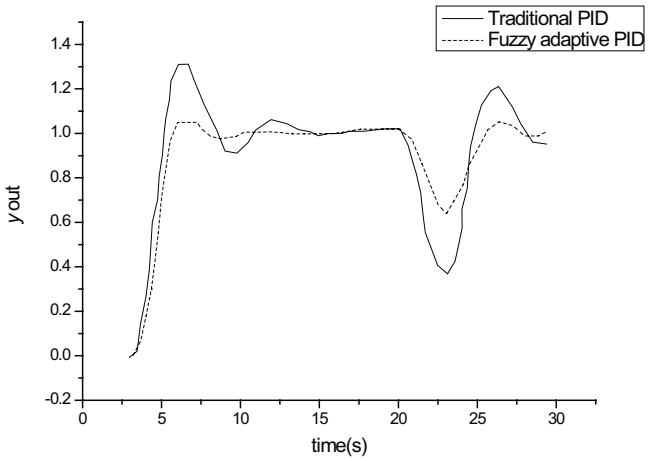

Fig. 13. Conventional PID control system fuzzy adaptive PID (interference) simulation results.

parameters for non-linear mathematical model of the system is difficult to determine. Three parameters fuzzy PID control, so can self-tune PID parameters. Single-input single-output general control problem, PID control has been able to achieve good effects. Fuzzy control with self-learning ability, respect for the interference of some systems have self-learning ability of fuzzy control to interference. Generally divided into direct fuzzy control as a fuzzy controller to replace PID control, or for setting the PID parameters.

Objectively speaking, it is ultimately a PID controller, but because parameters can be automatically adjusted, so it can solve a lot of general nonlinear problems, but when if nonlinear system, uncertainty is very serious, that fuzzy PID control effect will not be ideal. PID control and fuzzy rules or more complex, selected membership function also relies on the experience.

As shown in Fig. 13, the fuzzy PID control system between the adaptive error, the error rate of change of the parameter to establish a relationship of a function established empirically and intelligent adaptive line, improving system dynamic and static performance, improved anti-jamming capability, much better than the conventional PID control system.

5. Conclusion

The pH value control system for water treatment is designed in this paper. The research involves biochemistry, physics, automatic control, machinery, electronics, computer technology, communication, networking, instrumentation, process control and water treatment. It is a complex and comprehensive field of research. Wastewater treatment system is a huge systematic project, which involves a lot of contents and knowledge. This paper makes a detailed study of the content of some of them. In this paper, the advanced intelligent control strategy is applied to the water treatment system after the water treatment process is analyzed. After more than 3 months of debugging and running, it has been proved that the design scheme is successful. The design and selection of the electrical control system are reasonable. The degree of automation is high, the network communication is stable and reliable. The monitoring interface is practical and safe. Since the project has been put into operation, the whole system runs well, and the effect is obviously better than the traditional PID control.

The fuzzy adaptive PID control is introduced to S7-300PLC, and the key technical problems in the process of wastewater treatment are solved successfully. Its economic benefits are remarkable, and the operation of technology and equipment is also reliable in the wastewater treatment system. It also provides successful experience for water treatment in other fields.

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