Research Paper Engineering

Smart Control of Parameter of Microgrid Having Renewable Sources Using ZIEGLER-NICHOLS Method

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ABSTRACT

A new concept in power generation is a micro grid. Isolated micro grid system is a small scale independent power system having renewable energy sources- solar and wind power sources and backup by controllable sources- diesel generator, and fuel cell. In the micro grid, the ramp rate limit has been implemented by means of Generation Rate Constraint (GRC) and power-frequency (P-f) droop characteristics (R) is also included for the parallel operation of generating sources. participating in Smart Control of Sources. These GRC and P-f droop make the system non linear and we have proposed a Zigler nicholos based optimization to tune important parameters simultaneously in micro grid. The proposed method improves dynamic and steady state response of the microgrid and maintains the system frequency at desired level.

KEYWORDS Smart Grid, MicroGrid, Frequency deviation, Power deviation

I. Introduction

A smart grid is an electricity network that can inteligenty intregate the action of all users connected to it- generator, consumer and those that do both- in order to efficinty diliver sustainable, economic and secure electric supply.A smart grid employs inovetive products and services together with intelligent monitoring, contol, communication and self healing technologies .

Smart grids co-ordinate the needs and capabilities of all generators, grid operators, end-users and electricity market stakeholders to operate all parts of the system as efficiently as possible, minimising costs and environmental impacts while maximising system reliability, resilience and stability.

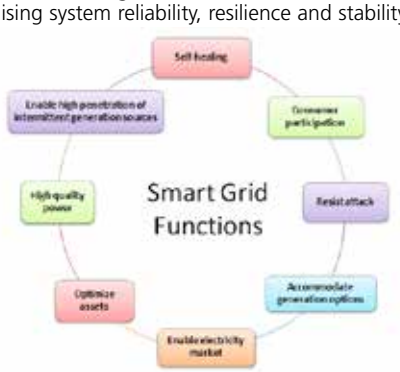


Fig-1 Function of smart grid

A microgrid is a cluster of micro sources, storage system and loads which present itself to the gird as single entity that can respond to central control signal. The heart of the micro grid concept is the notion of flexible, yet controllable interface between microgrid and wider power system. This interface essentially isolate the two sides electrically and yet connects economically.

The application of distributed generation has given rise to many problems, such as protection, control, power quality etc., in the distribution network. Micro-grid, which is the integration of distributed generation and loads, is regarded as a potential solution to the problems mentioned above. Microgrid has become an important supplementary means to solve the many problems of power system in some developed countries. As an important component of distribution network, micro-grid is the necessarily development trend for future, which can not only improve the reliability of power supply, but also ease up the pressure on energy conservation and environmental protection.



Fig-2 Hybrid micro grid

In order to utilize the renewable energy cost effectively, many researchers have studied the algorithm to calculate the capacity of applicable generator units that can constitute a reliable power system with low cost. Many different sizing methods , such as iterative method and artificial intelligence method, have been reported to design a techno-economically optimum hybrid renewable energy system.

II. System Model

Solar energy has expressed its unique advantage in the remote area where the cost of the power transmission is very high or even has no power supplies, although solar power is too costly to be economic. Integrating wind and solar resources in a proper combination can overcome the drawback of their unpredictable nature and dependence on weather and climatic changes. Therefore, it is convenient to develop a microgrid thatconsists of wind-turbine generator (WT), photovoltaic array (PV) and battery backups to satisfy power demands in remote areas.

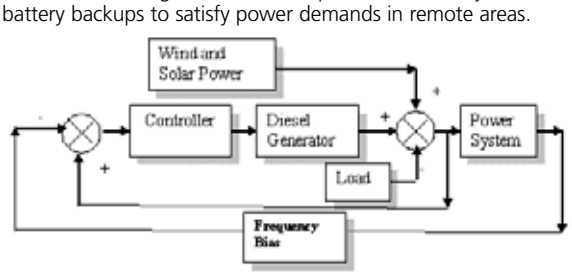


Fig-3 Functional block diagram

A. Mathematical model of wind turbine:
The simulated wind speed can be calculated using following equation:

$S\omega\ t = \mu t + \alpha tyt$

Where μt and αtyt are the average wind speed and standard deviation respectively.

$Pw = ½\ \rho\ A\ V3\ Cp$

Where Cp is Characterisic of wind turbine and Pw is output power.

B. Mathematical model of PV generation:
***Ppv* = $\eta S\phi${1–0.005(*Ta*+25)}**

Where η ranging from 9% to 12% is the conversion efficiency of the PV array, S is the measured area of the PV array, Φ is the solar radiation, and Ta is ambient temperature in degree Celsius. The value of Ppv depends on Ta and Φ because η and *S* are constant.

C. Modelling of Diesel generator
Diesel generator basic principle of diesel generator is the basic structure of the diesel engine and generator and diesel engine power generator power generation. First said the basic structure of diesel engine: it by cylinder piston and cylinder head, the intake and exhaust, door, the piston pin, connecting rod, crankshaft, flywheel bearing and the component such as composition. Diesel generator of single cylinder diesel engine is generally more than four stroke or the diesel engine cylinder, below I only about four stroke of single cylinder diesel engine working principle: diesel engine is starting by human or other power rotation diesel engine crankshaft make the piston cylinder at the top of the up and down in airtight reciprocating movement. The piston in movement finished four stroke: intake stroke, compression stroke, burning and function (inflation) itinerary and the exhaust stroke. When the pistons downward movement by the valves on when to open, the air filter filter of fresh air into the cylinder complete intake stroke. The piston by next to move up, exhaust doors closed, compressed air, temperature and pressure, complete the compression process. The piston is about to reach the top, the fuel injectors by filtering with mist spray into the combustion chamber of high temperature and high pressure air mixed with immediately to ignition and combustion, formation of high pressure to drive the pistons under the work, promote the crankshaft, finish doing work schedule

III. THE ZIEGLER-NICHOLS METHOD
In 1942 Ziegler and Nichols, both employees of Taylor Instruments, described simple mathematical procedures for tuning PID controllers. These procedures are now accepted as standard in control systems practice. Ziegler-Nichols formulae for specifying the controllers are based on plant step responses.

Steps to determine PID controller parameters:
1. Reduce the integrator and derivative gains to 0.
2. Increase Kp from 0 to some critical value Kp=Ku at which sustained oscillations occur
3. Note the value Ku and the corresponding period of sustained oscillation, Tu
4. The controller gains are now specified as follows:

Controller type	Kp	Ki	Kd
P type	0.5Ku	0	0
PI type	0.45Ku	1.2Kp/Tu	0
PID type	0.6Ku	2/Tu	Tu/8

Table-1 ZN method

In this system the PID is used to compensate the error generated due to the variation in power demand and frequency deviation. And parameter of PID controller is tuned through the ZN method.

IV Case study:

Solar Power, Wind Power and load is taken as step function. Which is shown below.

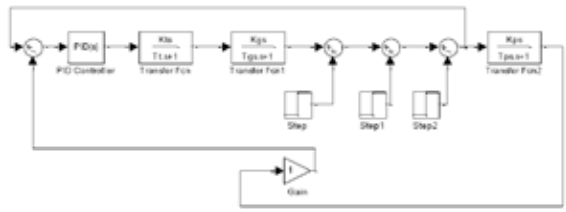


Fig-4 Block diagram of system model

A. Model of speed governing system:
$\Delta Y_E(s)=k1k3kc\ \Delta Pc(s)- k3k2\Delta F(s)/(k4+s/k5)$

$= [\ \Delta Pc(s)- \Delta F(s)]x[Ksg/1+TsgS\ ]$

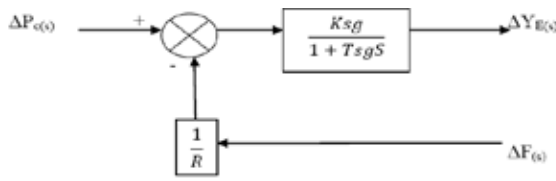


Fig-5 Block diagram of speed governing system

B. Model of Turbine:
Let us now relate the dynamic response of steam turbine in terms of change in power output to change in steam valve opening ΔyE.

Two stage steam turbine with reheat unit, is represented by the transfer function as shown below.

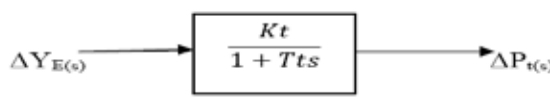


Fig-6 Block diagram of turbine system

C. Generator Model
The increment in power input to the generator load system is

ΔPG- ΔPD

$$\Delta P_G - \Delta P_D = \frac{2H}{f}\frac{d}{dt}(\Delta f) + B\Delta f$$

$$\Delta F = [\ \Delta P_G - \Delta P_D]x[\frac{Kps}{1+TpsS}]$$

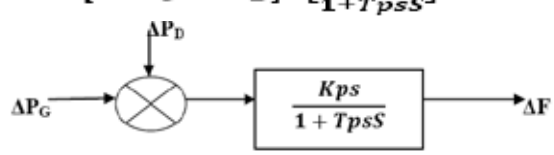


Fig-7 Block diagram of power system

controlled by P and PI controller. The controller parameters are chosen based on proposed method as shown in the Table. The deviation in load is automatically adjusted by diesel generator through these controllers since the wind generator and solar power are under constant power strategy.

In this case all the parameter are initialized as under
Kts=0.1 ,Tts= 0.5,Kgs= 10,Tgs = 0.4,Kps= 100,Tps=20

R=3 .

The analysis of system is carried out for different cases. Initially solar power, wind power and load is taken as 0.3 pu , 0.5 pu and 0.8 pu respectively. The following condition were studied

(a) sudden change in load (d) sudden change in wind power.

Frequency deviation in the system due to sudden change in load is

Case-1:
The load is suddenly increase from 0.8 pu to 0.85 pu, wind power is 0.5 pu and solar power is 0.3 pu kept constant. The change in load demand is met by the diesel generator using PI controller. Frequency and power deviation is observed and plotted in fig for particular case.

Type of controller	Kp	Ki	Kd
P Type	0.38	0	0
PI Type	0.342	0.04104	0

Table-2 Tune Parameter of case-1

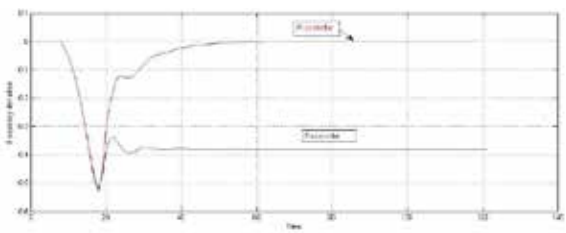


Fig-8 Frequency deviation for case-1

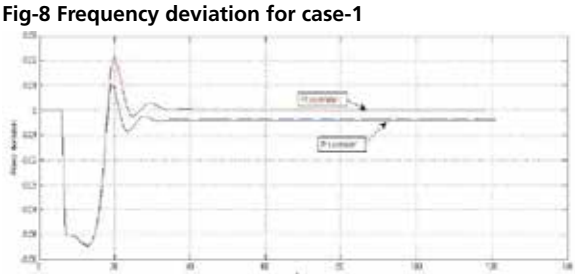


Fig-9 Power deviation for case-1

Case-2:
Wind power increase from 0.5pu to 0.6 pu. Solar power and load is kept constant at 0.3 pu and 0.8 pu. The change in wind generation is met by the diesel generator using PID controller. Frequency and power deviation is observed and plotted in fig for particular case.

Type of controller	Kp	Ki	Kd
P Type	0.3775	0	0
PI Type	0.33975	0.05096	0

Table-3 Tune Parameter of case-2

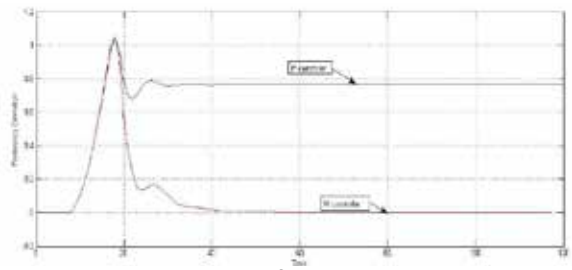


Fig-10 Frequency deviation for case-2

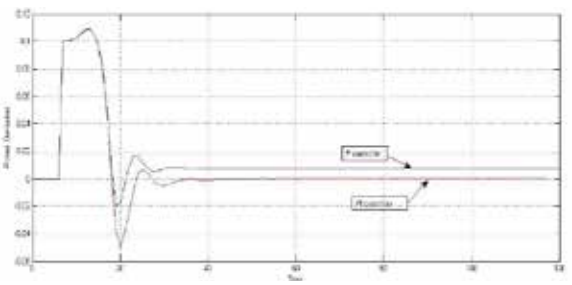


Fig-10 Power deviation for case-2

V CONCLUSION

In this paper a systematic approach for tuning of PI controllers in DGS and calculation of optimal frequency bias are presented. The robustness of the proposed controller is checked with different case studies. The simulation studies of DGS with PID controller shows a better performance in terms of time domain specifications: rise time, peak over shoot, peak time, settling time, and steady state error, than P and PI controllers. When the load or power generation changes occur in the DGS, the PI controller acts such that the Diesel Generator will compensate for the required power. This resulted in the minimum oscillations in the frequency and power. Finally the PI controllers stabilize the system quickly with zero steady state error in less settling time.

Acknowledgement
I wish to express my sincere gratitude to Prof. R.R Kapadia, and Prof S.N.Shivani, Electrical Engineering Department, Government Engineering College, Bhuj for their intellectual guidance and invaluable advice throughout. And I also thank ful to Prof.H.S Pandya and Prof.J.N.Patha, Electrical Engineering Department Nirma University .

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