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Dynamic Power Conditioning Method of Microgrid via Adaptive Inverse Control

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ABSTRACT

The basic idea of the Project on "Dynamic Power Conditioning Method of Microgrid via Adaptive Inverse Control". Here is Different micro sources have different frequency regulation functions and capabilities. The droop control can allocate power among the micro sources according to the operation demand during system dynamics; however, the steady-state frequency often deviates from the rated value because of the droop characteristics. To ensure the precise condition of power and the stability of frequency even in a low-voltage network, this paper puts forward an improved droop control algorithm based on coordinate rotational transformation. With the ability to accurately regulate the unbalance power, this method realizes self-discipline parallel operation of micro sources.

Furthermore, an adaptive inverse control strategy applied to modified power conditioning is developed. With an online adjustment of modified droop coefficient for the frequency of microgrid to track the rated frequency, the strategy guarantees maintaining the frequency of microgrid at the rated value and meeting the important customers' frequency requirements. The simulation results from a multiuse microgrid show the validity and feasibility of the proposed control scheme.

INTRODUCTION

Micro-grid technology has provided a new technical approach for the large- scale integration of renewable energy and distributed generation. As a key building block of smart grid, micro-grid has the potential to improve the utilization efficiency of energy cascade and improve power-supply reliability and power quality (PQ). Though micro-grid has a flexible operation style, how to effectively control a variety of micro sources in micro-grid to ensure its safety, efficiency, and reliability in different operating modes are subjects of concern.

When the main grid fails to meet the PQ demand for the internal load in the micro-grid, the micro-grid will promptly disconnect from the main grid and operate in an autonomous mode. However, inertia of the micro-grid is small when operating independently. Besides, there are other factors, such as nonlinear load and the randomness, volatility, and intermittent of micro source. As a result, it is difficult to control the system frequency and voltage accurately in the micro-grid. Peer-to-peer control is one of the hotspots of micro-grid research. The primary objective of the peer-to-peer control of the micro-grid is to assign power and distribute load among distributed generators without communication, for reducing the cost of Micro-grid, and enhancing the reliability and flexibility. In addition, a game-theoretic approach is presented to the control decision process of individual sources and loads in small-scale and dc power systems, and this game-theoretic methodology enhances the reliability and robustness of the Micro-grid by avoiding the need for central or supervisory control. Game-theoretic communication helps to share local controller information, such as control input, individual objectives among controllers, and find a better optimized cost for the individual objectives. For the robustness of the system operation, the peer to peer should be equipped with the feature of plug-n-play and hot swapping. The conventional power droop control is suitable for the line parameters whose reactance is much larger than the resistance. But the resistance and reactance have the same order of magnitude in micro-grid and the conventional droop control is no longer applicable. So a new droop control strategy is needed. To ensure the power quality (PQ), system frequency should be maintained within the desired range. Since most micro source is connected to micro-grid through inverters, fixed droop coefficients will cause deviation between micro-grid stable frequency and the rated value when output power is balanced. There is a need to develop a new power control strategy combined with zero-error frequency regulation to mimic the primary and secondary frequency control of traditional power systems, which has the advantage of droop control and guarantees micro-grid steady-state frequency maintained at the rated value.

After analysing conventional droop control for the parallel-connected micro source, this paper introduces flat rotation transformation, an improved droop control and droop coefficient selection method, to enhance the operation of an LV micro-grid. In addition, this paper proposes a novel power conditioning method based on adaptive inverse control to mitigate frequency deviation caused by the use of fixed droop coefficient. The proposed control method can dynamically and effectively balance power in the micro-grid while maintaining frequency at the rated value. The validity and feasibility of the proposed model are proved by simulation results.

Traditional droop control

Traditional droop control is the conventional propose technique. In this project traditional droop control is using because when the line impedance is considered in the micro-grid the accuracy of load sharing will decrease. The impact of line impedance on the accuracy of load sharing is analysed. A strong droop control for a high-voltage micro-grid is proposed based on the signal detection on the high-voltage side of the coupling transformer. For a high-voltage micro-grid the equivalent impedance of coupling transformer connecting distributed generator with the grid is usually the control factor. Compared with the conventional droop control strategy, this control detects the feedback signal from the load sharing accuracy can be mitigated significantly. This droop control only changes the detection point of the feedback.

Drawback of Traditional Droop Control

- Due to circulating current losses occurs in the line are more.
- Power factor is lagging of very less terminal voltage.
- Voltage regulation is very poor.
- Frequency and Reactive power compensation required.

ACTIVE POWER CONDITIONING

Non-linear loads are commonly present in industrial facilities, service facilities, office buildings, and even in our homes. They are the source of several Power Quality problems such as harmonics, reactive power, flicker and resonance. Therefore, it can be observed an increasing deterioration of the electrical power grid voltage and current waveforms, mainly due to the contamination of the system currents with harmonics of various orders, including inter-harmonics. Harmonic currents circulating through the line impedance produces distortion in the system voltages. Moreover, since many of the loads connected to the electrical systems are single-phase ones, voltage unbalance is also very common in three-phase power systems. The distortion and unbalance of the system voltages causes several power quality problems, including the incorrect operation of some sensitive loads. Figure 1 presents a power system with sinusoidal source voltage (SSV) operating with a linear and a non-linear load. The current of the non-linear load (iL1iL1)

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contains harmonics. The harmonics in the line-current (is) produce a non-linear voltage drop (Δv) in the line impedance, which distorts the load voltage (LV). Since the load voltage is distorted, even the current at the linear load (iL2iL2) becomes non- sinusoidal.

The problems caused by the presence of harmonics in the power lines can be classified into two kinds: instantaneous effects and long-term effects. The instantaneous effects problems are associated with interference problems in communication systems, malfunction or performance degradation of more sensitive equipment and devices. Long-term effects are of thermal nature and are related to additional losses in distribution and overheating, causing a reduction of the mean lifetime of capacitors, rotating machines and transformers. Because of these problems, the issue of the power quality delivered to the end consumers is, more than ever, an object of great concern. International standards concerning electrical power quality (IEEE-519, IEC 61000, and EN 50160) impose that electrical equipment's and facilities should not produce harmonic contents greater than specified values, and also indicate distortion limits to the supply voltage. According to the European COPPER Institute – Leonard Energy Initiative, costs related to power quality problems in Europe are estimated in more than €150.000.000 per year. Therefore, it is evident the necessity to develop solutions that are able to mitigate such disturbances in the electrical systems, improving their power quality.

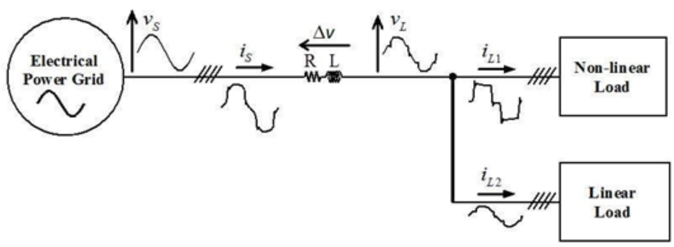

Fig.1.1 Single line block diagram of a system with non-linear loads.

Passive filters have been used as a solution to solve harmonic current problems, but they present several disadvantages, namely: they only filter the frequencies they were previously tuned for; their operation cannot be limited to a certain load; the interaction between the passive filters and other loads may result in resonances with unpredictable results. To cope with these disadvantages, in the last years, research engineers have presented various solutions based in power electronics to compensate power quality problems. This equipment's are usually designated as Active Power Conditioners. Examples of such devices are the Shunt Active Power Filter, the Series Active Power Filter, and the Unified Power Quality Conditioner (UPQC).

Shunt Active Power Filter

The Shunt Active Power Filter is a device which is able to compensate for both current harmonics and power factor. Furthermore, in three-phase four wire systems it allows to balance the currents in the three phases, and to eliminate the current in the neutral wire. Figure 2 presents the electrical scheme of a Shunt Active Power Filter for a three-phase power system with neutral wire.

The power stage is, basically, a voltage-source inverter with a capacitor in the DC side (the Shunt Active Filter does not require any internal power supply), controlled in a way that it acts like a current-source. From the measured values of the phase voltages (va,vb,vc) and load currents (ia,ib,ic), the controller calculates the reference currents (ica*,icb*,icc*,icn*) used by the inverter to produce the compensation currents (ica,icb,icc,icn). This solution requires 6 current sensors: 3 to measure the load currents (ia,ib,ic) for the control system and 3 for the closed-loop current control of the inverter (in both cases the fourth current, the neutral wire currents, in and icn, are calculated by adding the three measured currents of phases a, b, c). It also requires 4 voltage sensors: 3 to measure the phase voltages (va, vb, vc) and another for the closed-loop control of the DC link voltage (Vdc). For three-phase balanced loads (three-phase motors, three- phase adjustable speed drives, three-phase controlled or non-controlled rectifiers, etc.) there is no need to compensate for the current in neutral wire, so the forth wire of the inverter is not required, simplifying the Shunt Active Power Filter hardware. Since they compensate the power quality problems upstream to its coupling point they should be installed as near as possible of the non-liner loads, avoiding the circulation of current harmonics, reactive currents and neutral wire currents through the facility power lines. Therefore, it is advantageous to use various small units, spread along the electrical installation, instead of using a single high power Shunt Active Power

Filter at the input of the industry, at the PCC (Point of Common Coupling – where the electrical installation of the industry is connected to the electrical power distribution system).

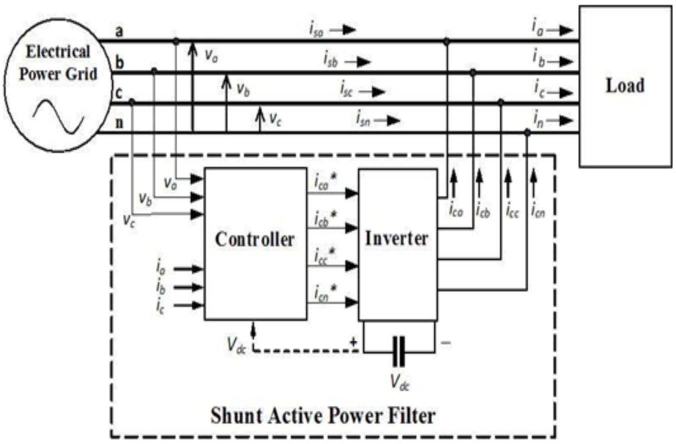

Fig.1.2 Shunt Active Power Filter for a three-phase power system with neutral wire.

Typical waveforms of an electrical installation equipped with a Shunt Active Power Filter. It can be seen that the currents in the load present high harmonic content (THD% of 58%), and are also unbalanced, which results in a considerable neutral wire current. The Shunt Active Power Filter makes the currents in the source sinusoidal and balanced. The THD% of the source currents is only of about 1%.

Series Active Power Filter

The Series Active Power Filter is the dual of the Shunt Active Power Filter, and is able to compensate for voltage harmonics, voltage sags, voltage swells and flicker, making the voltages applied to the load almost sinusoidal (compensating for voltage harmonics). The three-phase Series Active Filter can also balance the load voltage. It shows the electrical scheme of a Series Active Power Filter for a three- phase power system.

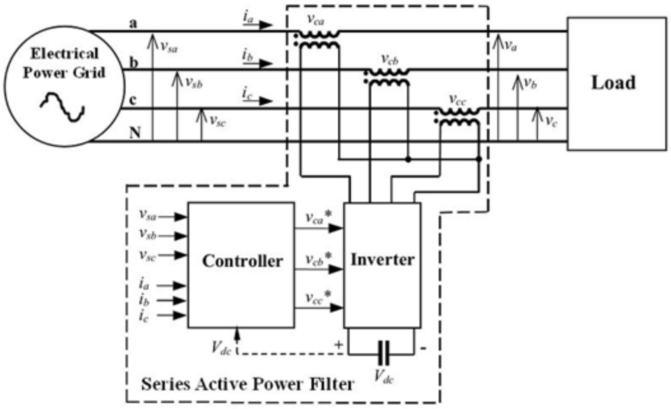

Fig.1.3 Series Active Power Filter for a three-phase power system.

The Series Active Power Filter consists of a voltage-source inverter (behaving as a controlled voltage-source) and requires 3 single-phase transformers to interface with the power system. However, some authors have presented research results of Series Active Power Filter topologies without the use of line transformers. From the measured values of the phase voltages at the source side (vsa,vsb,vsc) and of the load currents (ia,ib,ic), the controller calculates the reference compensation voltages (vca*,vcb*,vcc*), used by the inverter to produce the compensation voltages (vca,vcb,vcc). The Series Active Power Filter does not compensate for load current harmonics but it acts as high-impedance to the current harmonics coming from the electrical power grid side. Therefore, it guarantees that passive filters eventually placed at the load side will work appropriately and not drain harmonic currents from the rest of the power system.

Unified Power Quality Conditioner

The Unified Power Quality Conditioner (UPQC) combines the Shunt Active Power Filter with the Series Active Power Filter, sharing the same DC Link, in order to compensate both voltages and currents, so that the load voltages become sinusoidal and at nominal value, and the source currents become sinusoidal and in phase with the source voltages. In the case of three-phase systems, a three-phase UPQC can also balance the load voltages and the source currents, and eliminate the source neutral current. It shows the electrical scheme of a

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Unified Power Quality Conditioner for a three-phase power system.

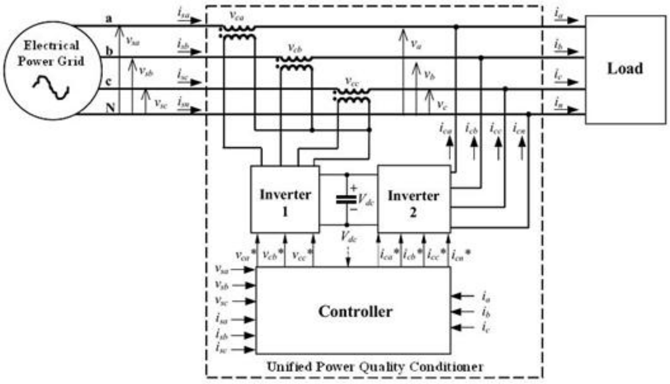

Fig.1.4 Unified Power Quality Conditioner for a three-phase power system.

From the measured values of the source phase voltages (vsa,vsb,vsc) and load currents (ia,ib,ic), the controller calculates the reference compensation currents (ica*,icb*,icc*,icn*) used by the inverter of the shunt converter to produce the compensation currents (ica,icb,icc,icn). Using the measured values of the source phase voltages, and source currents (isa,isb,isc), the controller calculates the reference compensation voltages (vca*,vcb*,vcc*) used by the inverter of the series converter to produce the compensation voltages (vca,vcb,vcc).

MICRO-GRID

A micro-grid is a network consisting of distributed generator and storage devices used to supply loads. A distributed generator (DG) in a micro-grid is usually a renewable source, such as combined heat and power (CHP), photovoltaic (PV), wind turbine, or small-scale diesel generator. DGs are usually located near the loads, so that line losses in a micro-grid are relatively low. A micro-grid can work with a host grid connection or in islanded mode. When grid connected, DGs supports the main grid during peak demand. However, if there is a disturbance in the main grid, a micro-grid can supply the load without the support of the main grid. Moreover, a micro-grid can be reconnected when the fault in the main grid is removed. Furthermore, as in any technology, micro-grid technology faces many challenges. Many considerations should be taken into account, such as the control strategies based on of the voltage, current, frequency, power, and network protection.

MICRO-GRID STRUCTURE AND COMPONENTS

Figure 2.1 shows the structure of a micro-grid. The main grid is connected to the micro-grid at the point of a common coupling. Each micro-grid has a different structure (number of the DGs and types of DGs), depending on the load demand. A micro-grid is designed to be able to supply its critical load. Therefore, DGs should insure to be enough to supply the load as if the main grid is disconnected. The micro- grid consists of micro source, power electronic converters, distributed storage devices, local loads, and the point of common coupling (PCC). The grid voltage is reduced by using either a transformer or an electronic converter to a medium voltage that is similar to the voltage produced from the DG. The components of the micro-grid are as follows.

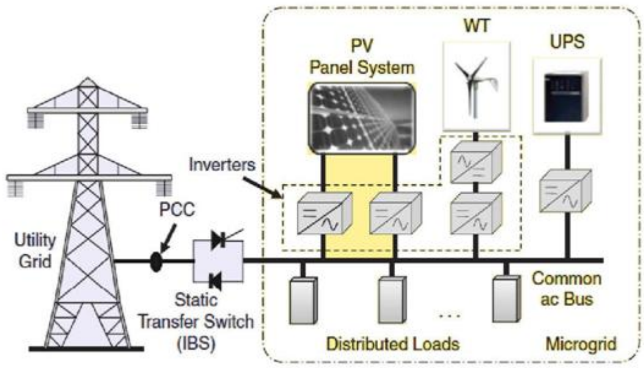

Fig.2.2 Micro-grid Structure based on renewable energy sources

CONVENTIONAL METHOD OF CONTROLLING STRATEGIES

Peer-to-Peer (P2P) Control

Computing or networking is a distributed application architecture that partitions tasks or workloads between peers. Peers are equally privileged, equipotent participants in the application. They are said to form a peer-to-peer network of nodes.

Peers make a portion of their resources, such as processing power, disk storage or network bandwidth, directly available to other network participants, without the need for central coordination by servers or stable hosts. Peers are both suppliers and consumers of resources, in contrast to the traditional client-server model in which the consumption and supply of resources is divided. Emerging collaborative P2P systems are going beyond the era of peers doing similar things while sharing resources, and are looking for diverse peers that can bring in unique resources and capabilities to a virtual community thereby empowering it to engage in greater tasks beyond those that can be accomplished by individual peers, yet that are beneficial to all the peers.

While P2P systems had previously been used in many application domains, the architecture was popularized by the file sharing system Napster, originally released in 1999. The concept has inspired new structures and philosophies in many areas of human interaction. In such social contexts, peer-to-peer as a meme refers to the egalitarian social networking that has emerged throughout society, enabled by Internet technologies in general.

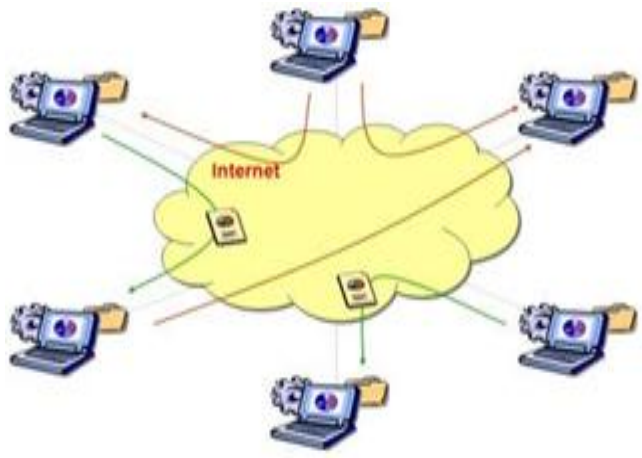

Fig: - 3.1.1 peer to peer control

Hierarchical Control System

A Hierarchical control system is a form of control system in which a set of devices and governing software is arranged in a hierarchical tree. When the links in the tree are implemented by a computer network, then that hierarchical control system is also a form of networked control system. A human-built system with complex behaviour is often organized as a hierarchy. For example, a command hierarchy has among its notable features the organizational chart of superiors, subordinates, and lines of organizational communication. Hierarchical control systems are organized similarly to divide the decision making responsibility.

Each element of the hierarchy is a linked node in the tree. Commands, tasks and goals to be achieved flow down the tree from superior nodes to subordinate nodes, whereas sensations and command results flow up the tree from subordinate to superior nodes. Nodes may also exchange messages with their siblings. The two distinguishing features of a hierarchical control system are related to its layers.

Each higher layer of the tree operates with a longer interval of planning and execution time than its immediately lower layer.

The lower layers have local tasks, goals, and sensations, and their activities are planned and coordinated by higher layers which do not generally override their decisions. The layers form a hybrid intelligent system in which the lowest, reactive layers are sub-symbolic. The higher layers, having relaxed time constraints, are capable of reasoning from an abstract world model and performing planning. A hierarchical task network is a good fit for planning in a hierarchical control system.

Besides artificial systems, an animal's control systems are proposed to be organized as a hierarchy. In perceptual control theory, which postulates that an organism's behaviour is a means of controlling its perceptions, the organism's control systems are suggested to be organized in a hierarchical pattern as their perceptions are constructed so.

- Primary Control:-It is proposing and implemented for Changing the load sharing among the load sharing ration among the converter.
- Secondary Control: -it is proposing to achieve desirable system damping level when tertiary control shift virtual resistance.
- Tertiary Control:-It improves the system level efficiency

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Droop Control

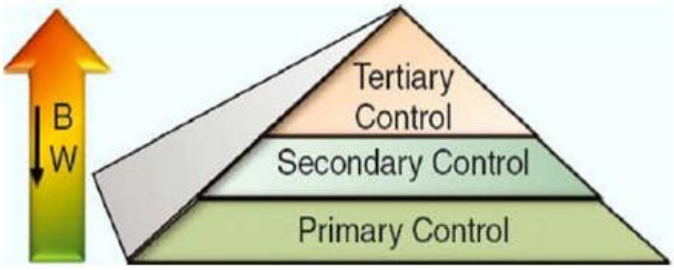

Fig: -3.1.2 Hierarchical Control Pyramid

Droop control is a control strategy commonly applied to generators for primary frequency control to allow parallel generator operation. A droop control scheme uses only local power to detect changes in the system and adjust the operating points of the generators accordingly. The droop control uses the real power out of a generator to calculate the ideal operating frequency. This relaxing of a stiff frequency allows the micro-grid to dampen the fast effects of changing loads, increasing the stability of the system. Droop control is reviewed and simulations will be used to determine the effectiveness of the droop controller as well as alternative forms of the traditional droop control. Experimental results are presented detailing how the droop gain affects power distribution and system stability.

This forms the basis of frequency and voltage droop control where active and reactive power are adjusted according to linear characteristics, based on the following control equations:

$$f = f_0 - k_p(P - P_0)$$

$$V = V_0 - k_q(Q - Q_0)$$

Where f is the system frequency?

F_o is the base frequency.

k_p is the frequency droop control setting

P is the active power of the unit

P_0 is the base active power of the unit

V is the voltage at the measurement location

V_0 is the base voltage

Q is the reactive power of the unit

Q_0 is the base reactive power of the unit

k_q is the voltage droop control setting

These two equations are plotted in the characteristics below:

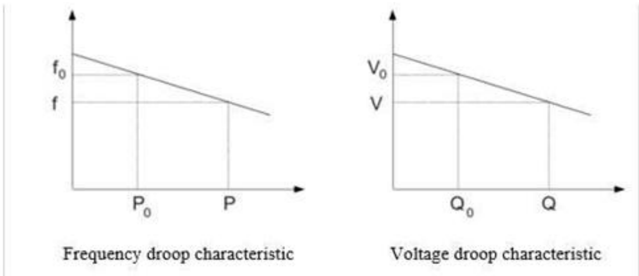

Fig: -3.2.1 drooping characteristics

According to the Fig: -3.2.1; when frequency falls from f0 to f, the power output of the generating unit is allowed to increase from P0 to P. A falling frequency indicates an increase in loading and a requirement for more active power. Multiple parallel units with the same droop characteristic can respond to the fall in frequency by increasing their active power outputs simultaneously. The increase in active power output will counteract the reduction in frequency and the units will settle at active power outputs and frequency at a steady-state point on the droop characteristic. The droop characteristic therefore allows multiple units to share load without the units fighting each other to control the load called "hunting".

MODERN CONTROLLING TECHNIQUE

3.2.1Adaptive Inverse Control

In this approach an Adaptive droop control has been implemented, which is capable of changing the gain value with the change in load demand and the DG supply. This control action is based on equation (4.17), which deals with the change in power supplied by the DG and the change in load demand, with the objective to keep the system frequency (ω) within its safe limit. Therefore, a high value of droop coefficient is selected when the power supplied by DG goes below the rated power (P0), where as a low droop gain results in faster steady state where the load power demand is high. This method uses a threshold active (P_{ithres}) and reactive power (Q_{ithres}), which are load dependent, in order to compare with the active (P_i) and reactive (Q_i) power outputs of the i_{th} DG unit to set the value of the droop coefficient. The logic can be stated as follows:

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When $P_i<P_{(ithres)}, m_i<m_{i0}$

And $P_i>P_{(ithres)}, m_i<m_{i1}$

Similarly,

When $Q_i<Q_{(ithres)}, n_i<n_{i0}$

And $Q_i>Q_{(ithres)}, n_i<n_{i1}$

This method damps oscillations and helps to reach steady state faster. However, this method degrades the accuracy of load sharing among the DGs.

Line characteristics: The droop characteristics discussed above greatly depends upon on the network characteristics and the load type. The conventional droop equations (4.8) -(4.9) are derived based on the equations (4.6) and (4.7), which assumed the network to be highly inductive i.e. a high X/R ratio. Now, considering resistive impedance (low X/R), Z in the (4.4) and (4.5) is replaced by Rand with zero.

The block diagram of the proposed controller is shown in below

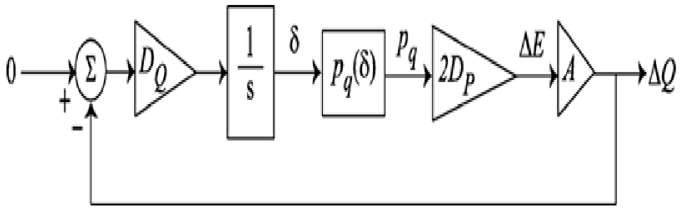

Fig.3.2.4 Block diagram of the signal injection method for reactive power sharing.

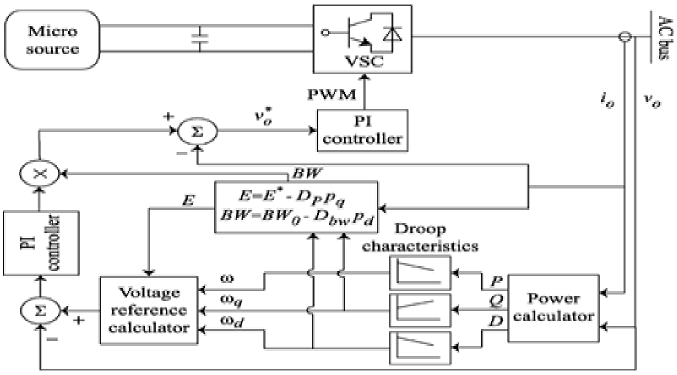

Fig.3.2.5 Block diagram of the updated signal injection method of Adaptive Inverse Control.

SIMULATION RESULTS

Simulation curves of active power conditioning based on Droop Control and Adaptive Inverse Control.

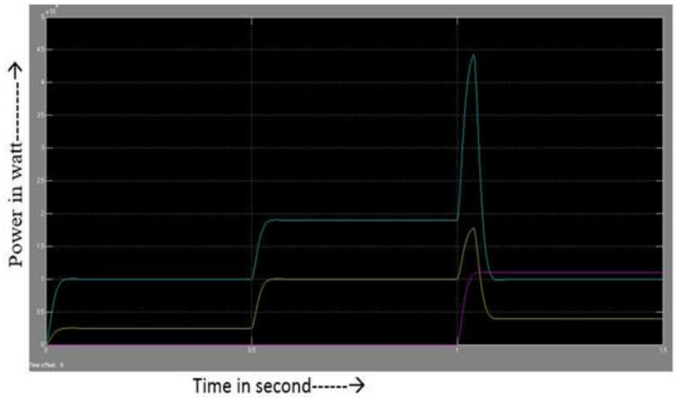

Fig: - 4.2.1(a) Active power droop control characteristics

In this above fig: -4.2.1(a) shows the graph between Active Power in watt and Time in second. Here in this graph Blue colour line represent the active power generated by PV cell, Yellow colour line represent the active power generated by wind energy and Purple colour line represent the Active power generated by biomass plant.

Here, At t=0 sec to t=0.5sec;

- Solar Energy Start generating of Active Power 1MW. It is more because PV Cell direct convert the Solar Radiant Energy into Electrical Energy.
- Wind Energy starts generating the Active power lesser than the Solar because Wind blade take some time to reach as threshold region
- Biomass Energy is zero during this period because it takes some time to decompose the organic wastes to convert into the marsh/methane gas

At t=0.5 sec to t=1 sec;

- Solar Energy is again reached up to 1.8MW.
- Wind Energy is again reached up to 1 MW.
- Biomass Energy is Again remains zero.

At t=1 sec to 1.5 sec;

Wind Energy & Solar Energy power is Fluctuating from 1.8 MW to 4.4 MW & 0.4MW to 1.8 MW

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Here sudden change in the power at t=1 sec with the magnitude of 4.4 ME & MW Simultaneously. The Stability Disturbance in this period and due to fluctuating these causes lot of problem such as damaging of power system components which causes heavy losses.

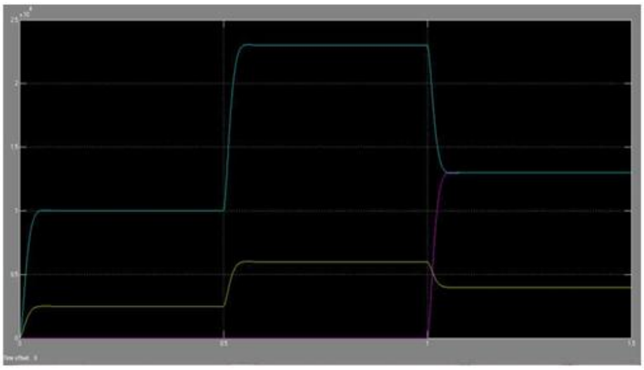

Fig: -4.2.1(b) Active Power Output curves of Adaptive Inverses Control

In the above fig: -4.2.1(b) shows the graph between Active Power and Time in Adaptive Inverse Control. Here in this graph Blue colour line represent the active power generated by PV cell, Yellow colour line represent the active power generated by wind energy and Purple colour line represent the Active power generated by biomass plant.

Here, At t=0 sec to t=0.5sec;

- Solar Energy Start generating of Active Power 1 MW. It is more because PV Cell direct convert the Solar Radiant Energy into Electrical Energy.
- Wind Energy starts generating the Active power lesser than the Solar because Wind blade take some time to reach as threshold region
- Biomass Energy is zero during this period because it takes some time to decompose the organic wastes to convert into the marsh/methane gas

At t=0.5 sec to t=1 sec;

- Solar Energy is again reached up to 2.4 MW.
- Wind Energy is again reached up to 0.6 MW.
- Biomass Energy is Again remains zero. At t=1 sec to t=1.5 sec;
- All the disadvantages of Droop Control Active power can overcome from Adaptive Inverse Control such as Transient & Stability.

Here, it is not a Large Magnitude Transient Occur and Over fluctuation. Hence it is more stable.
Simulation curves of Reactive power conditioning based on Droop Control and Adaptive Inverse Control.

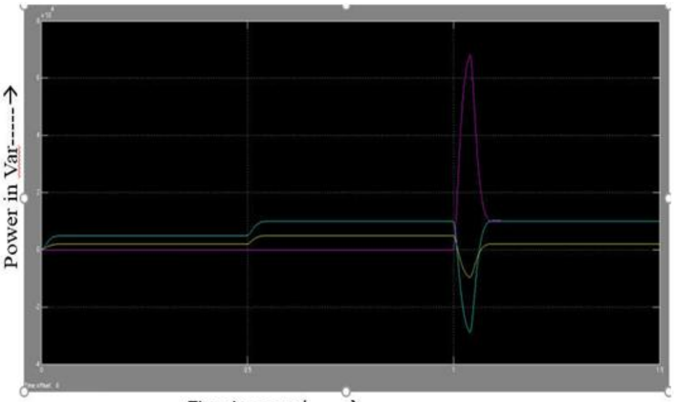

Fig: - 4.2.2(a) Reactive power droop control characteristics

In the above fig: -4.2.2(a) shows the graph between Reactive Power and Time in Droop Control. Here in this graph Blue colour line represent the Reactive power generated by PV cell, Yellow colour line represent the Reactive power generated by wind energy and Purple colour line represent the Reactive power generated by biomass plant.

Here, At t=0 sec to t=0.5sec;

- Solar Energy Start generating of Reactive Power 1MW. It is more because PV Cell direct convert the Solar Radiant Energy into Electrical Energy.
- Wind Energy starts generating the Reactive power lesser than the Solar because Wind blade take some time to reach as threshold region
- Biomass Energy is zero during this period because it takes some time to decompose the organic wastes to convert into the marsh/methane gas

At t=0.5 sec to t=1 sec;

- Solar Energy is again reached up to 1MW.

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- Wind Energy is again reached up to 0.5MW.
- Biomass Energy is Again remains zero.

At t=1 sec to 1.5 sec;
Wind Energy & Solar Energy power is Fluctuating from 1 MW to -3 MW & 0.5MW to -0.5 MW.
Biomass Energy is Fluctuating from 0 MW to 7 MW.
Here sudden change in the power at t=1 sec with the magnitude of 7MW & -3 MW Simultaneously. The Stability Disturbance in this period and due to fluctuating these causes lot of problem such as damaging of power system components which causes heavy losses.

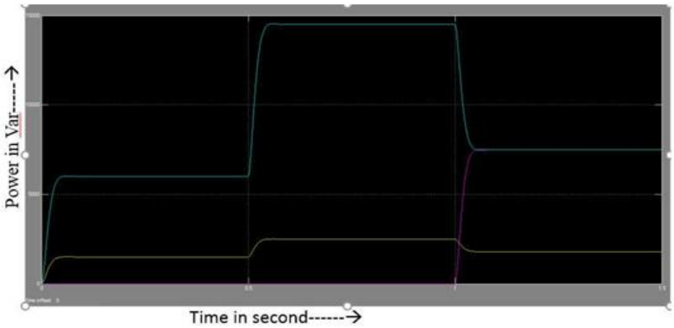

Fig: -4.2.2(b) Reactive power Adaptive inverse control characteristics

In the above fig: -4.2.2(b) shows the graph between Reactive Power and Time in Adaptive Inverse Control. Here in this graph Blue colour line represent the Reactive power generated by PV cell, Yellow colour line represent the Reactive power generated by wind energy and Purple colour line represent the Reactive power generated by biomass plant.

Here, At t=0 sec to t=0.5sec;

- Solar Energy Start generating of Reactive Power 6000 Var. It is more because PV Cell direct convert the Solar Radiant Energy into Electrical Energy.
- Wind Energy starts generating the Reactive power lesser than the Solar because Wind blade take some time to reach as threshold region
- Biomass Energy is zero during this period because it takes some time to decompose the organic wastes to convert into the marsh/methane gas

At t=0.5 sec to t=1 sec;

- Solar Energy is again reached up to 14000 Var.
- Wind Energy is again reached up to 2500 Var.
- Biomass Energy is Again remains zero. At t=1 sec to t=1.5 sec;

All the disadvantages of Droop Control Active power can overcome from Adaptive Inverse Control such as Transient & Stability.
Here, it is not a Large Magnitude Transient Occur and Over fluctuation. Hence it is more stable.
Simulation curves of Frequency Variation based on Droop Control and Adaptive Inverse Control.

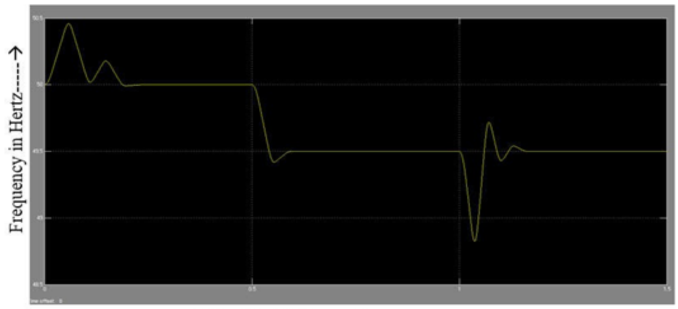

Fig: - 4.2.3(a) Frequency variation curve of the Droop Control

In the above fig: -4.2.3(a) shows the graph between Frequency and Time in Droop Control. Here frequency fluctuates badly because of the sudden load increase at interconnecting point in micro-grid at t=0 sec & at t= 1 sec.

The micro-grid frequency basically fluctuates above and below the synchronising frequency due to transient in micro-grid.

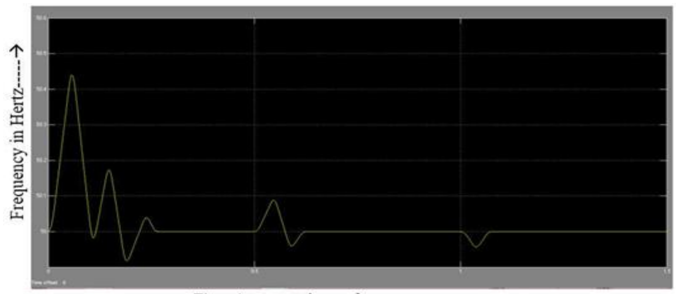

Fig: - 4.2.3(b) Frequency variation curve of the Adaptive Inverse Control.

In the above fig: -4.2.3(b) shows the graph between Frequency and Time in Adaptive Inverse Control. Here, due to sudden change in the load there is fluctuation in the frequency but by using Adaptive Inverse Control Technique.

The frequency is not fluctuating more and more at t=0 sec & t=0.5 sec & t= 1 sec. This method maintains the fluctuating near the Synchronization. So Under Synchronising the stability is more that's why very less equipment will damage in the micro-grid.

CONCLUSION

Conventional droop control has fixed droop coefficients; it will cause frequency deviation and so that it cannot guarantee the output frequency will reach the steady-state index when applied to the micro-grid. Due to the characteristics of the line parameters and the operating frequency regulation, this paper proposes a power conditioning method based on adaptive inverse control. Theoretical analysis and simulation results show that this method can dynamically adjust the weight coefficients of digital filters online and in real time, in order to achieve accurate power balance regulation and zero-error frequency regulation.

The proposed method is suitable for the parallel operation system of micro source in an autonomous micro- grid. Moreover, it provides a strong guarantee to the stable operation of the micro- grid.

SCOPE FOR FUTURE WORK

The main scope of this project "Dynamic Power Conditioning method of microgrid via Adaptive Inverse Control" is in automobile industry, LVDC, LVAC, Automation industry, control engineering, because we are using the adaptive algorithm which makes the system automatic/autonomous .this project scope is spread on wide area because it contain the power conditioning filter, adaptive algorithm which is responsible for boost the frequency, active power, reactive power and reduce the harmonics due to facts device and also reduce the transient and improve the stability of the microgrid, so scope is more in power system also.

In this project "adaptive power conditioning method of microgrid via adaptive inverse control" we are using here the droop control strategy or LMS adaptive power conditioning and controlling simultaneously. But this method is best according to my acknowledgement but if we will use PID control replace of conventional control then the efficiency is boost up as compare to previous propose method.

Sometimes controlling of microgrid we can use the PLC and SCADA system so that to controlled the n- number of micro sources automatically Which is more reliable and most efficiently for the microgrid according to my point of view because SCADA is a supervisory control system with the help of this we can control the microgrid by sitting in any corner of the room or world.

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