Comparative Analysis of Faults Clearing on EHV Line through Normal and Hybrid Circuit Breaker

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Abstract -- In the Modern Power System the protection of Single bus system is a bigger challenge from L-L,L-L-L faults. To avoid the interruption of Bus and load Hybrid circuit breakers are used. Hybrid circuit breakers interrupt faulty half section and backup is provided though other half, such that bus and load remains. This paper will be the comparative analysis between the normal breakers and hybrid breakers on Single bus system. The EHV line is being taken for study and simulates though PSCAD.

Key Words -- Fauts, Hybrid Circuit Breakers, Bus Bar Protection.

I. INTRODUCTION

In modern power system there are various types of fault such as L-G, L-L , L-L-G, L- L-L, L-L-L-G fault. Under normal conditions, a power system operates under balanced conditions with all equipments carrying normal load currents and the bus voltages within the prescribed limits. This condition can be disrupted due to a fault in the system. A fault in a circuit is a failure that interferes with the normal flow of current. A short circuit fault occurs when the insulation of the system fails resulting in low impedance path either between phases or phase(s) to ground. This causes excessively high currents to flow in the circuit, requiring the operation of protective equipments to prevent damage to equipment. The short circuit faults can be classified as:

- Symmetrical faults
- Unsymmetrical faults

These faults can be of two types: (a) line to line to line to ground fault (LLLG fault) or (b) line to line to line fault (LLL fault). Since the three phases are equally affected, the system remains balanced. That is why, this fault is called a symmetrical or a balanced fault .Faults in which the balanced state of the network is disturbed are called unsymmetrical or unbalanced faults. The most common type of unbalanced fault in a system is a single line to ground fault (LG fault). Almost 60 to 75% of faults in a system are LG faults .The other types of unbalanced faults are line to line faults (LL faults) and double line to ground faults (LLG faults). About 15 to 25% faults are LLG faults and 5 to 15% are LL faults.

LLL fault in this type of faults all three phases are simultaneously short circuited. Since the network remains balanced, it is analyzed on per phase basis. The other two phases carry identical currents. A fault in the network is simulated by connecting impedances in the network at the fault location. Prior to the occurrence of fault, the system is assumed to be in a balanced steady state and hence per phase network model is used the transmission lines are represented by their with all impedances referred to a common base.

In High voltage line, as the percentage occurrence of L-L and L-L-L fault is very less but the severity of this type of fault is very high. So there is a need to protect the single-bus system from this type of fault. If the fault occurs on single-bus system the SF6 and vacuum circuit breaker has ability to isolate the fault but the continuity of electric supply is not maintained. So to overcome this demerit, we are focusing on the Hybrid Circuit Breaker.

II. RESEARCH ELABORATION

In modern power system, the protection of single-bus system is bigger challenge three-phase fault may from L-L, L-L-L faults. So there is a need to protect the single bus system from this type of severed fault, as back-up protection is not provided in case of single-bus system. The VCB and SF6 circuit breaker has the ability to protect the single- bus system from

fault but the continuity of supply is not maintained through fault clearing. Since overcome this demerit we are using Hybrid circuit breaker (HCB).

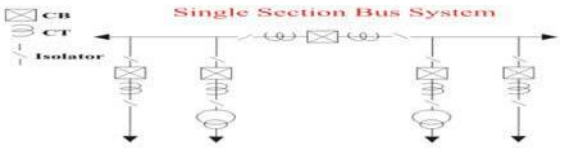

Fig. 1: - Protection of Single Bus System

There are n no. of generator is connected fed a power to a single bus system. Figure (1) shows the two generator fed a power to a single bus system 220 kv HVAC line. Single bus have two section are section A and section B, hybrid circuit breaker is placed between the two section on single bus. In hybrid circuit breaker has turret CT which is used for monitoring and controlling purpose. Which is directly connected to protective equipment relay room, It is used for fault current sensing device. In hybrid CB have two arcing chamber act as two earth switch and SF6 gas use as a insulating medium. , which can provide a path for the fault dissipation in the single-bus system.[1] This arcing chamber are preceded by a common transmission line. First arcing chamber is firmly connected first transmission and second is firmly connected to second arcing chamber. This transmission which allows the movement of two arcing chamber to be technically matched to be one another [3] HCB has fixed and moving contact, moving contact move under fault condition and contact of HCB are opened.

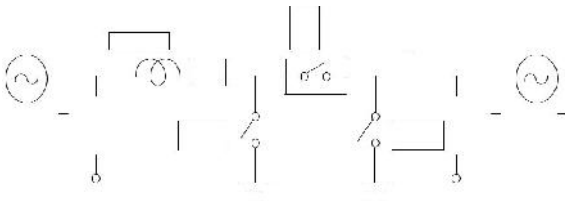

Fig. 2: - Construction Diagram of Hybrid Circuit Breaker

If the two generator fed a power to single bus system. Two arcing chamber act as a earth switch during normal operation fixed and moving contact is closed and two earth switch are open, earth switch is directly connected to ground provide a low resistance path during faulty condition. L-L-L fault is most severe and rare fault. if this type of fault is occur on generator side A large amount of fault current flows through single bus it affect the generator it changes the phase sequence of the system and generator get jerk , since faulty condition turret CT measure the fault current is to detect any abnormal current flowing through the circuit and trigger the relay.

Relay sense the fault give command to breaker. Moving contact move from fixed contact and contact is open earth switch A is closed and provide path for discharging the fault current. And HCB isolate the faulty section from healthy section provide protection to other generator from fault and maintain the continuity of supply[6]. if fault is occur on the generator side B similar procedure is repeat again. In normal breaker operation continuity of supply is not maintain.

III. RESULTS

The given figure shows the actual model of single-bus system using normal breaker (SF6)in PSCAD. In the given system L-L-L fault is occurring at the mid-point of the single-bus. The rated voltage of system is 220kv. The resistance and inductance of system is 2Ω and 1(mh). Measuring equipment is connected on both side of generator (CT & PT).

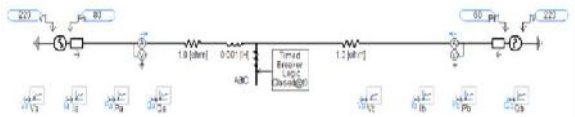

Fig. 3: - Simulation Diagram of L-L-L Fault

If the fault is occur on the single-bus system at any point both the generator gets affected and get jerk. All three phases get affected , The normal rated current is 20KA and if the fault occurs on the system the fault current increases to 5 to 6 times of normal rated current this result is shown in fig.(4). Time of normal breaker operation is 0.3 sec.

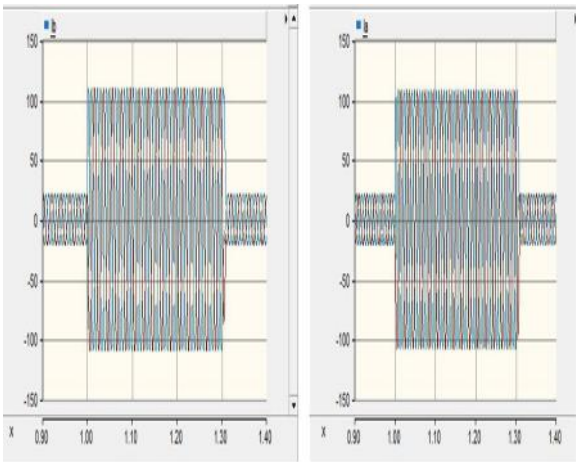

Fig. 4: - Simulation Result L-L-L Fault on Single Bus System of Both the Generator Current

If the fault is occur on the single-bus system at any point the normal rated voltage of the system gets affected and it causes voltage drop during abnormal condition. The normal voltage of the system is 220kv and the affected voltage is 220kv.Voltage drop is dependent upon line resistance.

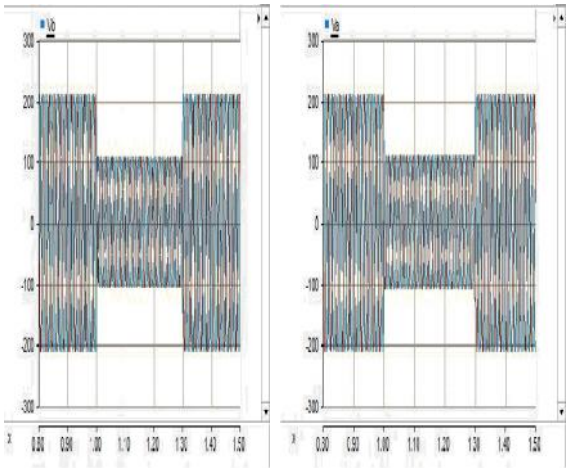

Fig. 5: - Simulation result L-L-L fault on single bus system of both the generator voltage

The fault occurs on the single-bus system the active and reactive power of system get affected the transmission line, active and reactive power suddenly increases. L-L-L fault occurs on the single-bus system the active power & Reactive power of the system changes is shown in fig (6).

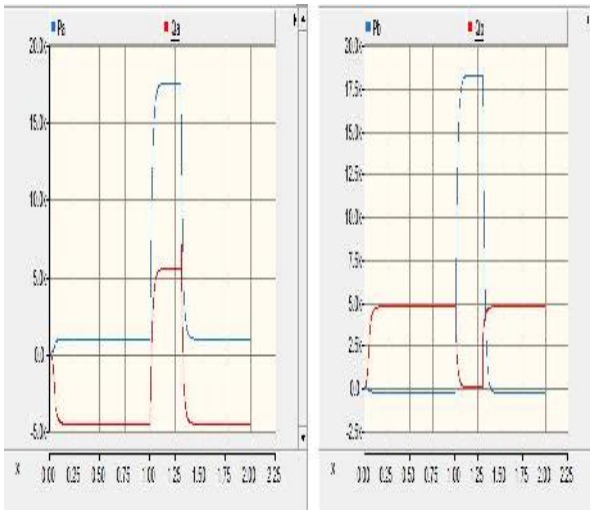

Fig. 6: - Simulation result L-L-L fault on single bus system of both active and reactive power of both the generator

Simulation of hybrid during L-L-L fault occur on single bus system:

The given figure shows the actual model of single-bus system using hybrid circuit breaker (SF6). In the given system L-L-L fault is occurring at the mid-point of the single-bus. The rated voltage of system is 220kv. The resistance and inductance of system is 2Ω and 1(mh). Measuring equipment is connected on both side of generator.

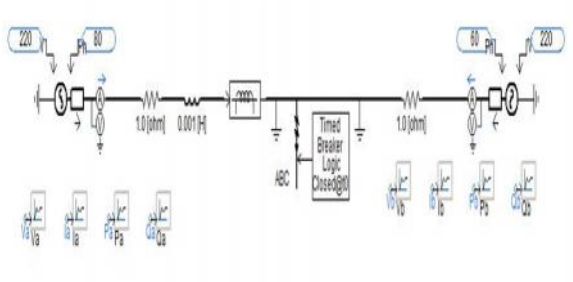

Fig. 7: - Shows the simulation of L-L-L fault

When fault occur on generator side A:

If the fault is occur on the single-bus system at any point both the generator gets affected and get jerk. The normal rated current is 20KA and if the fault occurs on the system the fault current increases to 5 to 6 times of normal rated current. It can affect only one generator when fault occur on the system.

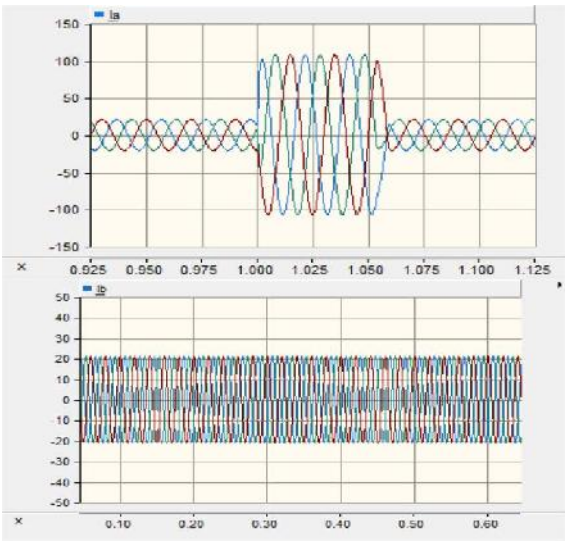

Fig. 8: - Simulation result L-L-L fault on single bus system of the generator a current

If the fault is occurring on the single-bus system at any point both the generator gets affected. The normal rated voltage is 220KV and if the fault occurs on the system the voltage of the system is 110KV.The voltage drop is depend on the resistance of line conductor.

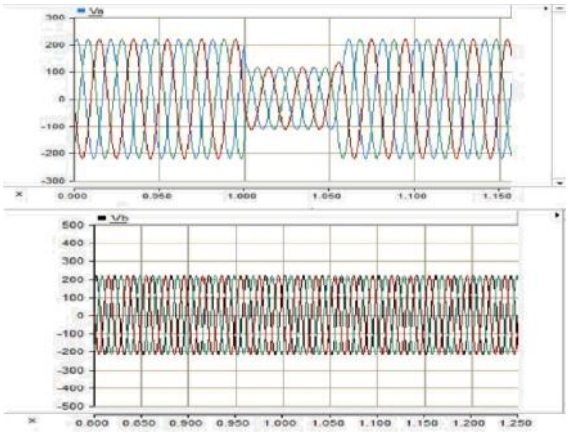

Fig. 9: - Simulation result L-L-L fault on single bus system of the generator a voltage

The fault occurs on the single-bus system using hybrid circuit breaker the active and reactive power of system get affected the transmission line active and reactive power suddenly increases as shown in figure.

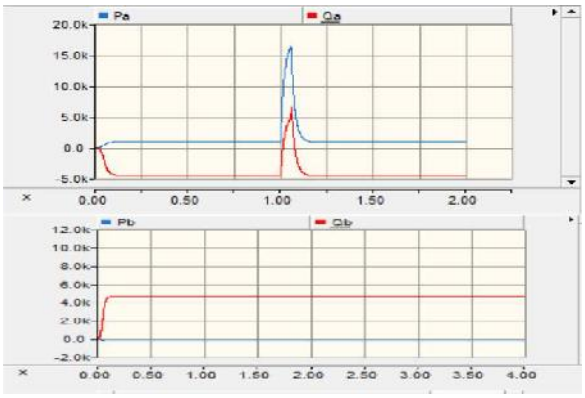

Fig. 10: - Simulation result L-L-L fault on single bus system of both active and reactive power of the generator A

When fault occur generator side B on single bus:

If the fault is occur on the single-bus system at any point both the generator gets affected and get jerk. The normal rated current is 20KA and if the fault occurs on the system the fault current increases to 5 to 6 times of normal rated current this is shown in fig (11).

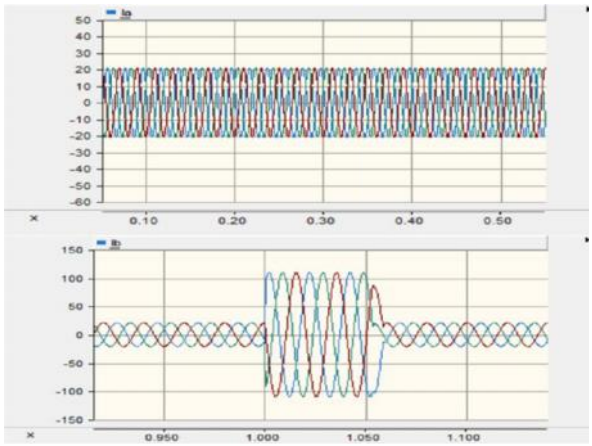

Fig. 11: - Simulation result L-L-L fault on single bus system of the generator B current

If the fault is occur on the single-bus system at any point both the generator gets affected and get jerk. The normal rated voltage is 20KA and if the fault occurs on the system the voltage of the system is.

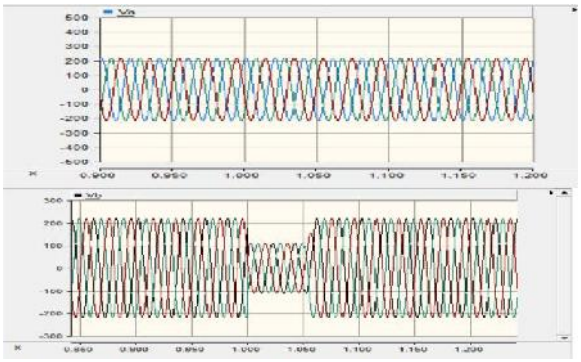

Fig. 12: - Simulation result L-L-L fault on single bus system of the generator B voltage

The fault occurs on the single-bus system using hybrid circuit breaker the active and reactive power of system get affected the transmission line active and reactive power suddenly increases as shown in figure.

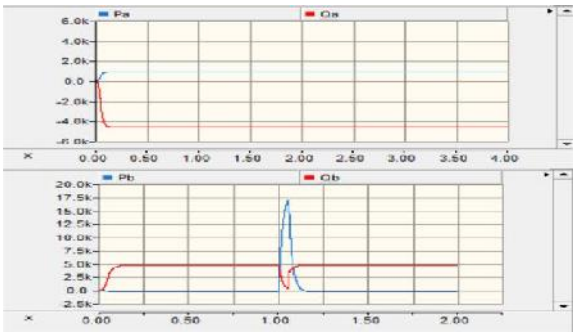

Fig. 13: - Simulation result L-L-L fault on single bus system of both active and reactive power of the generator B

IV. CONCLUSION

The simulation result shows clearly the effect of the L-L-L fault on the transmission line. When the fault occurs in power system even in case of the zero of fault resistance, the measured impedance may be deviated from the actual value. Since, the deviation of the measured impedance is not constant because of varying parameters of transmission line. since in normal breaker L-L-L fault is occur on single bus circuit breaker clear the fault but continuity of supply is not maintain, using hybrid circuit breaker has two earth switch provide ground for each generator side during fault condition and maintain the continuity of supply during fault clearing. Hence it is conclude that the breaking capacity of hybrid circuit breaker more than SF6 and other HVCB

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