IJAREEIE

e-ISSN: 2278-8875
p-ISSN: 2320-3765

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

Volume 11, Issue 2, February 2022

ISSN INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.282

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.282|

|| Volume 11, Issue 2, February 2022 ||

DOI:10.15662/IJAREEIE.2022.1102009

Enhancement of Transient Stability of a Grid Connected Induction Generator by using Plugging Mode Operation

Mr.Yogesh S. Pathe[1], Ms.Vaishali Malekar[2]

Research Student, Department of EEE, Tulsiramji Gaikwad-Patil College of Engineering and Technology, Nagpur, India [1]

Professor, Department of EEE, Tulsiramji Gaikwad-Patil College of Engineering and Technology, Nagpur, India [2]

ABSTRACT: This paper deals with increasing the temporary stability of a grid-connected squirrel cage induction generator. Induction generators are widely used in most wind power generation due to its reliability and low cost. A fault occurs in the electrical system, which increases the speed and voltage instability of the induction generator. Rotor speed is high when the fault is obvious, causing the system to become unstable. A special feature of induction machines is that they reverse the direction of rotational flow, to improve stability. After the error is cleared, the operating mode of the induction machine is changed from product to plugging mode for a short time. This suggests that the proposed method is effective in increasing temporary stability.

KEYWORDS: Induction Generator, Transient Stability, Plugging Mode Operation etc.

I.INTRODUCTION

Most wind turbines are equipped with a squirrel cage or wound rotor induction generator due to their simplicity and low cost. Induction generators require excitation to excite the stator winding to produce a rotating magnetic field. It is therefore connected to the grid with the help of a transmission line and absorbs the reactive energy from the grid. Now that the rotor of the induction machine is rotated mechanically it moves at synchronous speed and acts as a generator which gives a negative value of slip. When a transmission line fault occurs, it causes rotor speed instability and voltage instability. But when the error is cleared, its rotor speed is so high that it takes longer to stabilize.
[1] To overcome this problem, plugging is one of the electrical braking techniques implemented in induction machines, which increases the AC voltage and, therefore, improves voltage and rotor stability.
There are previous methods to improve the stability of an induction generator.
Rotor circuit control, Flexible AC Transmission System (FACTS) device, Breaking resistor.
In [2], to improve the stability of the induction generator, as described with the braking resistor. If the induction generator is accelerated at high speeds, it will take more reactive power from the system, resulting in a voltage drop.
In [3] Examines improvements in the stability of grid- connected fixed-speed wind farms after disruptions such as breakdowns using braking resistors along with reactive power compensation devices.
In [4] Analyzes the effect of inserting resistance into the rotor of induction machines during voltage sags to improve its operation.

II.SYSTEM MODEL AND ASSUMPTIONS

Existing System

Temporary instability is caused by sudden disturbances such as, three phase faults, loss of excitability, sudden loss of load. The problem of transient instability in induction generators causes an increase in rotor speed, loss of power and a decrease in voltage profile. Temporary instability can also damage the induction generator. Therefore, it is necessary to improve the temporary stability of induction generators for wind power generation.

Proposed System

The purpose of this method is to improve the transient stability of the induction generator by reducing the rotor speed after fault clearance and thereby preventing the generator from further acceleration. The operating mode of the induction generator can be changed from the generating mode to the plugging mode by switching any two leads in the

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stator winding. The interchangeability of the leads leads to a reversal in the rotating magnetic field that opposes the mechanical torque and reduces the rotor speed. Reducing the rotor speed reduces the reactive power absorbed by the machine, which increases the AC voltage and, therefore, improves the voltage and rotor speed stability

III.OBJECTIVE

The basic objectives of this study can be summarized as follows:

1. The main objective of this project is to increase the transient stability of the induction generator after a three phase failure and to achieve a constant state of speed of the rotor, stator and rotor current, terminal voltage as soon as possible. Temporary stability plugging mode operation is used for this improvement.
2. Comparison between squirrel cage and double cage induction generators to increase the transient stability at 50 Hz.
3. Design and explore the proposed system and power stability based on simulation.
4. Compare the traditional method and the new proposed method.

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IV.COMPUTATIONAL ANALYSIS

In this analysis we have investigated the performance of Plugging Mode Operation on squirrel cage and double squirrel cage induction generator under three phase fault condition. We have seen the natures of rotor speed, stator current, rotor current and electric torque under the transient disturbance.

Simulation results of induction generator without Plug- ging Mode

For the investigation of the performance of induction generator under the three phase fault condition or various sudden disturbances, System consists of induction generator connected to grid through trans- mission line with some load. Transient instability developed by creating a three phase to ground fault for the time duration of 0.7 to 0.9 second. It is observed from the simulation

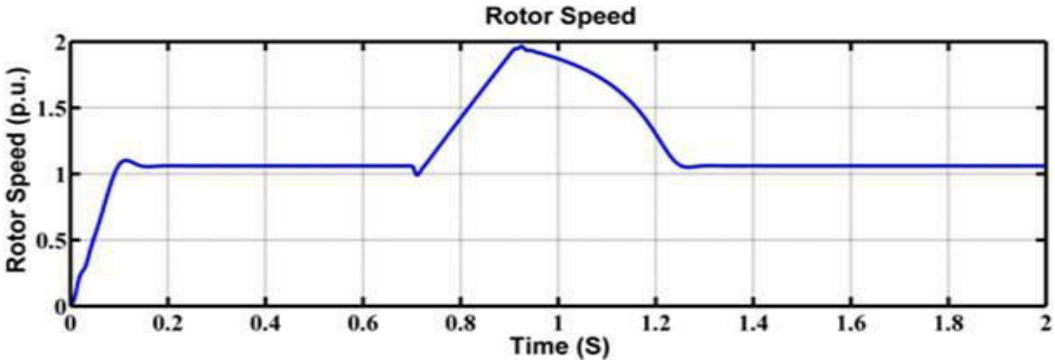

Figure 4.1.1 Rotor speed without plugging.

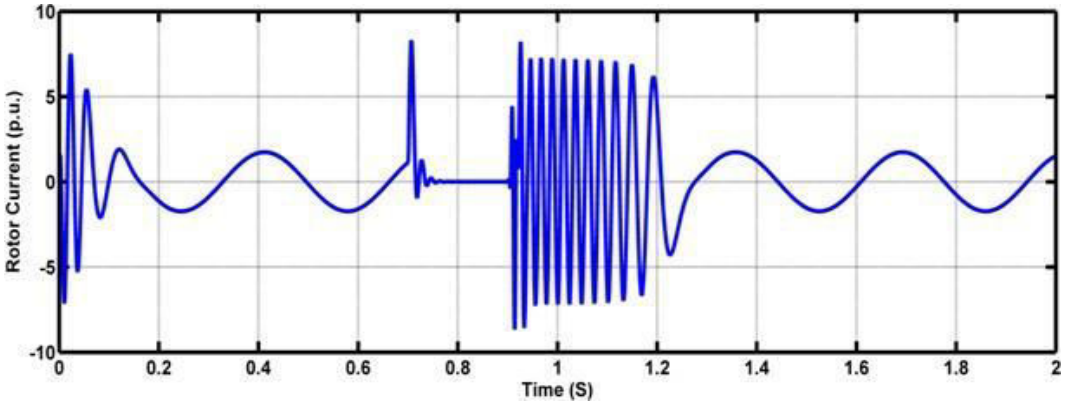

Figure 4.1.2 Rotor current without plugging of IG.

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result that due to three phase to ground fault at o.7 second the speed of rotor of induction generator increases suddenly to high till the fault cleared at 0.9 seconds. After fault cleared at 0.9 seconds rotor does settles to the steady state immediately but it undergoes further acceleration and took long time to settle to steady state. The simulation results shows that rotor speed settles to steady state at 1.3 second as the fault cleared at 0.9 seconds shown in figure 4.1.1.

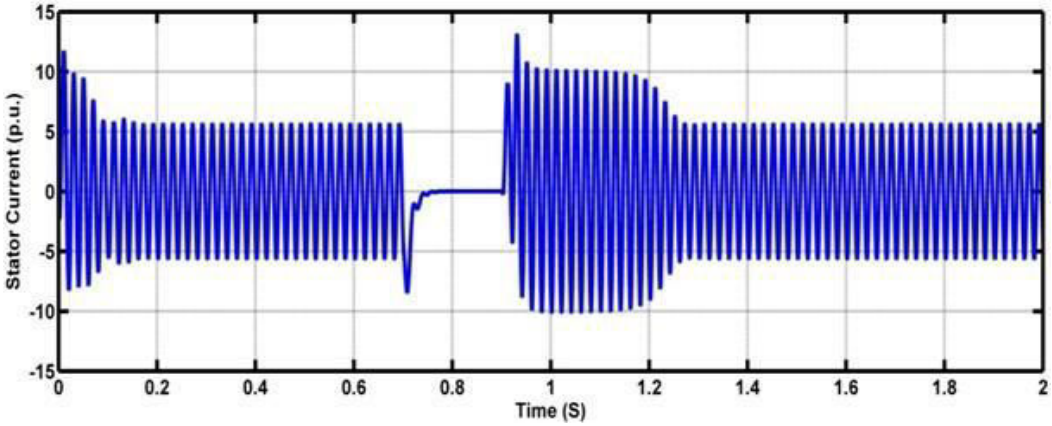
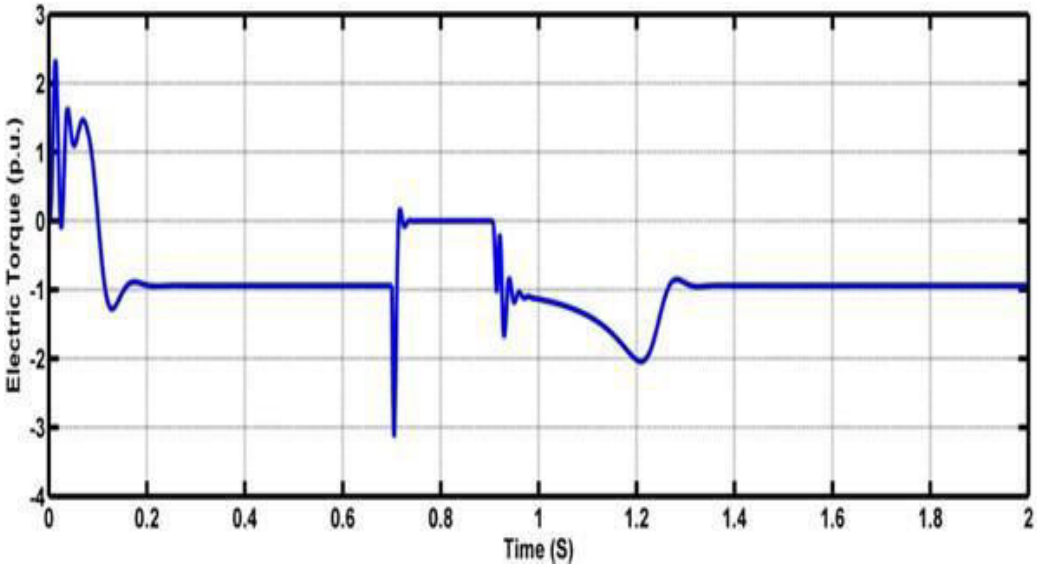


Figure 4.1.3 Stator current without plugging of IG.

Rotor current frequency of induction generator is less; initially large starting current flow then current comes to the stable value. At o.7 second when fault occurs large current flows



V. RESULT AND DISCUSSION

In this analysis comparative study of induction generator with and without plugging is done during transient instability occurred. The result for without plugging shows that in fault duration of 0.7 to 0.9 seconds when fault is cleared, induction generator takes long time to reach steady state condition i.e. 0.4 seconds. While inserting plugging circuit in system induction generator stabilized in 0.2 to 0.3 seconds. In case of squirrel cage rotor, the induction generator stabilized in 0.28 seconds. While in case of double

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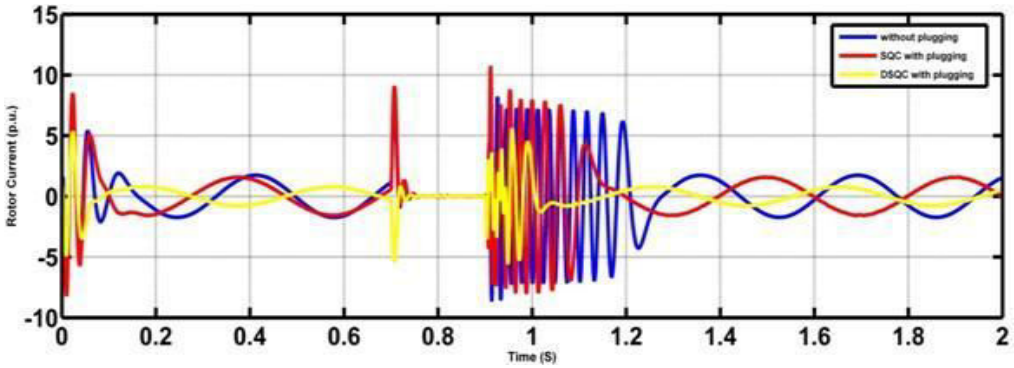


Figure 4.1.4 Comparative analysis of stator current of IG

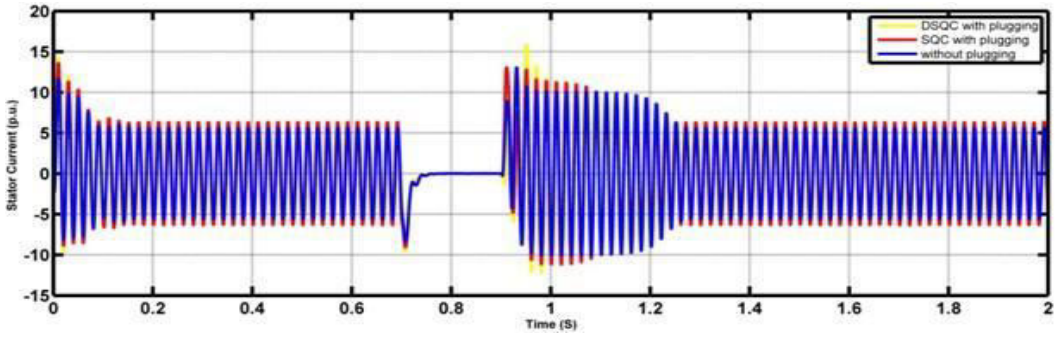
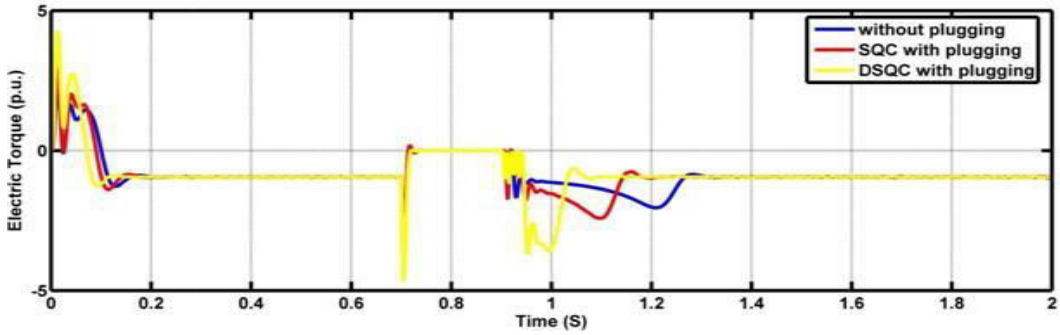


Figure 4.1.16 Comparative analysis of electric torque of IG



VI.CONCLUSION

Simulation results shows that plugging mode operation is able to stabilize the induction generator to the steady state after three phase fault on transmission line.Also simulation result shows that plugging mode operation reverse the rotating magnetic field of stator during fault duration and damp out the further acceleration rotor speed after fault is cleared. This operation tries to bring the accelerated speed of induction generator after fault clearance to steady state value as early as possible.In case of plugging mode operation along with rotor speed of IG stator current, rotor current and electromagnetic torque also stabilized to steady state condition in short interval of time from transient state as compare to conventional system.

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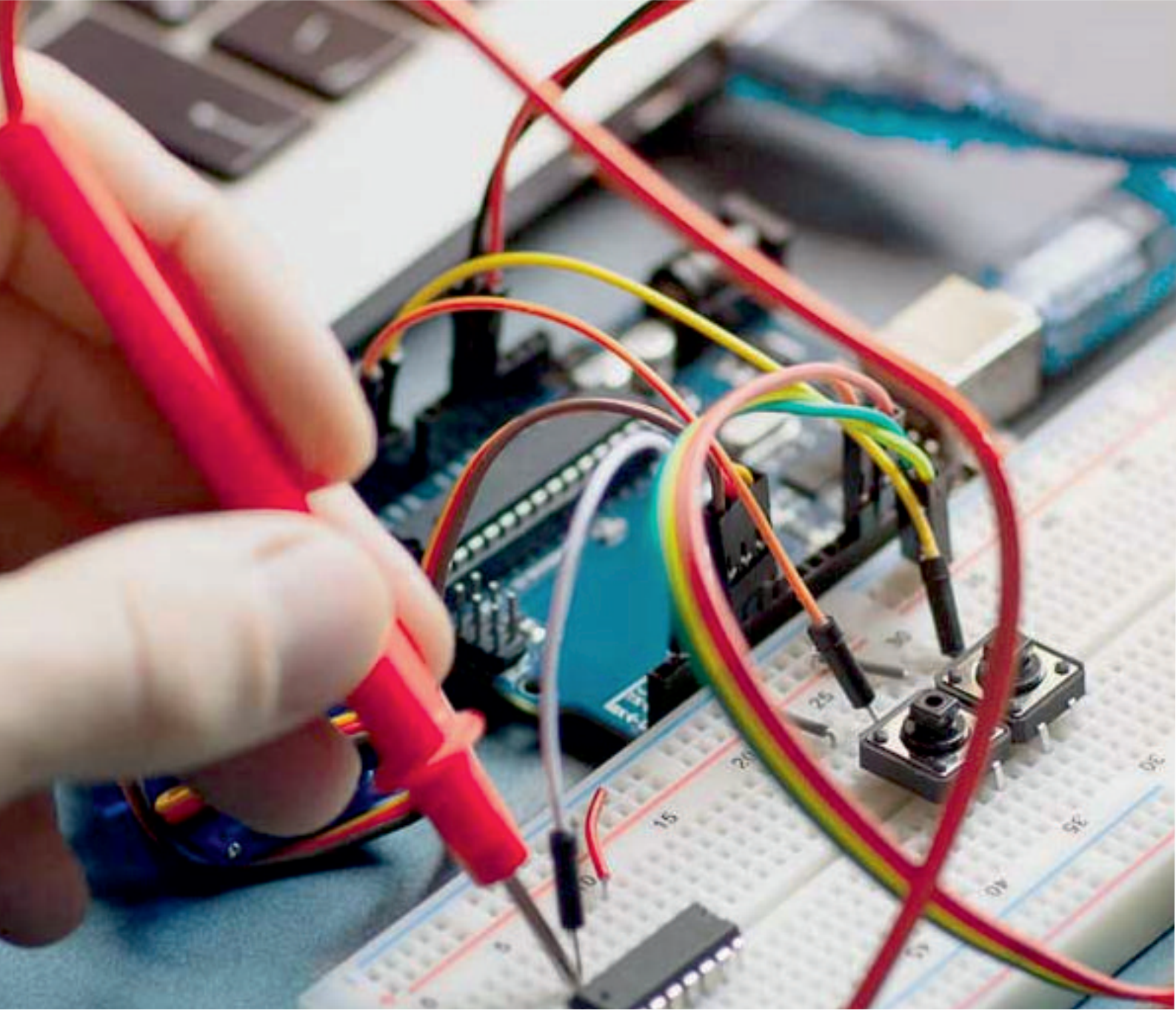

INNO SPACE
SJIF Scientific Journal Impact Factor

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doi cross ref

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