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A Fuzzy Logic Based Power Plant Conveyor Coal Fired Boiler System

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ABSTRACT: Main essence for the thermal power plants that may be either coal or natural gas power plants to be in command of the temperature and pressure controllers (PI.PD, PID) is generally employed. The raw material, coal is nosh in to the boiler using conveyer system and it is a time shifting one. This coordinated boiler turbine system, multivariable complex process, nonlinear and also slowly time variant plant with hefty settling time. This is due to the unpredictable demand in the load side Also it makes the PI.PD, PID controllers to have very a reduced amount of efficiency. To make it as a high efficient one, the FUZZY LOGIC is used to control and it is a self and auto tuning process. The control of boiler temperature and pressure is done by FUZZY logic controller without the human intervension. Sensor materials like Temperature sensor (LM235) and pressure sensor (POTENTIOMETRIC TYPE) are used to sense the temperature and pressure. When the normal level of temperature and pressure value exceeds, it will give the signal to FUZZY controller. Then fuzzy logic controller that is used to control is worn the boiler system by given value to it by using its membership functions values. Since FUZZY logic controller is used, controlling sped is possible at any time Multivariable, nonlinearity and time varying and time varying of the unadventurous coal conveyor system can be easily eliminated. Unremitting controlling is applied by relay unit. Effectiveness is high compare with existing technology. Low temperature and pressure values can be set up in this strategy of FUZZY logic controller comparing with the conventional controller approach.

KEYWORDS: Fuzzy, P, PI, PID, auto-tuning, linguistic variables

I.INTRODUCTION

This paper gives coordinated control method techniques like fuzzy and self tuning in a newly developed boiler turbine. This boiler turbine system includes many features like multi variable process, nonlinear, deadly time variant plant with high settling time and lot a of cautious. These turbines have strong couplings which are implemented between control loops of main stream pressure and power output of turbines results in large time delay is the major problem which has to be consider. Boilers consists of colossal thermal mass and it is lag to react. But turbines are lissom that reacts quickly to operators degree. The entire plant is coordinated which requires association of systems and to select the correct logic elements to retrieve them together. The front end of power plant is operated by engineer, which consists of boiler unit and turbine unit. As given in part 1 of two part series , the station or master is referred by operators window of control system and also for control loop it provides operator boundary. In accordance to that loop is formed from a switch which are spot in plants control panel or in addition, digital control can be equipped by the operator.

In the boiler follow mode, the boiler is detached from the production control, which means the steam turbine utilizes stored vigour in the boiler to provide instantaneous load rejoinder The boiler must then revolutionize firing rate to bring pressure back to set point. In the turbine follow mode, Turbine control valves sustain a set pressure while the boiler fires to retain load. Hitch here is a slower generation rejoinder. There are variations with this scheme, in that the turbine control valves can be smarmy opened at higher loads to curtail the energy sentence associated with the DP slaughter across them. In that case, it has been called sliding-pressure control, or even surge control. In the harmonized control, in general, if we provide a choice of logic schemes to stir the steam turbine valves for quick load rejoinder, as well as fire the boiler for the predictable energy requests of the boiler (generally via an energy balance equation). This paper gives a new organized method which is well thought-out a singular subclass of fuzzy inference system(FIS) which uses the Gaussian partition with evenly spaced(GPE) midpoint systems is used to discover the head stream pressure. The slip signals decides it's parameters and its difference, focused to overcome the unease due to fuel

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calorific value, machine wear, smear of the boiler heating surfaces and plant modelling errors. A bureaucratic control level for large deviation of operating stipulation has been developed by auto tuning practice operandi using fuzzy logic superior control concert and economic assistance have been resolved. Many valued logic's synopsis is Fuzzy logic and it deals with reasoning that is somewhat precise rather than fixed and dutiful. In disparity with established logic theory, where the Boolean set having the two valued logic: true or false, fuzzy logic set may have a truth values ranging from 0 to .

Fuzzy logic is extensive to prise the theory of hidebound truth, where the truth value may range amid degrees of possibilities and completely true and completely false. Fuzzy system have the plenty of applications from control theory to artificial intelligence, it still fragments divisive FUZZY logic is competent of authority approximate information in a methodical way and it is consequently used for nonlinear classification and to model the complex system. It also help to reduce the human operator. The rule base system uses a linguistic variable which require a human familiarity to frame a rules. The paper is well thought-out as follows. The second section deals with the predicament formulation. The third section deals with the technique used in fuzzy logic problem. The fourth section presents the chronological steps of fuzzy logic in coal conveyor predicament the fifth section reveals the grades achieved for thermal plant coal conveyor systems.

II. PROBLEM FORMULATION

Coal fired boiler coordination is more often than not used in the thermal power plant and it is controlled by the P, PI, PID controllers. It is a very multifaceted process as it is multivariable, nonlinear, slowly time varying plant and it makes the coordination to have a reduced amount of efficiency. So FUZZY Logic is used to organize the coal fired boiler system with sky-scraping efficiency and also it is an auto tuning progression Low temperature and pressure level of the coal fired boiler coordination can be found by using the fuzzy logic controller. The temperature and pressure of a boiler are embarrassed by Proportional (P), Proportional Integral controllers (PI).Coal feeder is embarrassed by the Proportional Integral (PI) and Proportional Integral Derivative controllers (PID).

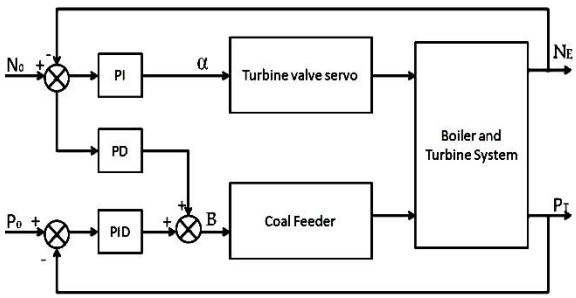

Fig 1. Breathing system of Coal conveyor system

(a) DISADVANTAGES OF THE EXISTING SYSTEM

Squat temperature and pressure values could not unearth by means of P, PI, PID controllers. Valve open and close speed is low; hence domineering speed and efficiency is low.

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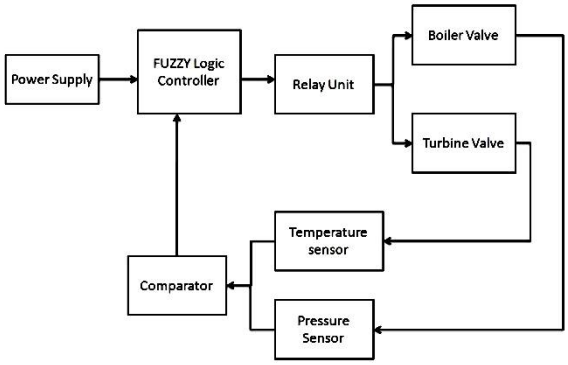

Fig 2. Projected system of Coal Conveyor system

III. METHODS USED IN FUZZY LOGIC

Fuzzy logic and probabilistic sense are scientifically analogous in cooperation having values ranging from 0 to 1 but abstractly diverse, having interpretations of chalk and cheese like probability theory interpretations. Fuzzy logic gives "degrees of truth", here the probabilistic logic results "probability, likehood". i.e there is fluctuation between the these two logics yield poles other than models in real world situations. At first analogous is seen because the degree of truth and probabilities lies between in the middle of 0 and 1. Consider an example, 100 ml glass have 30 ml of water. Now we can go for two cases. i.e empty and full. Firm fuzzy set gives the interconnection between each of them. One glass is characterize as 0.7 vacant and 0.3 full. Depending upon the spectator, the thought of empties may vary. Another spectator may equally come up with a membership function of glass will be taken as full for all values after 50 ml. It is complicated to take the fuzzy logic rules which uses mathematical model of truth degrees of unawareness. This also can be achieved by using probabilistic methods having "full" as a binary variable which depends on continuous variable. The continuous variable describes hoe full the glass is.

(a)APPLYING TRUTH VALUES

A basic applicability might demonstrate the ranges of continuous variable. For example, anti-lock braking system have lot of break up membership functions having ranges of temperature needed to control the brakes more accurately. Every function maps truth value with matching temperature in the middle of 0 and 1. These truth values is used to extend how the brakes get disturbed.

(B)FUZZY LOGIC TEMPERATURE

Let us consider linguistic variable for temperature are cold, warm and hot is represented by mapping process. Three truth values are taken as a function. Straight line represents temperature. Red arrow represents zero, which is denoted as "No Hot". Orange arrow represents "light warm" and blue arrow "fairly cold".

(C)LINGUISTIC VARIABLES

In mathematics variable is chosen as numerical values as like, in fuzzy logic operations linguistic variables are used for smoothening the phrase of rules and facts which are non numeric. For example linguistic variable is taken as a age which may have standards like young or old. Moreover the main advantage of these variables is that they can be. Linguistic variables are modified with barrier that can be applied to primary terms. A linguistic barrier is bound with convinced function. The Boolean logics like AND, OR and NOT functions are taken as a minimum, maximum and complement. When they are clear this way, they are called zadeh operators for the fuzzy variables x and y:

NOT x= (1-truth(x))
x AND y=minimum(truth(x),truth(y))
x OR y=maximum(truth(x),truth(y))

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There are also other operators, more linguistic in scenery, called hedges that can be applied. These are commonly adverbs such as “very”, or “somewhat”, which modify the denotation of a set by means of a mathematical formula.

(D)LOGICAL ANALYSIS

In mathematical acumen, there are a number of formal systems of “fuzzy logic”; in that t-norm fuzzy logic is suitable for this paper. These can be lengthen fuzzy logic rules by adding collective and extended qualifiers in analogue which can predict logic from propositional . the truth degree formula is derived from human competency to develop fuzzy logic membership functions having their own impulsive intelligence and involvement. These associates background and semantic. In the detection of a triangle, let A, B, C be the inner angles of a triangle.

Where,

$A \geq B \geq C$

Let U be the universe of triangles, i.e.

$U = \{(A, B, C) \mid A \geq B \geq C \geq 0;\ A+B+C = 180^{\circ}\}$

Let‘s define a number of geometric shapes

1. Approximate isosceles triangle
2. Approximate right triangle
3. Approximate isosceles and right triangle
4. Approximate equilateral triangle
5. Other triangles

IV.THEOREM

All axiomatizable fuzzy logic can be countable. In general, the crisp set of formula is not countable. In despite of the fact that fuzzy true formulas are countable. And also we can demonstrate any axiomatizable and a complete theory.

The Gödel incompleteness theorems may be paraphrased as: Any effectively generated theory which is capable of elaborating the elementary arithmetic cannot be that of both consistent and absolute. In general, for any constant, effectively generated formal theory that proves certain basic arithmetic truths, there is an arithmetical statement that is true, but not provable in the theory. Fuzzy logic deals with partial truth which can be related to the consistency part of the theorem (the paradoxical part of the Theorem) while probability theory deals with partial Knowledge of the system so that could be associated with the incompleteness part.

V. SIMULATED RESULTS AND DISCUSSIONS

The transfer function which is used to obtain the conveyor control logic is shown in the figure. It is obtained by using the mat lab software.

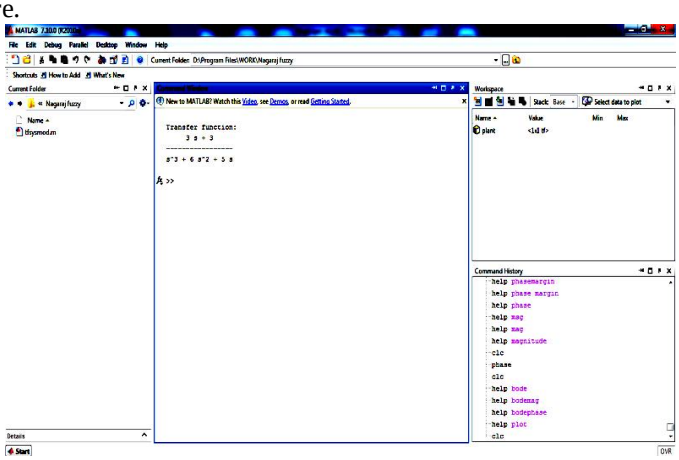

Fig 3. Transfer function of Conveyor

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The phase and gain margin values for each of the corresponding value input is obtained and gets easily converged.

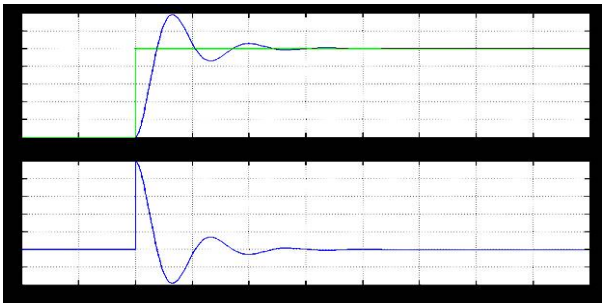

Fig 4.Simulation response of Phase and Gain Margin without Fuzzy controller.

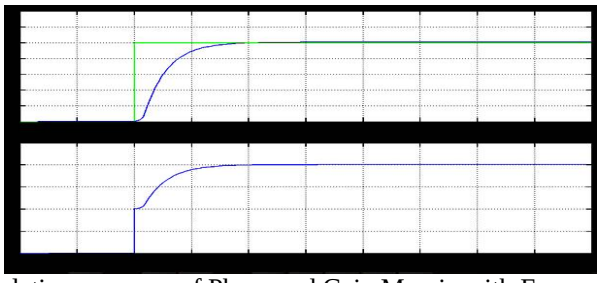

Fig 5.Simulation response of Phase and Gain Margin with Fuzzy controller.

Fuzzy logics rules and membership functions are also loaded initially as follows for our problem.

```
[System]
Name='fuzctrl1'
Type='mamdani'
Version=2.0
NumInputs=2
NumOutputs=1
NumRules=49
AndMethod='min'
OrMethod='max'
ImpMethod='min'
AggMethod='max'
DefuzzMethod='centroid'

[Input1]
Name='Error'
Range=[-1 1]
NumMFs=7
MF1='NM':'trimf',[-0.85 -0.6 -0.35]
MF2='NS':'trimf',[-0.5 -0.25 0]
MF3='PS':'trimf',[0 0.25 0.5]
MF4='NB':'trapmf',[-1 -0.99 -0.8 -0.7]
MF5='PB':'trapmf',[0.7 0.8 0.99 1]
MF6='PM':'trimf',[0.35 0.6 0.85]
MF7='Z':'trimf',[-0.2 0 0.2]
```

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[Input2]
Name='DelErrorr'
Range=[-1 1]
NumMFs=7
MF1='NB':'trapmf',[-1 -0.99 -0.8 -0.7]
MF2='PB':'trapmf',[0.7 0.8 0.99 1]
MF3='PM':'trimf',[0.35 0.6 0.85]
MF4='NM':'trimf',[-0.85 -0.6 -0.35]
MF5='NS':'trimf',[-0.5 -0.25 0]
MF6='Z':'trimf',[-0.2 0 0.2]
MF7='PS':'trimf',[0 0.25 0.5]

[Output1]
Name='CTRL'
Range=[-1 1]
NumMFs=7
MF1='NB':'trapmf',[-1 -0.99 -0.8 -0.7]
MF2='PB':'trapmf',[0.7 0.8 0.99 1]
MF3='PM':'trimf',[0.35 0.6 0.85]
MF4='NM':'trimf',[-0.85 -0.6 -0.35]
MF5='NS':'trimf',[-0.5 -0.25 0]
MF6='Z':'trimf',[-0.2 0 0.2]
MF7='PS':'trimf',[0 0.25 0.5]

TRIANGULAR MEMBERSHIP FUNCTION

A triangular MF is specified by three parameters {a, b, c} as follows:

$$\text{triangle}(x;a,b,c)=\begin{cases}0, & x\le a.\\ \frac{x-a}{b-a}, & a\le x\le b.\\ \frac{c-x}{c-b}, & b\le x\le c.\\ 0, & c\le x.\end{cases}$$

$$\text{triangle}(x;a,b,c)=\max\left(\min\left(\frac{x-a}{b-a},\frac{c-x}{c-b}\right),0\right)$$

Figure 1(a) illustrates a triangular MF defined by triangle (x; 20, 60, 80).

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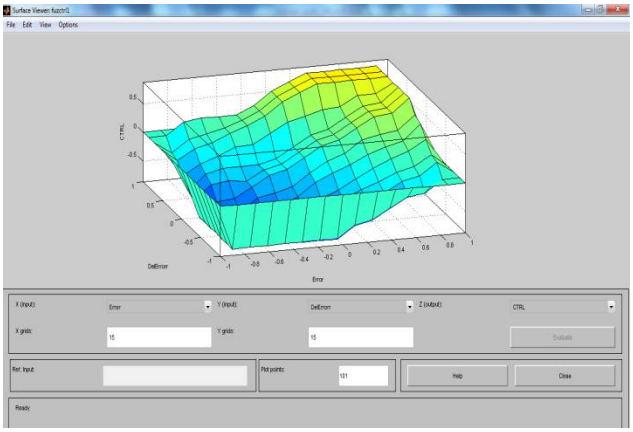

Fig 5. Surface viewer of Fuzzy Controller

The final result obtained is shown in Fig 6. The hardware architecture for this proposed solution is as follows,

POWER SUPPLY

- Input circuit
- Transformer
- Rectifier and reservoir
- Regulator
- Switched mode supply

MICRO CONTROLLER

- ATMEGA 16

SENSORS

- Temperature sensor (LM 35)
- Pressure sensor (Piezo resistive strain gauge, Capacitive, Electromagnetic, Piezo electric, Optical, Potentiometric)

SOLENOID VALVE

LCD DISPLAY

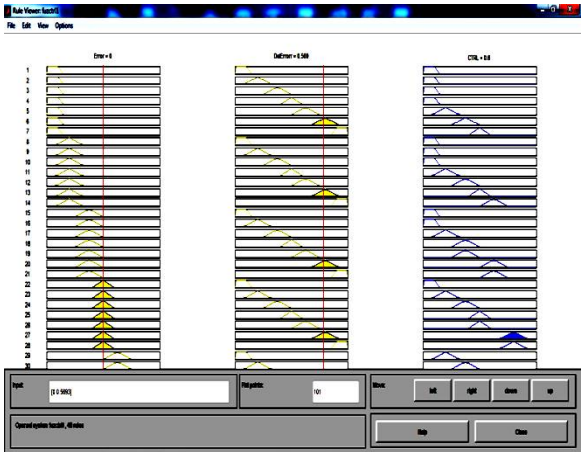

Fig 6. Control and Change in control

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VI. CONCLUSION

In this paper, the coal feeding temperature and pressure of the coal fired boiler system is inhibited by using fuzzy logic. So the accessibility of coal echelon can be augmented for the upcoming year to engender the required power. It can unearth low temperature and pressure level. Continuous controlling is applying by relay unit. Controlling speed is towering, for the reason that of fuzzy logic controller. Efficiency is towering weigh against with breathing technology. So the ease of use of coal level can be enlarged for the approaching year to engender the mandatory power. And the system is finished into automatic now so the man power can be eliminated. In some engineering applications PID controllers are used for the reason that of their simple constitution and the easy control propose in the case when a plant is linear or can be linearized in an operating point, numerous processes and plants. Nonetheless are not linear in the full operating range still piecewise linearizable, for example plants with nonlinear description chemical processes, robots etc. If the plant has to be stabilized in a different operating point then the PID control gains have to be malformed according to the system attribute in that point. This can effortlessly be done by conniving the PID controllers for a convinced set of operating points and entrench them in a Takagi-Sugeno fuzzy control configuration The advantage is that the consequential controller (a fuzzy gain scheduler) not only can soothe the system in the regions originally selected but also for the duration of the transients sandwiched between the regions because of the interpolation belongings of the fuzzy controller. Nevertheless this requires a more conformist system analysis and control design as that for a unadulterated linear system (see Tanaka, Sugeno 1992: Stability analysis and design of fuzzy control systems).

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BIOGRAPHY

R.Senthil kumar received UG degree from PSNA college of Engineering, Dindigul, Tamilnadu. He received PG degree from the same college. He attended more conferences and presented more reputed papers in the field of Power Electronics and Drives. Currently he is working as an Assistant Professor in M.Kumarasamy College of Engineering, Karur. His interest is in the field of Power electronics ,control systems, soft computing techniques and AC drives.