

Bridge-Type Fault Current Limiter to Improve the Transient stability enhancement of Doubly Fed Induction Machine based Wind Generator

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ABSTRACT: *In this paper Transient stability is a major sympathy toward doubly fed induction machine (DFIM). A DFIM-based wind generator is promptly influenced by shortcomings at the network side as its stator windings are interfaced to grid. Be that as it may, the wind generators need to stay connected and proceed with operation during flaws at the grid side as indicated by the network code prerequisites. Along these lines, it is imperative to improve the transient soundness of the DFIM-based wind generators. To accomplish upgraded transient steadiness of the DFIM, a bridge type fault current limiter (BFCL) is proposed through FLC in this paper. Symmetrical as well as unsymmetrical faults were applied to test system efficiency of the BFCL in transient stability enhancement. Simulations were carried out in Matlab/Simulink environment. To demonstrate the effectiveness of the proposed BFCL ,its performance is compared with series dynamic braking resistor(SDBR). Simulation results of BFCL gives better stabilization of DFIM.*

Keywords: BFCL,SDBR, Doubly Fed Induction Machine (DFIM, Rotor-Side Converter (RSC) and Grid Side Converter (GSC),Fuzzy Logic Controller(FLC)..

I. INTRODUCTION

Technological advancement and industrialization has brought the expansion up in electrical power demand all around the globe. Quick fatigue and restricted store of fossil powers, escalation of natural concerns have made it dire to look for alternative energy sources and to devise enhanced techniques for abusing renewable energy sources. Among the available renewable energy sources, wind energy is the quickest developing and most noticeable choice to create electric power because of its zero fuel cost, no carbon discharge, lower maintenance, and cleaner, less expensive and renewable nature. It is assessed that around 10% of worldwide power interest will be supplied from the wind energy by the year 2020. Because of adaptability in operation and upgraded highlights like higher output power, higher proficiency, enhanced power quality, variable pace operation, lower mechanical weight on turbine subsequently bring down support, decoupled control of the active and

reactive power, the variable rate wind generators are getting to be favored decision for new establishments and drawing higher consideration than the conventional impelling machine-based altered rate wind generators. Lower cost, sturdiness, basic structure, probability to cover an extensive variety of wind rate, in part evaluated variable frequency ac/dc/air conditioning converter and lower switching loss have made the doubly sustained incitement machine (DFIM) a better decision over the other wind generator choices.

Contrasted with variable pace wind generators having full appraised converter, the DFIM is more powerless against grid shortcoming or unsettling influences from the soundness point of view, as its stator windings are straight forwardly associated with system while rotor windings are interfaced to grid by means of the rotor-side converter (RSC) and the grid side converter (GSC) that are connected consecutive through a dc-link capacitor. At the occasion of system deficiency, terminal voltage of the DFIM goes low and high current moves through both stator and rotor winding. This is a danger to stable operation and may inevitably blaze from the machine and the converters. Customarily, to shield from such blame occurrences, wind generators were detached from the grid. The converter of the DFIM topology has the control capacity to keep up solidness at flaw condition. Since the converters have fractional rating, their ability alone is deficient to guarantee dependability. A helper gadget like static synchronous compensator is proposed yet it needs extra converter, coupling transformer and symphonious channels. Energy stockpiling systems like flywheel energy stockpiling, superconducting attractive energy stockpiling and superconducting deficiency current limiter are additionally proposed, however the high establishment cost counterbalances their great execution.

The bridge type fault current limiter (BFCL) is another method with promising applications in power systems and issue ride through ability improvement of altered speed wind turbine generators. Be that as it may, the BFCL is never connected to improve the transient solidness of DFIM-based wind generators. In this study, execution of the BFCL on upgrading the transient stability of the DFIM in

Fig. 6. Single phase SDBR topology

B. SDBR Operation

During the normal condition, the SDBR would operate with the IGBT switch closed. The line current will flow through the IGBT switches bypassing the braking resistors. At the event of fault, the line currents tend to rise very sharply. The shunt resistor will be dynamically inserted into the network by opening the IGBT switch. The fault current will then flow through the inserted resistor and the resistor will continue to be in the circuit until a desired voltage V_{ref} is achieved at PCC. As V_{pcc} passes V_{ref} , the IGBT will be closed and the circuit will return to its normal state.

V. SIMULATION RESULTS

A. Without Controller 1LG

The below figures 7,8,9,10 shows without controller 1LG. It is seen that the voltage level drops around 0.7 p.u. The machine speed goes low right after the fault instant rises with no controller same as 3LG. The active power fluctuation is lowest and demand of machine power is highest from fault initialization to breaker opening. DC link voltage is not much stable in this case.

Fig :7 TERMINAL VOLTAGE

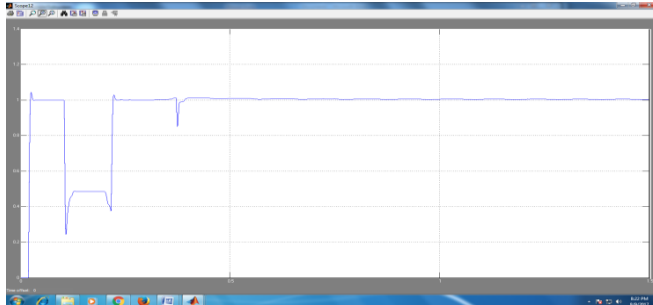


Fig.8 Speed response .

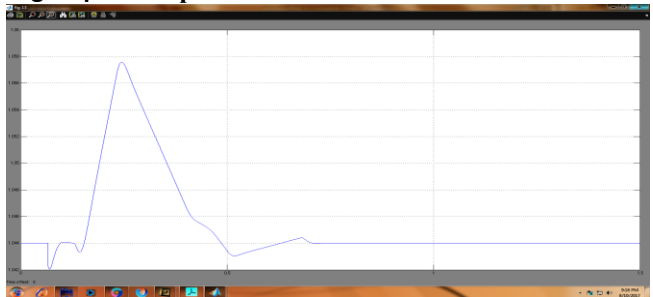


Fig.9.Machine output active power response.

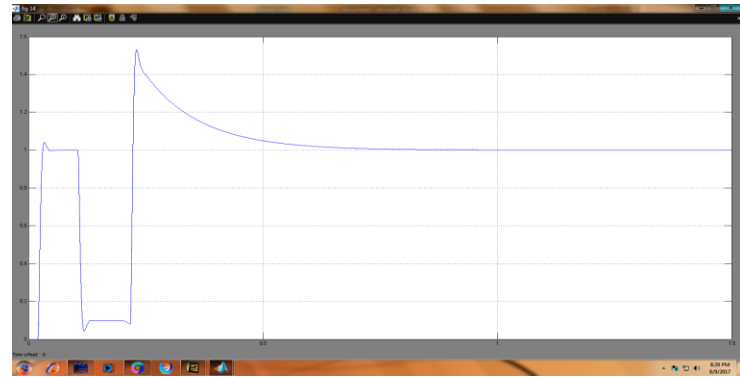


Fig.10.Vdc.



B. Without Controller 3LG

In below figures 11,12,13,14 shows without controller for 3LG. It is seen that the voltage goes very low right after fault is initiation and even goes lower till breaker opens. Machine speed goes high and may cause instability due to long fault duration. The active power demand of machine becomes very close to zero after the fault instant and remain same till breaker is open. When breaker is open it causes large imbalance of output power without any controller action. DC link voltage can be maintained constant.

Fig. 11 Terminal voltage

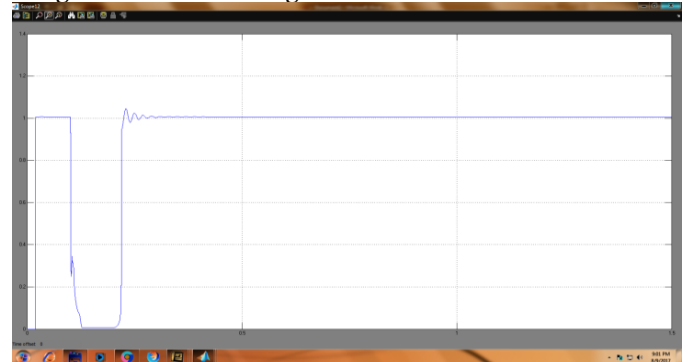


Fig.12 Speed response

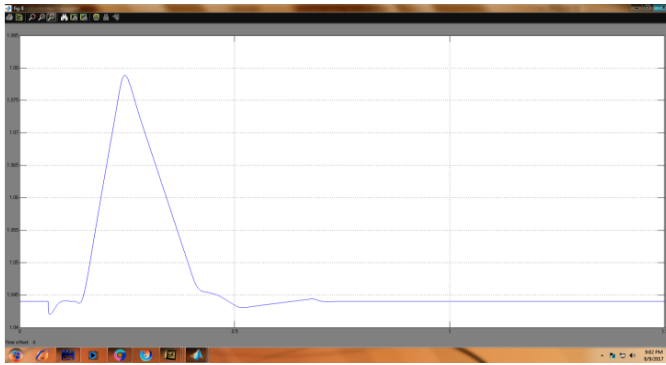


Fig.13 Machine output active power.DC link voltage response

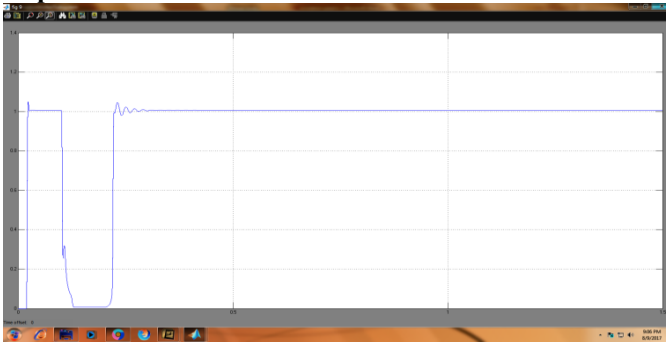
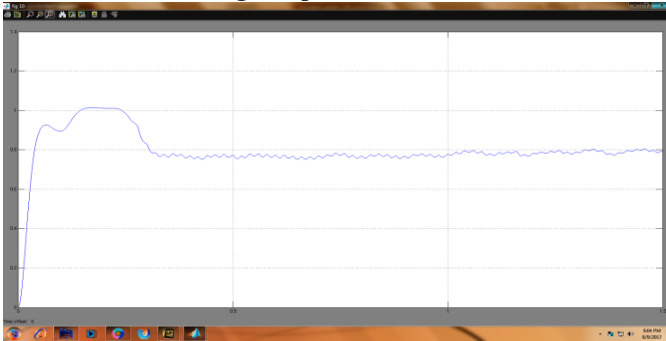


Fig.14. DC link voltage response



C. SDBR 1LG

In below figures15,16,17,18 shows SDBR1LG. It is seen that voltage can be maintained at rated level properly. The machine speed oscillation is kept to lowest and variation is minimum. The output power fluctuation is highest and active power demand of machine is lowest from fault initiation to breaker opening. DC link voltage can be maintained constant

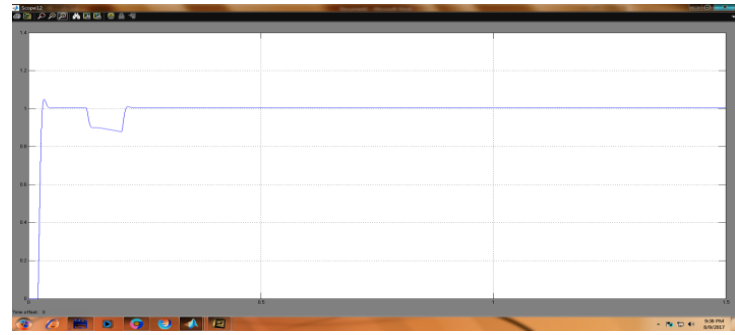


Fig.16 Speed response

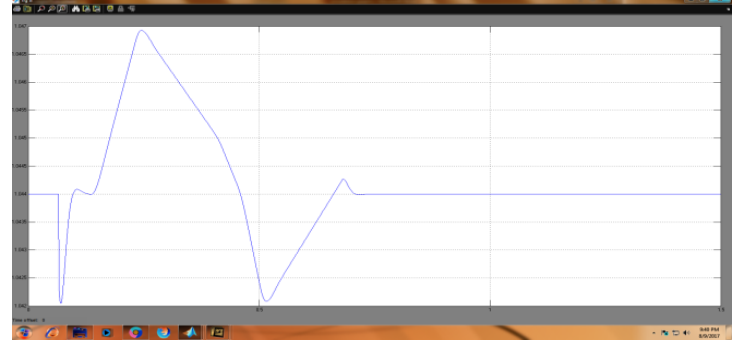


Fig.17.Active power responses.

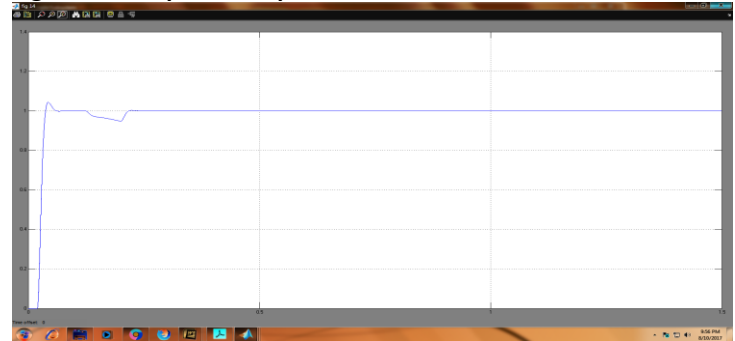


Fig.18 DC link voltage



D. SDBR 3LG

In below figures 19,20,21,22,23 shows SDBR 3LG. It is seen that SDBR cannot maintain voltage levels to 0.9 p.u also after the breaker opening terminal voltage comes back to nominal value faster with the help of BFCL. Machine speed gives lower oscillation and faster stabilization. It is noticeable that right after fault initiation machine speed drops and rises sharply. Directional speed variation is threatening the

mechanical system. The active power suddenly goes high and goes low which is harmful for machine. The breaker opening action rise output power with SDBR operation. The SDBR consumes no active power during normal operation which clearly shows that it has no effect on system during normal operation. DC line voltage can be maintained constant but not much as BFCL.

Fig.19 Terminal voltage

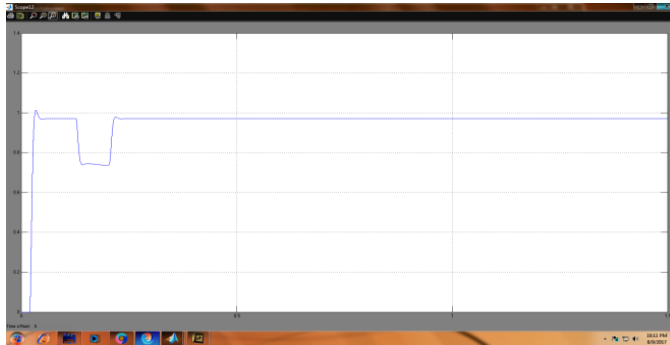


Fig.20 Speed response

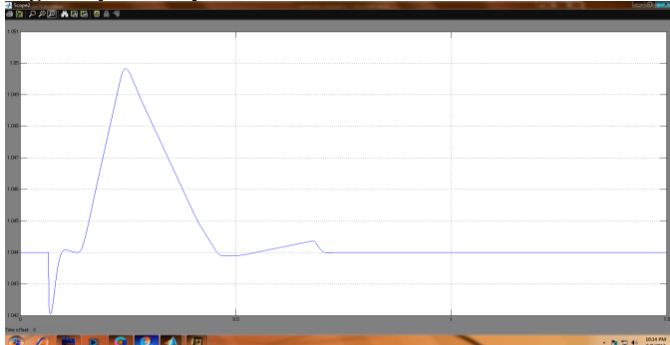


Fig.21.Active power response.

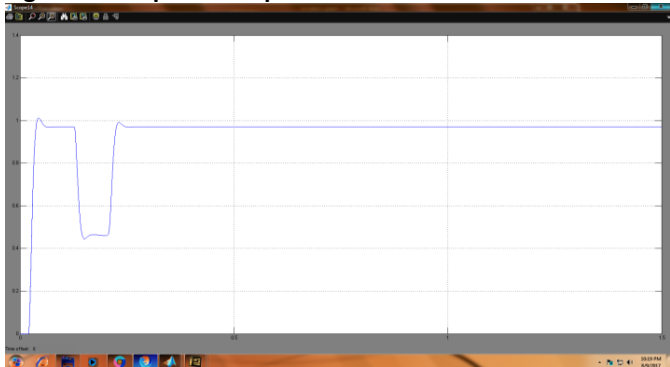


Fig.22 Sdbr voltage.

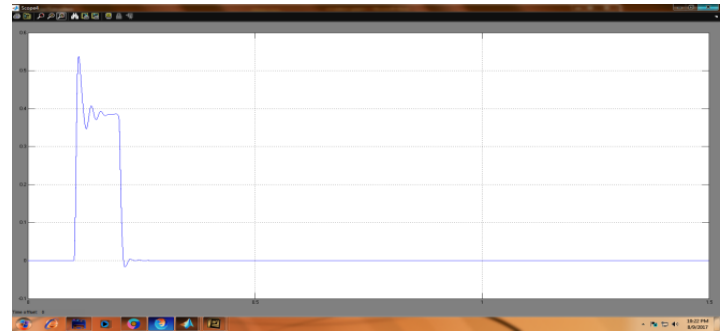
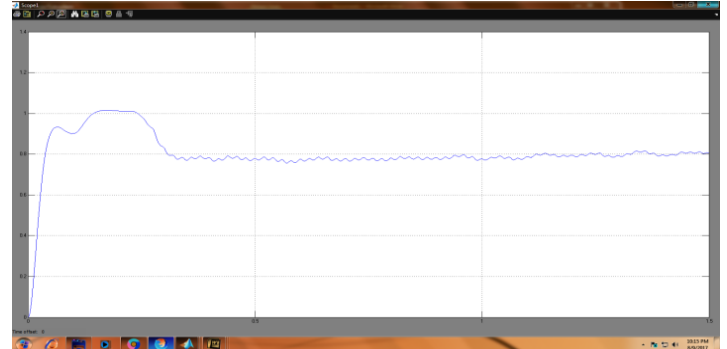


Fig.23 DC link voltage



E. BFCL 1LG

In below figures 24,25,26,27 shows BFCL1LG. It is seen that BFCL can maintain voltage at rated level properly. The BFCL performance is better than SDBR. The machine speed oscillation is kept to lowest and variation is minimum so machine is well stable with application of BFCL. The output active power fluctuation is lowest and active power demand is highest from fault initiation to breaker opening with application of BFCL. DC link voltage can retain more stable voltage than SDBR.

Fig. 24 Terminal voltage

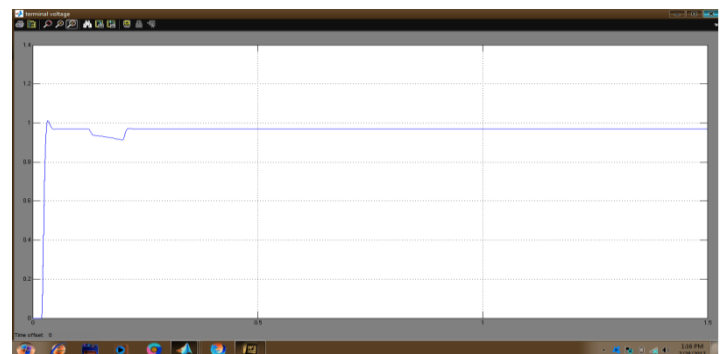


Fig.25 Speed response



Fig.26 Active Power Response:

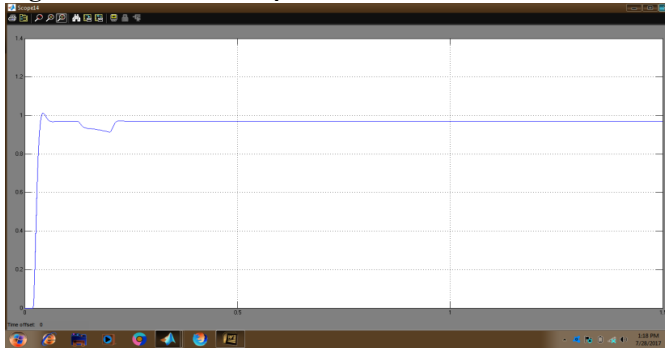


Fig.27 DC link voltage



F. BFCL 3LG:

In below figures 28,29,30,31,32 shows BFCL 3LG. It is seen that voltage level of BFCL keeps 0.1 p.u of nominal value which indicates BFCL is more sensitive and faster respond to fault and gives better voltage stabilization than SDBR. The BFCL limits the rate of rising of machine speed and ensures better stability than SDBR because it totally prevented by application of BFCL. The output power demand to the machine is highest with low fluctuation at fault and breaker opening instant. Faster stabilization of output power is also provided with BFCL. It consumes more active power than SDBR from fault initiation to breaker opening instant and gives better transient stability. It is also noticeable that BFCL has no active power during normal operation. It is possible to maintain more constant dc link voltage and GSC controller works well in conjunction with BFCL.

Fig.28 Terminal voltage

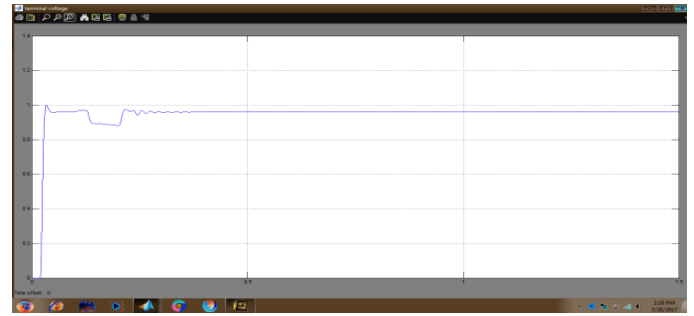


Fig.29 Speed response.

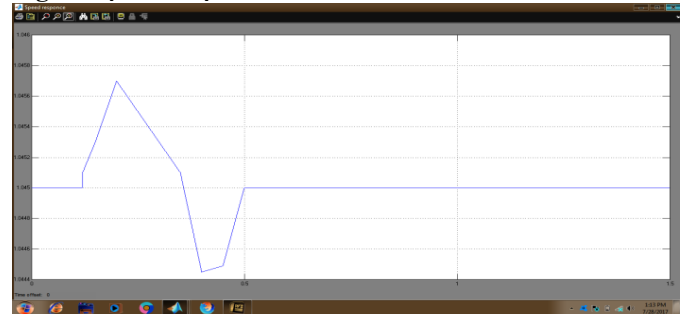


Fig.30 PCC active power responses.

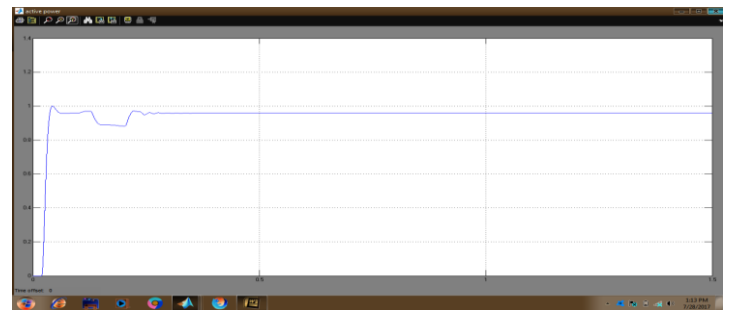


Fig.31 Active power response.

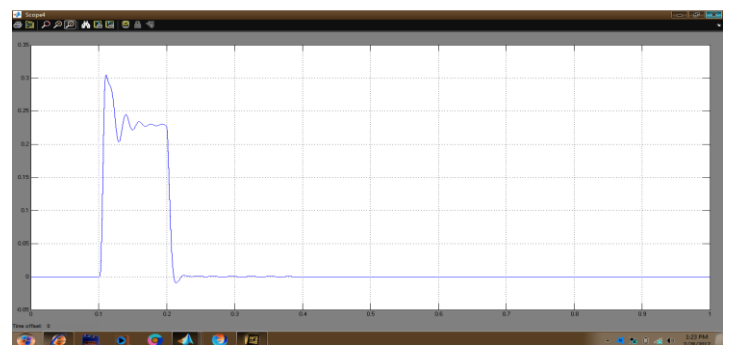
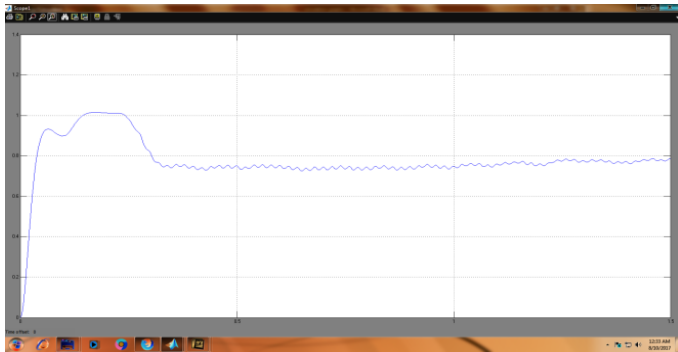


Fig. 32 DC link voltage.



G. BFCL EXTENSION 3LG

In below figures 33,34,35,36,37 shows BFCL 3LG using FLC. It is seen that voltage level of BFCL keeps rated nominal value which indicates BFCL is more sensitive and faster respond to fault and gives better voltage stabilization than BFCL using PI controller. The BFCL limits the rate of rising of machine speed and ensures better stability because it totally prevented by application of BFCL using FLC. The output power demand to the machine is lowest with low fluctuation at fault and breaker opening instant. Faster stabilization of output power is also provided with BFCL . It consumes less active power than BFCL using PI controller from fault initiation to breaker opening instant and gives better transient stability. It is also noticeable that BFCL has no active power during normal operation. It is possible to maintain more constant dc link voltage .

Fig. 33 terminal voltage

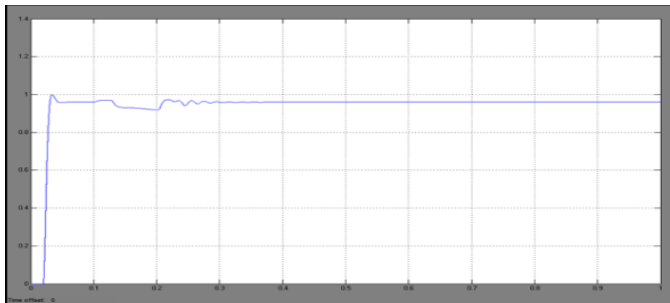


Fig.34Speed

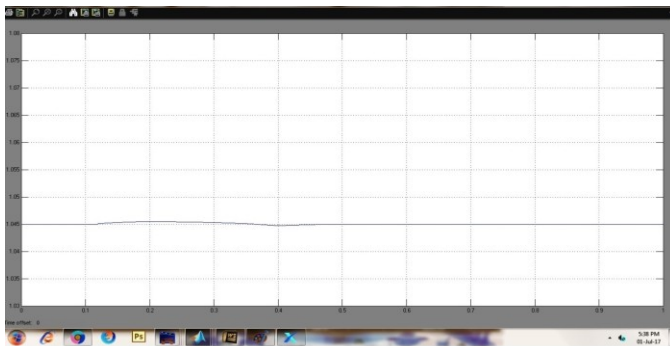


Fig.35 Active power

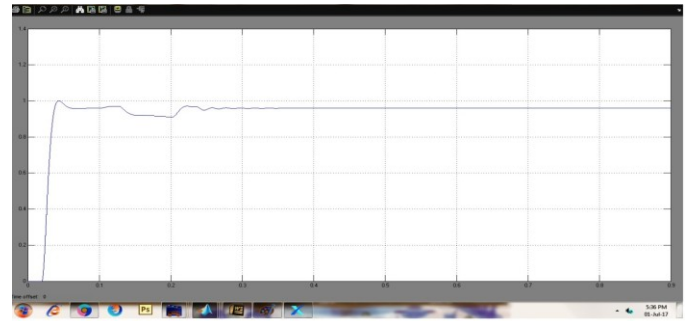


Fig.36 active power response



Fig.37 DC link voltage.



H. BFCL EXTENSION FOR1LG

In below figures 38,39,40,41 shows BFCL1LG using FLC. It is seen that BFCL can maintain voltage at rated level properly. The BFCL using FLC performance is better than BFCL using PI. The machine speed oscillation is kept to lowest and variation is minimum so machine is well stable with application of BFCL. The output active power fluctuation is lowest and active power demand is highest from fault initiation to breaker opening with application of BFCL. Here DC link voltage retain more stable voltage than BFCL using PI controller.

Fig.38 Terminal Voltage

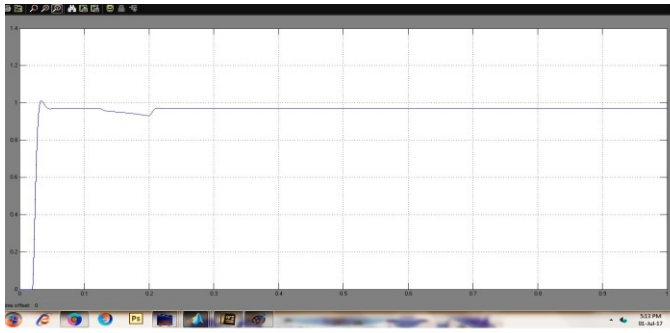


Fig. 39 speed response

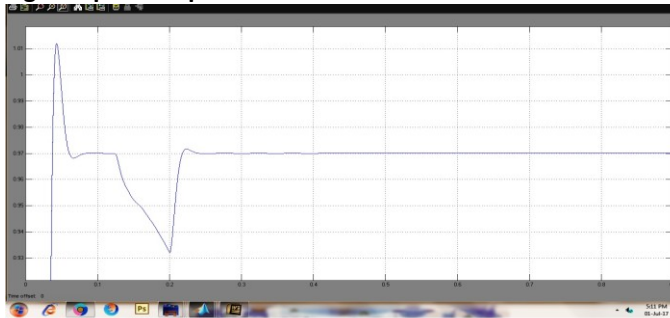


Fig.40 active power

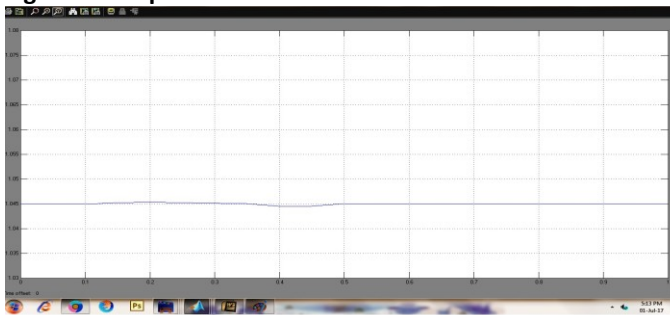
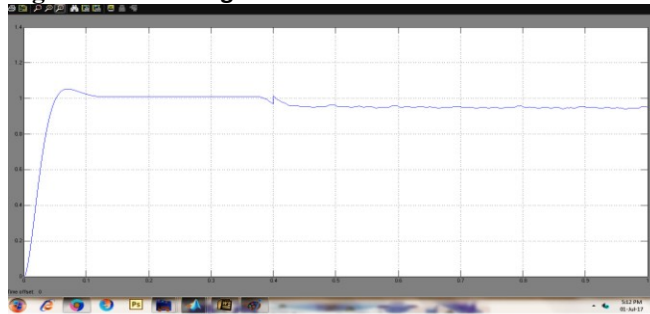


Fig.41 Dc link voltage.



VII. CONCLUSION

The application of the BFCL to enhance the transient stability of DFIM is proposed in this paper. The performance of the proposed BFCL is compared with that of the SDBR. From the simulation results, the BFCL is a very effective means to enhance the transient stability of the DFIM-based variable speed wind generator and the BFCL can help the DFIM-

based wind farms abide by the grid code requirements. The SDBR is outperformed by the BFCL in every aspect, as seen from graphical and numerical results. In the proposed BFCL FLC is used instead of PI controller. The proposed system gives better performance and characteristics compared to existing.

In our future study, a high capacity variable speed wind farm connected to a large power system will be considered. Further more, an optimal design of the BFCL will be developed considering variable values of the shunt impedance.

VIII. REFERENCES

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