SYNCHRONIZING of GENERATORS and SIMPLE APPLİCATION TO HOSPITAL

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Abstract

Synchronizing between power system and the generator must be set on time and carefully to prevent the damages on the system. By using the technology, we will see that cost is reduced therewithal can gain the time and prevent the faults of the technician. Technology improves the reliability, beneficial applicatıon of automation, and remote control of the system. We need to analyze our own system and make our choices according to economical costs and sustainability.

Keywords: Synchronizing, Phase difference, Power system, Electrical grid, Network

INTRODUCTION

Synchronizing between power system and the generator must be set on time and carefully to prevent the damages on the system. Both the frequency and the voltage of generator must be matched to system's previous frequency and the the voltage closely by the help of the rotor velocity and the exciting voltage provided around the rotor. Then generator's circuit breaker would be signaled by the control device to close the generator on to power system and at the same time open the breaker of the main. After isolating the generator from the main (network) it operates the take the load on to generator. That is the simple and traditıonal definition of the synchronous systems which is based on the discussion of this study applicate to the hospital.

Poor synchronizing cause damage the prime mover (diesel machine). Mechanical stress cause of rapid acceleration or deceleration while set the frequency (speed) to the power system. It causes the distortions such as power oscillations and voltage deviations than the nominal. Short circuits provide a high current which cause damages on the generator and the transformers. Also it prevents generator to stay online and pick up the load. Relays are affected by this condition and evaluate the system as in abnormal and trip the generator.

In this paper discusses about the technology whether it will reduce the cost or not and put approaches to interpret the beneficial advantages at the same time it helps us to find out the disadvantages of the complex automation systems.

Most of the generators systems have own control devices placed on the devices which used to control both the system and generator parameters until the optimum level to operate the breakers for synchronizing. Hence this paper interprets the generator, fault backup; co-aging, control of coupling switch and unloading were done with the help of PLC. Synchronization is done with microprocessors devices (synchronization devices) which are detailed in this study. Remote monitoring is possible and technician mistakes are minimized.

1.1 CONSEQUENCES OF FAULTY SYNRONIZATION

Synchronous speed determined by the number of poles wound on the stator. The rotor creates a rotating magnetic field when the rotor turning and a field is applied [1]. When generator picks up the load electrical and mechanical system must be matched to each other and move together. Mechanical system is the primary mover as diesel device and frequency of voltage induced in the stator governed by rotor speed. Then the governor on the generator adjusts the speed of the primary mover so the rotor then connects the generator to system at the certain time.

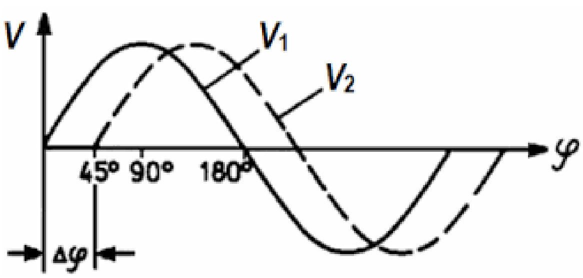

Figure 1. *Phase Angle Difference*

Fig. 1 shows the phase difference between 2 generators V1 the voltage of the generator 1 and V2 the voltage of the generator 1.Afi is the angle between 2 voltages.

IEEE standards C50.12 an C50.13 is about the refer the specifications for the construction of cylindrical-rotor and salient-pole synchronous generators that specify "Generators shall be designed to be fit for service without inspection or repair the synchronizing that is within the limits listed [2] [3].

- Angle +- 10 degrees
- Voltage 0 to 5 percent
- Slip +- 0,067 Hz

If the synchronization angle is more than 0 degrees' breakers might close late and the governor triggers the primary mover to drive the rotor quıckly that will cause the transients torque on the mechanical system when erase the fault to set the lash. Transients torque in mechanical system is oscillation in electrical system.

Reactive power system has side effects on the generator system when the exciters are at manual. If the capacitors are online and the exciter is in manual mode they cause the distortion on the exciter which allows and set the magnitude of the voltage in wrong regulation way.

Another issue might occur in system is reverse power. If that might happen the primary mover stops to produce mechanical energy. Then the generators continue to turn synchronously as motor among the persisting conditions.

The phase sequence of the three phases of the alternator which is being connected to the power system bus must be same as the phase sequence of the three phases of the bus bar (or electric grid). This problem occurs mostly in the event of initial installation or after maintenance.

The RMS (root mean square-average) voltage of the incoming alternator should be same as the RMS voltage of the bus bar or electric grid. If the incoming alternator voltage is more than the bus bar voltage, there will be a high reactive power that flows from the generator into the grid.

If the incoming alternator voltage is lower than the bus bar voltage, generator absorbs the high reactive power from the bus bar.

1.2 SYNCHRONIZING SYSTEM COMPONENTS

The synchronizing system must assure the functions below

- Controlling governor to match the speed
- Control the exciter to match voltage
- Close the breaker almost zero-degree angle.
- Control phase sequence

These functions can be provided by the operator as manual, with the help of automation or both combined system as applied.

2. SYNCHRONİZİNG TECNIQUES

There are many techniques for synchronization. Typical and most common techniques listed below.

2.1 THREE DARK LAMP METHOD

This method based on the potential difference between the bus bar and the generator's source. Simply, first generator connected to bus bar. Lamps connect as parallel to each phase which also ends up with the load bar. Voltage observed by the help of the voltmeters which measure the voltage between two phases on each bus bar and generator2 line. If lamps go ON and OFF concurrently, referring that the phase sequence of generatoror-2 matches with bus bar. When all these parameters are set, the lamps become dark and then the synchronizing switch can be closed to synchronize generator-2 with genarator-1.Fig 2 shows the phase difference between 2 generators when both phases matched all lamps get dark.

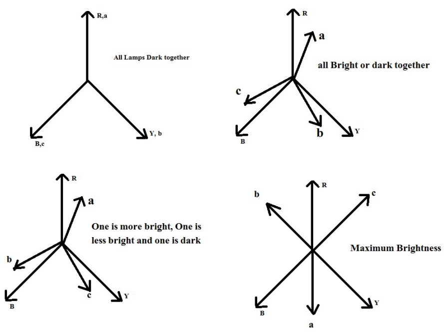

Figure 2. *Phase in Dark Lamp Method*

2.2 TWO BRIGHT AND ONE DARK LAMP METHOD

Here, the lamp L1 is connected across the pole in the middle line of synchronizing switch as similar to the dark lamp method, whereas the lamps L2 and L3 are connected in a transposed manner

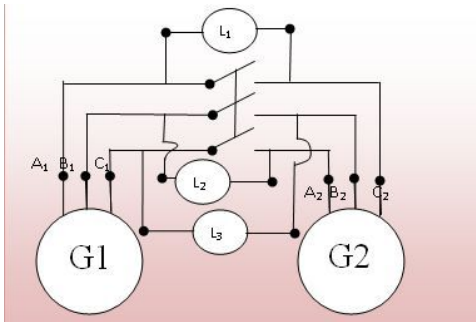

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Figure 3. *2 Bright 1 Dark Lamp Method Connections*

Speed of the rotor is increased by the prime mover until the rate of flickering is brought down to as small as possible. The synchronizing switch is then closed at the instant when lamps L2 and L3 are equally bright and lamp L1 is dark. Connection of lamps is shown in the figure3.

2.3 SYNCHROSCOPE METHOD

The synchro scope evaluates the angle difference so that when the two voltages are in phase, the pointer points straight up (12 o'clock position). When the one of generator is running faster than the bus, the pointer rotates in the clockwise direction; when the generator is running slower than the system, the pointer rotates in the counterclockwise direction and set the speed to the ideal and optimizes frequency of system. However, the synchro scope cannot measure the voltage therefore voltmeters must be used to check the voltage. In figure 4 shows the simple synchro scope.

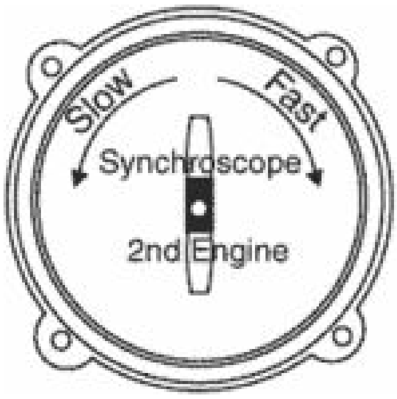

Figure 4. *Synchro scope*

3. AUTOMATİC SYNCHROZİNG SYSTEMS

An automatic synchronizer often includes generator control functions for frequency and voltage matching.

Modern synchronization equipment operates and fix synchronization procedure with the help of microprocessor based systems against manual lamps and synchro scope methods. These methods are easier to manage and more reliable. It's shown in fig4.

Designed for the most demanding applications, the device provides synchronization, load share, mains synchronization, soft transfer, microprocessor control device AMF (uninterrupted transfer), ATS, remote start, engine control and remote display panel functionalities in a single unit. It is provided multifunctional combination and wide communication ability with low cost and reliability. Also the mustimeters contribute the device to measure and compare the voltage, frequency, current, reactive power of the bus bar, generator (1 to generator 32) lines. Its proven that this kind of devices able to synchronize the 32 generators at the same time.[4]. Modern automatic transfer panel is shown in fig 6 which synchronizes two generators with micro process devices and mustimeters.

Figure 5. *An example of microprocessor control device*

Two generators with 1000KVA self-excited, brushless 231/400 V internal combustion diesel engine located as electricity supplier of part of Trakya University Hospital is synchronized and will be plug in when general network will cut off. Furthermore, despite general electrical system power is not cut off, when the mains fluctuations will be out of allowed limits this system would transfer the load on to itself then contınue to work with the required value for the hospital equipment until system turns to normal parameters. Thus, it provides a sustainable energy in the system.

Generator, fault back up, co-aging, control of coupling circuit breaker and load disposal (unloading) and load sharing are done with this control system. Synchronization between the network and the generators is provided by the synchronization devices.

Figure 6. *Transfer Panel*

The power failure in the hospital is undesirable and the building's electrical infrastructure needs to be improved in order to avoid this problem.
Although the cost of investment is high, it is much more than the fact of human’s fault. Improper operations and overloads on a single generator are shown as examples for those failures. There are many ways to reduce the cost. One of them is, instead of assembling a huge powerful single generator, it is also possible to put low-power generators in a synchronous provides to reduce this cost. This is due to the limited availability of large-scale internal combustion engines have limited production volume. Because the diesel engines up to 600kW, construction machinery, cranes, generators, fire pumps are used in applications such as the mass production band is produced. For this reason, because the production costs are low, the prices of the generators are cheaper than the larger power generators. Save the fuel and extend the mechanical life. In fig 5 shows that the optimum cost scale is between 200 and 715kVA for the generators.

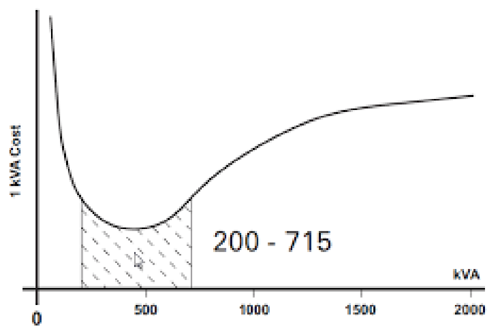

Figure 7. *Cost Graphic per kVA*

In that application both 2 of generators are 1000kVA. Since the system load generally consumes at a rate of %70 of the generator power, it is selected as 1000 kVA due to this ratio. And also not enough proper place to put the more generators together to reduce the cost and ıncrease the number of synchronized devices. As it's known convenient place need that the winding and cooling conditıons need to fit for generators to work permanently and persistently also.

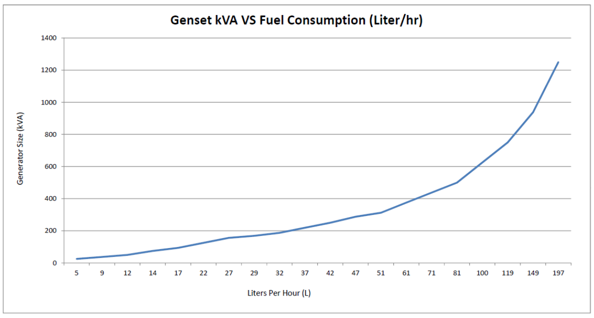

Figure 8. *Fuel Consumption lt/hr*

3. CONCLUSİON

If we do the synchronization correctly, we will avoid the destruction caused by systemic errors. By establishing the technical infrastructure, we can establish a suitable realistic and efficient working enterprise, facility, factory or hospitals. It should be ensured that automation is utilized by utilizing technology.

This study clarified that if the synchronization is correct, both investment costs and long-term operating costs can be reduced. For this, we have to use manpower and automation systems. Its advantages are more than its disadvantages and pave the way for its applicability.

We have to know our electrical system well and we have to transfer the systems and applications that provide suitable solutions to this system.

Synchronous generators must be connected to the power system only when the frequency difference, voltage difference, and angle difference and phase sequences are within acceptable parameters as like closer to zero.

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