Automatic Generation Control of Interconnected Reheat Power System with Generation Rate Constraint using Fuzzy Logic Controller

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Abstract- The present paper relates to "Automatic Generation Control of Interconnected Reheat Power System with Generation Rate Constraint using Fuzzy Logic Controller". The paper delivers the analysis of 2-areas, with the involvement in each area of reheat thermal power system. GRC with AGC is investigated in the paper. It is observed that dynamic model of the system becomes non-linear if GRC is considered while exhibiting less deviation in frequency in the absence of GRC. After considering one percent of perturbation dynamic response is considered. To provide the control over the system frequency fuzzy logic controller is used in the system. By employing this controller the system becomes faster and handles the non-linarites properly. In this comparison is done between with or without GRC. Many outcomes are exposed using MATLAB/SIMULNK.

Index Terms— AC Tie-line, AGC, GRC, 2-area interconnected power system.

INTRODUCTION

The term power quality relates to matching of the generation of overall system against the loading of the system plus total losses of the system therefore there is a possibility for the system to continue in steady state situation. Though, both real and reactive power fluctuates with the deviation of load[1][2]. To supply the proper demand steam value of input to the associated generators, should be controlled to meet the demand of the active power, weakening the speed that leads to consequential variation in frequency that is extremely unwanted[3]. By providing control over the reactive power, and generator's excitation, consequently voltage can be organized[4][5]. For identifying the change control system which provides automated control can be used, because of non-feasibility of manual regulation. This mechanism comes under automatic generation control (AGC) and notices the variations of the power system. The main object of this "Automatic Generation Control (AGC)" is providing the wanted active output power of the generator and to support the control of frequency. "Automatic Generation Control (AGC)" principal loop control involves the governor system for implementing the preferred generation control[6]. Conventional controller to control the frequency don't achieve the goal[7][8]. The simple ideas of speed governors are represented by involving secluded generating unit delivering power to a native load as exposed in figure1.

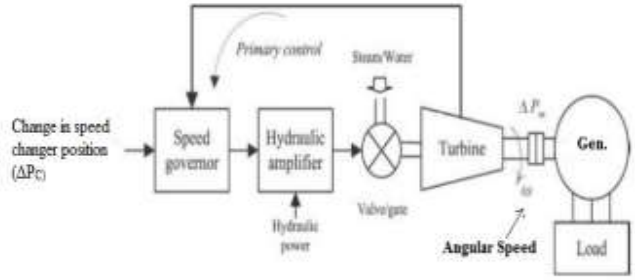

Fig. 1 block diagram of Governor- Turbine with frequency control loop

There are various benefits in case of interconnected power system. Wherein 1 is capable of selling and buying power with adjacent systems. If power transmission is zero, when 1 of the systems exhibits losses in the generating unit, all of the interconnected units would involve a variation in frequency and therefore frequency can be restored. The overall change is given by:

$P_{net\ int}$ = total actual net interchange (+ for power leaving the system - for power entering)

$P_{net\ int\ sched}$ = scheduled or desired value of net interchange

$$\Delta P_{net\ int} = P_{net\ int} - P_{net\ int\ sched} \qquad (1)$$

A control area to be portion of an interlinked system including the power flow of tie-line is monitored. The requisite variation in generation, known as "Area Control Error (ACE)". ACE signifies the changes in the generation area necessary to reestablish frequency and net swapping to the preferred values. Therefore expressions for area control error ACE is given by:

$$ACE_1 = -\Delta P_{net\ int1} - B_1 \Delta w \qquad (2)$$

$$ACE_2 = -\Delta P_{net\ int2} - B_2 \Delta w \qquad (3)$$

Wherein $+B_1$ and $+B_2$ denote "frequency bias factors". Whole control system would effort to drive ACE to "0" and motivates essential output from every unit. It's been conferred that the execution of this type "Fuzzy Logic Controller" significantly upgraded the functioning performance and also made the system robust. Researches are done on a 2-area reheat

“Thermal power system” allowing “Generation Rate Constraint (GRC)”. In this paper 5% min GRC is considered.

MODEL WITH GENERATION RATE CONSTRAINT:

In the system, generation of the power would change simply at a definite extreme rate and the mentioned rate is pretty short. Majority of the units have a rate of generation about three percent minimum and other have the percentage between 5 to 10%/minimum. In case if the GRC is considered the variation in frequency is high as compared to not considered GRC. Because of the consequence of existence of “Generation Rate Constraints (GRCs)” in the unit of generation, results in a non-linear system model and for the reason of control techniques to make the system linear cannot be applied. Limiter addition is 1 of the method for seeing the GRCs in plants of both the areas to the governors as illustrated inn figure 2.

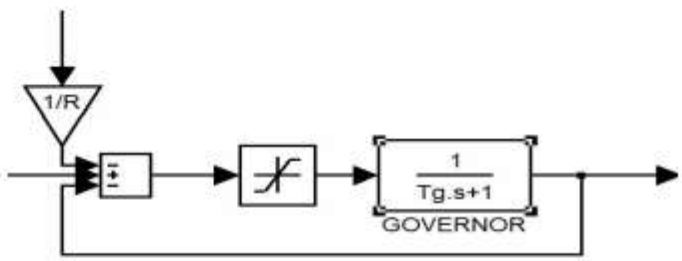

Fig. 2 Governor Model with GRC

FUZZY LOGIC CONTROLLER (FLC)

The 3 foremost components of the Controller includes Fuzzier, second one is Rule base and inference engine, and De-fuzzifier[9]. Initially it is to be decided that which of the states signify the performance of the dynamics of the system that should be considered as the i/p signal supplied to the controller. The “Fuzzy logic controller (FLC)” accepts linguistic type of variables. Consequently, initial step is converting the variables which are in numeric form (crisp values) into the acceptable linguistic variables and it’s known as fuzzification procedure. Inputs that are to be given to the controller are state error derivative, state error, state error integral etc. are utilized by the controller. In the paper “Area Control Error (ACE)” and derivation of “ACE” are selected for supplying signal as an input of the fuzzy. A function of membership is used to demonstrate the value of magnitude of the contribution of individual member. There’re various kind of “membership function” with respective input/output. The work, uses “triangular membership function” in case of input/output variables. 5 of the membership functions are employed for providing control with the help of “FLC”. With the increase in number of variable of linguistic type, results in improved quality response and time of computation. Thus, a cooperation is done to pick the variables. Table 1 represents 5 variables in the form of linguistics while investigating AGC[10].

Table 1

d(e) \ e	NL	NS	ZZ	PS	PL
NL	S	S	M	M	L
NS	S	M	M	L	VL
ZZ	M	M	L	VL	VL
PS	M	L	VL	VL	VVL
PL	L	VL	VL	VVL	VVL

For the determination of restricted state association between the variables, Rules are used. From the table one can see that rules are influenced for example when the error and change in error are “ZZ and NL” respectively then outcome result is “M”. Likewise, for PS error, and for PS as alteration in the error, result outcome is “VL”. By 2 inputs wherein each input comprises 5 “membership functions”, twenty five rules have been derived. The rule consequent is “then”. The outcome result of the controller is in linguistic form but the result witch is required in general is crisp output. Therefore de-fuzzification is employed in the system to convert these linguistic variables into crisp values and this procedure is just conflicts the Fuzzification. In this paper “Mamdani defuzzification” technique used.

RESULTS AND ANALYSIS

Error e (t) and change in error de (t) are taken in the designing of the fuzzy logic. Figure 3 and 4 represents model of MATLAB/SIMULINK for 2-area control employing “Fuzzy Logic Controller”. Dynamic response is illustrated in Figure 5 for the interconnected thermal power plant. Firstly the inquiries have been done by ignoring GRC. Comparison is done among the obtained results using a controller which is preferably “FLC”. A dash line represents non-appearance of GRC, while solid line is to show the occurrence of GRC. It is observed by the results that association of the controller makes the system robust and provides improved damping ratio. Along with the simple designing.

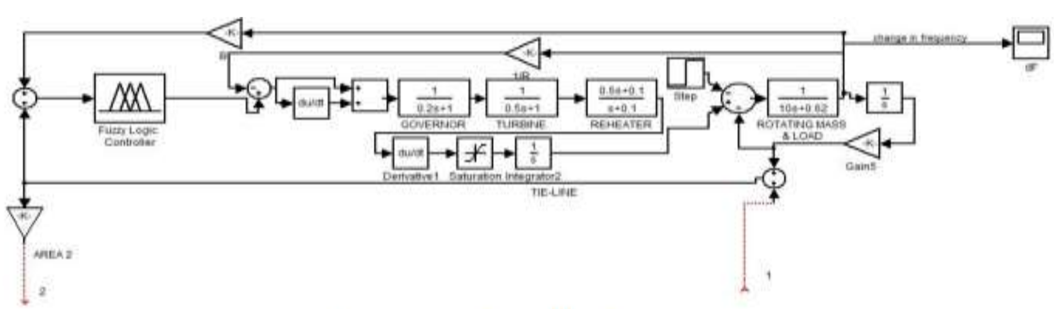

Fig. 3 area 1 of two area thermal power system with GRC

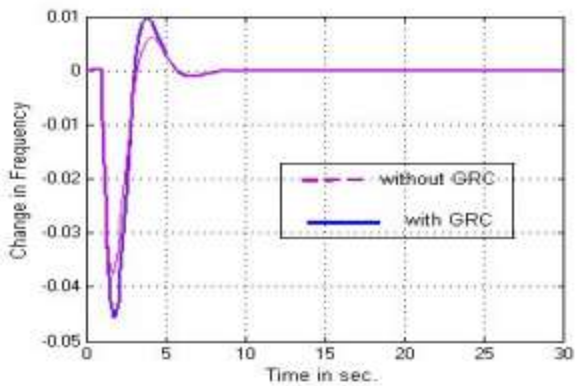

Fig. 4 Frequency response of Area-1

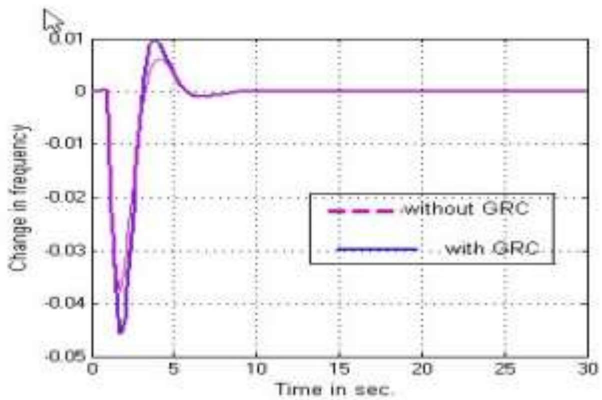

Fig. 5 frequency response of Area-2

CONCLUSION

The present paper "Automatic generation control of interlinked power system using fuzzy logic controller" have been completed efficiently. The simulations are done in the presence and absence of Automatic Generation Control (AGC). By the comparison of these results it is detected that the system remains stable even with the GRC and that the reaction response in the presence and absence of GRC don't varies much. Projected FLC is highly correct, quicker and also provides improved outcomes while considering GRC.

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