Design PID Controller for Controlling the Methane Gas Cylinder to Provide the Gas for Internal Consumption Generator

Noor Safaa, Wedian Hadi

Abstract*—In this paper we will concern on how to build the controlling system depend on the Ideal PID Matching with Ziegler-Nichole controller Tuning for enhanced the work and then will applied this system on the Methane gas cylinder input for control on the size of the gas inside the cylinder depend on the Maximum size level and its range around 3.8325m³ .The controller Tuning build by Matlab Simulink Model and the ZN-PID controller applied with the help of closed loop, third order transfer function build in Matlab Simulink block with step ramp block as an input and PID controller simulink block the block will run as a close loop transfer function to enhanced the input error with help of Ziegler Nichols controller and reduce the overshoot completely and provided a good tuning. This controlling method can be used for control on the output power distributed to the different loads.

***Index Terms*—PID, Ziegler Nichols, Methane Gas.**

I. INTRODUCTION

Proportional-Integral-Derivative (PID) control has been used successfully for regulating processes in industry for more than 60 years. Today, digital self-tuning PID controllers are ubiquitous in the industry. These controllers automatically set gain values (i.e. parameters) according to the process (alternatively, plant) and may optionally require inputs from a human designer. The parameter settings of a PID controller for optimal control of a plant depend on the plant's inputs from a human designer. The parameter settings of a PID controller for optimal control of a plant depend on the plant's behavior. Therefore, information about the plant is required to tune the PID controller [1]. The work of the PID controller will enhanced when use the Ziegler –Nichol tuning rules [2]. In this paper will concern on how we can build the control system controlling on the size of the methane gas as the example for PID input parameter, inside the cylinders after when it will emission from the sludge digester to use it as a burning gas for generate the electricity related to population in one building at least [3].

II. THEORY

Methane gas emission start after the digest process inside the digester totally completed , the outlet methane will collected in the gas cylinders depend on the size of gas inside the cylinder the process of open and close the valves that controlling on the inlet gas to cylinder will be control by the matlab simulink program using PID tuning controller combined with Ziegler- Nicole controller [3,4], the system details divided to three stages.

A. Methane gas emission rule

The amount of the gas collected from the digester chamber depends on the parameters below:

- Number of the people live in the building.
- The value of waste per person its constant (0.5).
- Biogas coefficient for human waste related to number of people multiply by the value of waste per person.
- TS (total solid human waste) its percentage 20% related to biogas coefficient.

the total size of methane emission, if we take the number of people live in the building approximate 105 person this number will multiply by value of waste per person (105×0.5), total biogas obtained from (n) numbers of people = (0.5 ×105× 0.2 × 0.365) = 3.8325 m^3 [3]. From each cubic meter biogas we get 1.4 kilo Watt per hour electricity, output from Internal Consumption Generator.

B. PID controller

Proportional- integral- derivative (PID) controllers have been used for industrial purpose because of its simplicity, easier design, low cost. Proportional (P), Integral (I) and Derivative (D) are the three main parameters of the PID controller. The values of these three parameters interpreted in terms of time ,where ,'P' depends on the present error, 'I' on the accumulation of past errors and 'D' is a prediction of future errors, based on current rate of change. By tuning the three parameters in the algorithm of PID controller, the controller can provide control action designed for specific process requirements [5].
The proportional, integral and derivative terms are summed to find the output of the PID controller. Where the output is given by [8]:

$$u(t)= K_p\, e(t) + K_i \int_0^t e(x)dx + K_d \frac{d\,e(t)}{d(t)} \quad (1)$$

Where:
Kp: proportional gain, a tuning parameter
Ki: integral gain, a tuning parameter
Kd: derivative gain, a tuning parameter
e: error present in the controller
t: time or instantaneous time

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Noor Safaa, Assist. Lect., Department of Electrical Engineering, Al-Mustansirya University, Baghdad, Iraq.
Wedian Hadi Abd-Al-Ameer, Assist. Lect., Department of Electrical Engineering, Al-Mustansirya University, Baghdad, Iraq.

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x: variable of integration, taken from time 0 to present 1.

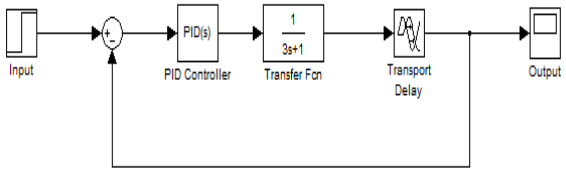


Figure 1. Matlab simulink model [5].

C. ZN-PID controlling on gas cylinder input

The proceeding work is carried out of PID controller's on line auto tuning that is based on Ziegler Nichols tuning method. The advantage of Z-N PID controller tuning is also carry out for higher order systems [6,7].

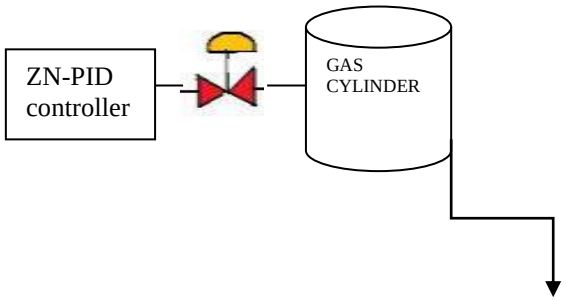


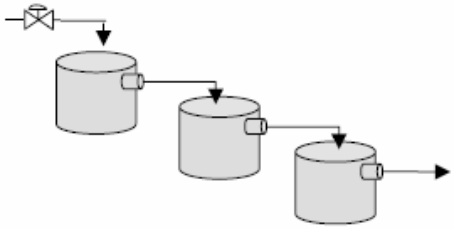
Figure 2. Controlling block

III. PID CLOSED LOOP TRANSFER FUNCTION WITH ZIEGLER-NICOLE CONTROLLER TUNING

Tuning of a PID controller refers to the tuning of its various parameters (P,I,D) to achieve an optimized value of the desired response .The necessity of tuning of the parameter of PID controller is very important. ZIEGLER-NICHOLS method is one of the mostly used tuning methods of PID controller. Ziegler-Nichols proposed rules for determining the values of the proportional gain Kp, integral time Ki and derivative time Kd based on the transient –response characteristics of a given plant [5].

With Ziegler-Nichols PID tuning formula, the resulting system exhibit a large settling Time in the step response method, which is unacceptable. In such a case, we need a series of fine-tuning until an acceptable result is obtained [8].

Consider the following third order process.



Tune a PID controller using a practical method and the Ziegler-Nichols tuning rules. The method is often used in industry because it does not require to know the process transfer function with the difference that the ultimate gain and ultimate period are determined experimentally, not analytically [4].

Consider the transfer function is [4]:

$$G_p = \frac{6}{(2s+1)(4s+1)(6s+1)}$$

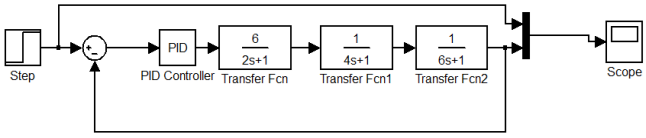


Figure 3. Matlab simulink model with Z-N method

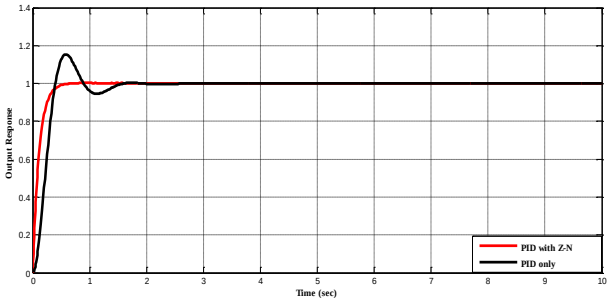


Figure 4. Compression between two methods

The PID controller has the overshoot in the output response, but in Ziegler Nichols method the overshoot is completely eliminated. In general, Ziegler Nichols method has provided good tuning so the tuning is necessary to get the appropriate value.

IV. CONCLUSION

In this paper, Ziegler Nichols method is used for tuning the PID controller. But this method is not satisfying for many systems. This method gives the statistical value but no the exact value. To get the better performance in PID controllers PSO and BFO algorithms can be used for future development.

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