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THE ADAPTIVE CONTROL SYSTEM OF ACETYLENE GENERATOR

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Abstract: The method of acetylene production in acetylene generator was analized. The PID controller was unable to give the desired process characteristics. The adaptive control system for the acetylene generator was designed. The suggested system brings together the classic controller with the fuzzy subsystem for controller parameter modification.

1. Introduction

Acetylene is important component of the chemical industry. The carbide process is one of the worldwide methods of producing acetylene. This method uses calcium carbide fed into the water as input raw material..

2. Techniques and Methods of experiment

The carbide method is implemented by acetylene generator, where the decomposition of acetylene carbide releases the compound.. A lot of heat is extracted during the process. This may result in overheating of the reaction mixture or possibly an explosion due to improper cooling. This indicates the current status of the development of the acetylene generator temperature control system.
The mathematical model of the generator and the setup of the control system can be gained by solving the material and heat balance equations. However, this process flows under persistent interruptions due to various features of the incoming material: carbide particle size, humidity, the presence of contaminants.

. This fact does not allow getting specified quality using classical linear regulators 2. It is feasible to fix this problem with adaptive control.

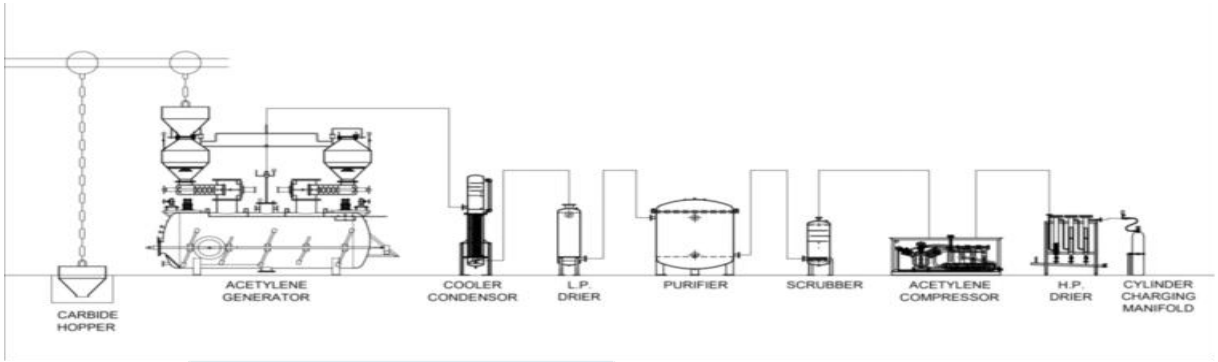


Fig. 1

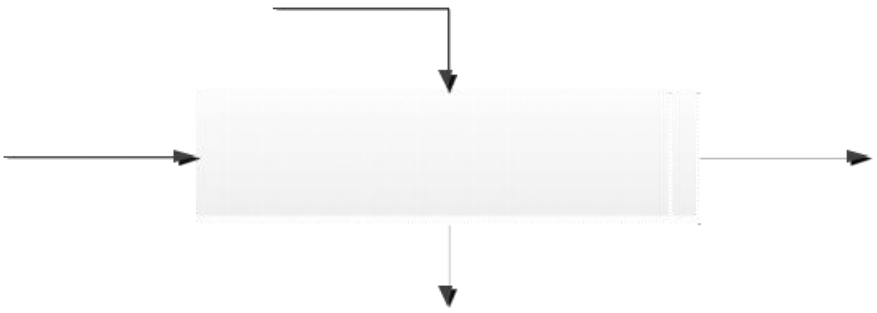
The invention discloses a preparation method for acetylene gas.The process involves producing crude acetylene by reacting calcium carbide and water in a generator, separating the gases and liquids, storing the crude acetylene in a gas cabinet, and allowing the crude acetylene in the gas cabinet to flow through a purification tower and a neutralizing tower to form refined acetylene gas, removing moisture from refined acetylene gas, and pressurizing refined acetylene gas in an acetylene compressor; and removing lubrication oil and moisture in the pressurized high-pressure acetylene gas through a high-pressure oil separator and high-pressure dryers, and feeding the acetylene gas to an acetylene filling grate through a flashback arrestor. According to the method, calcium carbide is crudely ground only and nitrogen replacement is not required during charging, so that the investment is low and the operation is convenient; and a plurality of acetylene gas purification apparatuses are arranged, so that impurities in the acetylene gas can be well removed and the acetylene gas with relatively high purity can be prepared.Furthermore, the acetylene gas is dried using high-pressure dryers; this method is straightforward and efficient, produces little waste residue, waste water, or waste acid during the drying process, is inexpensive, and has a good dehydration effect.

3. Results

Development of mathematical model of object

The object of control is acetylene generator. The main function of acetylene generator is to maintain a stable temperature of the interaction of calcium carbide and water. It should be pointed out, that generator has to maintain the temperature 55-60° for safe operationAs a result, the generator is constantly filled with cold water to remove reaction heat.. The volume of water is 10 m^3 per 1 ton of carbide. The scheme of the material flows is shown in Fig. 2

CaC2



$$CaC2 + 2H2O = Ca(OH)2 + C2H2$$

$C2H$ / Ga, Ta

Gsl, Tsl

Gc, Tc

$H2O$

Gw, Tw

$Ca(OH)_2$

Figure 1. The scheme of the flows of acetylene generator

Notation conventions of Fig.1: *G* - consumption, *T* - temperature; indices: *w*- water, *a* - acetylene, *sl* - slaked lime, c- carbide.

We create and develop highly advanced technological acetylene generators for use in welding operations. These generators are easy to use, have a high safety standard, and are convenient.. The machine functions by allowing two components - calcium carbide and water - to react and hence produce highly pure acetylene gas. The outputs of the generator are useful for a number of businesses and corporate houses on a daily basis. Since the acetylene is an extremely dangerous gas which readily explodes at a wide range of gas to air concentrations, it should be stored carefully. Acetylene is a colourless, extremely explosive gas that is often used in combination with oxygen for steel brazing, welding, and cutting. Commercial grade acetylene, on the other hand, smells slightly like garlic. Along with radiocarbon dating, it's used to harden steel components.. Almost 20% production is consumed for oxy-acetylene welding and cutting. There are a number of other applications where the gas play vital role to run. Being technologically very advanced, it is a fully automatic devic

The acetylene generator scheme is shown in Fig. 3

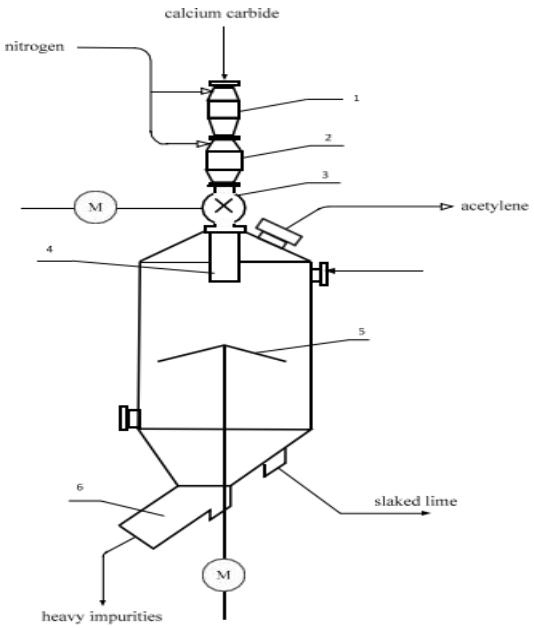


Figure 3. Generator type "carbide in water", model SMKV-300: 1, 2 – upper and lower bins; 3 – sectorial feeder; 4 – cone distribution in the feed tube; 5 – scraper mixer with shelves; 6 – siphon tube.

The assumptions to create the model of object are :

1. Generator is an object with distributed parameters.
2. Heat that comes from calcium carbide is neglected. The heat generated by the interaction of carbide with water is taken into account only.

3. The object is not insulated. There are the losses of heat to the environment.
4. The process takes place with an excess of water.
5. The temperatures at the entrance are stable.The device's starting temperature and the inflowing flows' temperatures match. The temperature in the generator during the reaction, determines the temperature of all output streams.
6. The process takes place under normal conditions:
    a. The reaction mass is mixed to avoid precipitate, which complicates expansion and leads to local overheating.
    b. The basic parameters of device are within specified limits.
7. There is a process of evaporation of water in generator. That's why the heat uses on evaporation is considers. The following conclusions have been made based on the assumptions and analysis object (Fig. 2, 3).

Control parameter is a temperature in generator. The process requires specified temperature for stable flow. The decomposition of acetylene is possible if redundant heat is not removed.

Channel control. The consumption of calcium carbide can be balanced applying the speed of rotation of the drum at a specific amount of acetylene.. That why, this parameter is neglected. The water flow can be easily changed by executing mechanism - valve. This method is used in practice. Therefore, the control channel is "Water consumption for cooling - The temperature in the machine."

According to equations of material balances, linearization and Laplace transform the transfer function of control channel has been obtained:

$$W(p) = \frac{1.54}{10.61p+1} * e^{-9.2p} \quad (1)$$

Development of the adaptive control system

The adaptive systems solve important problems of control

- To optimize the system operation.
- To ensure the performance of the system with the required quality parameters under changing object properties.
- To improve the stability of complicated systems and implement unified control algorithms for object classes.
- To reduce system design requirements, get information during operation.

These functionalities are achieved through two approaches: modifying the structure of the regulator or tuning the parameters of the regulator. This study proposes a second approach shown in Fig. 4.

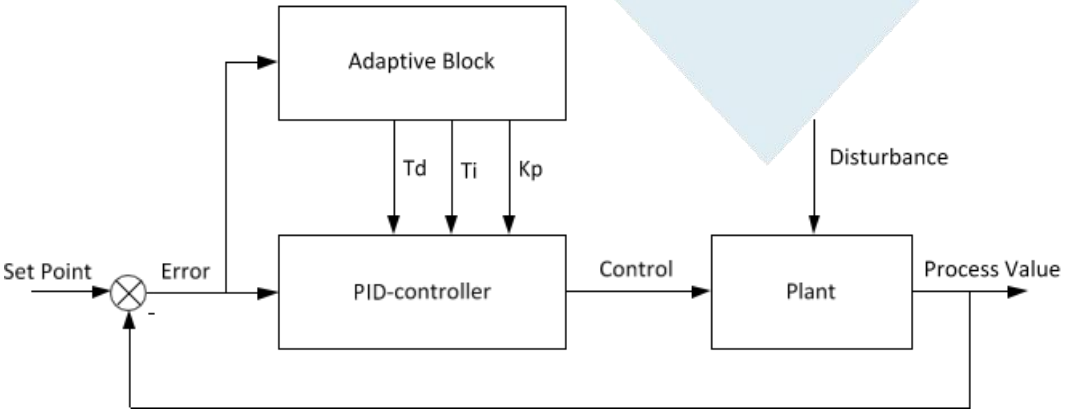
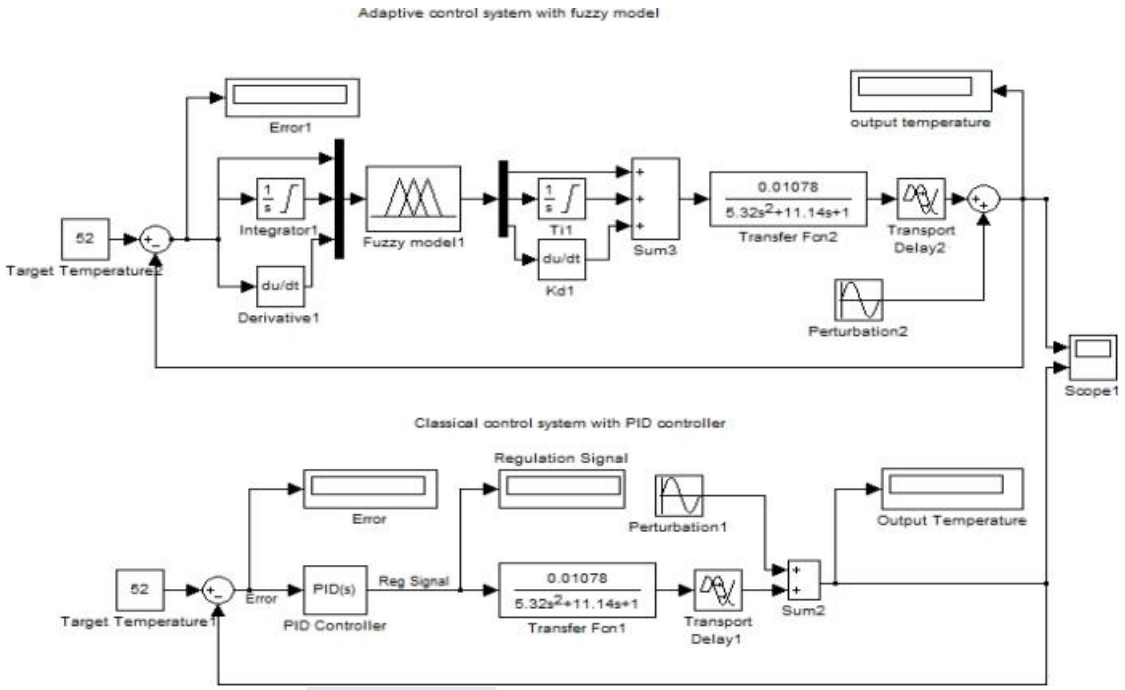


Figure 4. The structure of adaptive control system with regulators tuning.

The system operating algorithm is made up of these steps:

1. The analysis of control error (its current value and rate of change).
2. Calculation of regulator parameters in adaptation block.
3. Calculation of control signal based on the linear control law.

Comparison of adaptive control system and control system with PID controller



The scheme of simulation of control systems has been developed in Simulink (Fig. 5.)

According to the steps of study, computer simulation has been undertaken to compare the efficiency of the transition process of the adaptive control system and the PID control system. The research has been conducted with the gradual growth of the disturbances. The transition characteristic of the adaptive control system and system with PID-regulator is shown in Fig. 6 (without disturbances) and Fig. 7 (with disturbances).

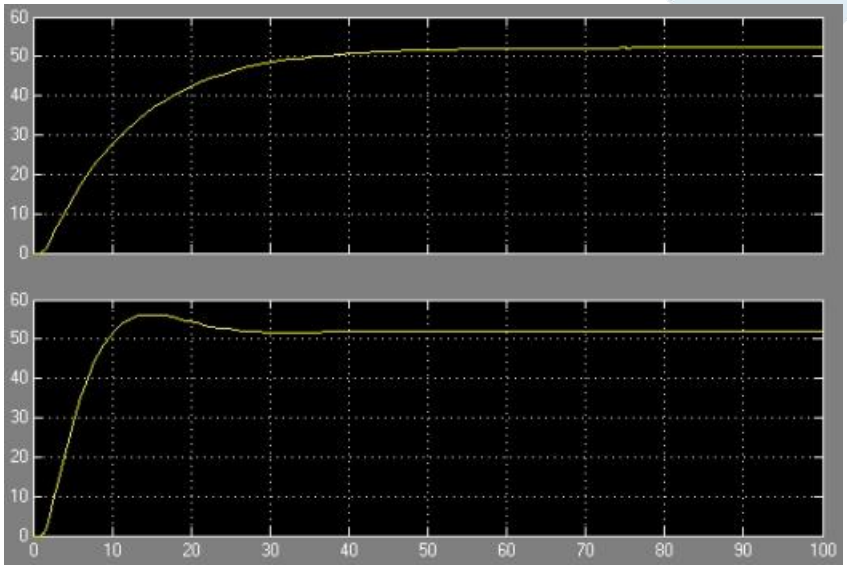


Figure 6. The transition characteristic of adaptive system (top) and PID-controller system (bottom) without disturbances.

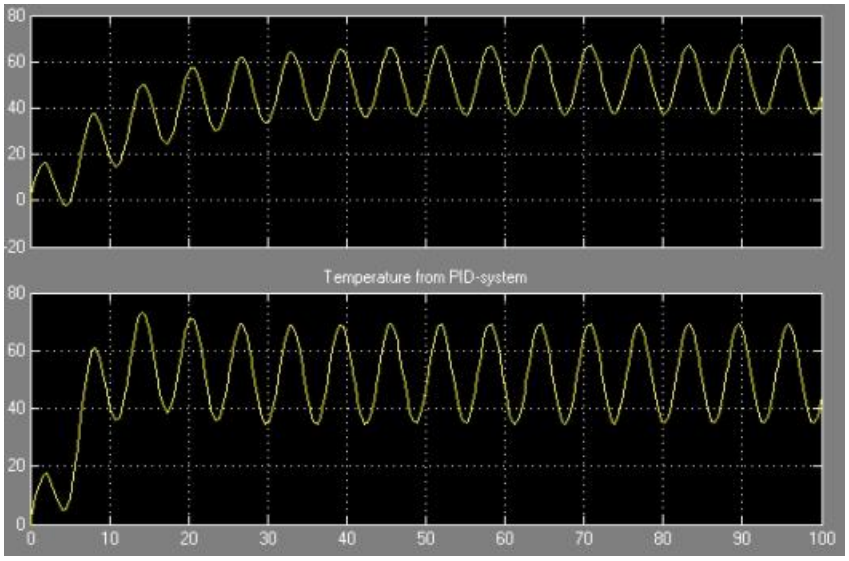


Figure 7. The transition characteristic of adaptive system (top) and PID-controller system (bottom) with disturbances.

The simulation results are in the table 1.

Criteria	**Adaptive**	**PID**

Criteria (3)	315,3	385,4
Overshoot	1,81%	0,23%
Time	24 s	32 s

4. Conclusion

This The adaptive control system has been proposed. It allows to adjust the coefficients of PID-controller based on the value of the error between the specified and the current value. The system has been implemented by fuzzy logic and Mamdani algorithm.

The simulation of control systems has been carried out in Simulink. The disturbances have been simulated using a sinusoidal signal with different amplitude. Thus, conclusions according to the simulation results are:

1. The adaptive system has less oscillation and overshoot.
2. PID-controller system provides lower the transition process.
3. The adaptive system has smaller integral criteria of quality under disturbances.
4. The PID-controller system is better without disturbances.
5. The adaptation block should be used in special cases.

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