IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 13, Issue 4 Ver. II (Jul. – Aug. 2018), PP 05-13
www.iosrjournals.org

Precision Control of Induction Motor Drive through Pressure Transducer

Mr. Atul Mandniya[1], Mr. Ankush Yadav[2], Mrs. Rashmi Sharma[3]
1 PG *Research Scholar, Oriental University, Indore (M.P), India.*
2 Assistant Professor in Electrical & Electronics. Oriental University, Indore (M.P), India.
3 Assistant Professor in Electrical & Electronics, Oriental University, Indore (M.P), India.
Corresponding Author: Mr. Atul Mandniya

Abstract: *The variable frequency drives in various applications could save energy, cut costs and increase profit margins. A system with a feedback controller will attempt to drive the system to a state described by the input, such as velocity. . In the various industrial applications the induction motor is mostly used. The loads on induction motor always vary as per its application but speed of induction motor is constant & cannot match with the load demand. If load on induction motor decrease, the speed of induction motor cannot be decreases as per the load. Hence it takes rated power from supply so the energy consume by the motor is same. Hence there is energy consumption is same during load varying condition also. To overcome this problem a VFD is used in industrial application to save the energy consumption and electricity billing. Variable frequency drive (VFD) usage has increased dramatically in industrial applications. The energy saving is the main aim of our work. And this can be achieved by varying the pressure and frequency of the drive.*

Keywords: *Variable Frequency Drives, Pressure Transducer, VVC +, Matlab, MCT 10*

Date of Submission: 19-07-2018 Date of acceptance: 02-08-2018

I. Introduction

Variable Frequency Drive or VFD is a power electronics based device which converts a basic fixed frequency, fixed voltage sine wave power (line power) to a variable frequency, variable output voltage used to control speed of induction motor [1]. The speed of induction motor is directly proportional to the supply frequency and no. of poles of motor. The multilevel inverter output so developed assuring the least THD is then passed through a filter to get a better sinusoid output. The filtered output is then fed to the induction motor. Induction motor speed control is employed by regulating the slip speed maintaining constant V/f [4]. Electric drives are used in boats, traction systems, lifts, cranes, electric car, etc. They have flexible control characteristics. They are available in wide range of torque, speed, and power [5]. A pressure transducer, often called a pressure transmitter, is a transducer that converts pressure into an analog electrical signal. Pressure applied to the pressure transducer produces a deflection of the diaphragm which introduces strain to the gauges.

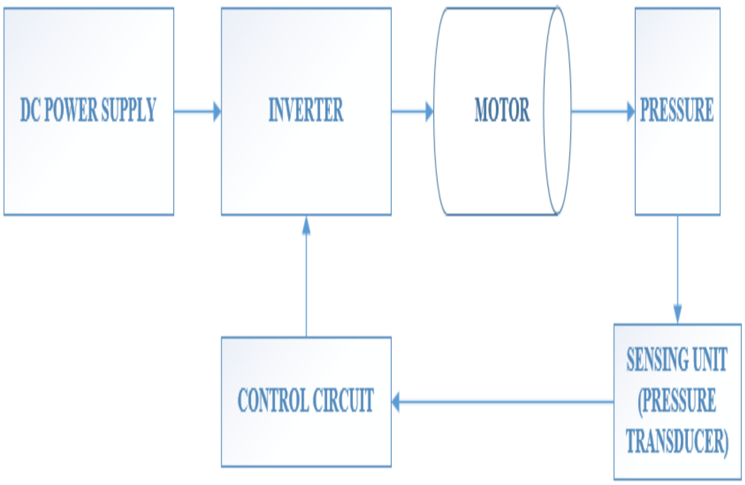

Figure 1 Block Diagram of Proposed Scheme

Figure 1 shows the block diagram for Proposed Technique. In this, the DC Voltage Supply is used to feed into Inverter which will provide the variable output voltage of the AC drive. The Load connected here is Suction Motor through which the suction pressure of the system will be maintained as per the requirement. The sensing unit used is Pressure Transducer, which will convert the mechanical pressure into electrical quantities. This Pressure Transducer will convert the pressure quantities (in Pascal) into 4 – 20 mA and 0 – 10 Volt.

II. Problem Identification

Without Pressure Transmitter, the drive will run at constant frequency or speed. The pressure plays a vital role in the Industries. The Pressure of the system will determined by the Pressure Transmitter. The pressure or heat applied to any suction fan will work as per required voltage and suction.

If the drive is running at fixed frequency and fixed output voltage then the power or energy consumption will be high if pressure of the system is required low. With constant frequency and voltage, the power consumption will also be constant.

III. Proposed Methodology

Figure 2shows the Proposed Methodology flow chart. In this technique, we have used the Pressure Transducer as sensing unit. VVC plus technique is used here. Sequential Logic Controller is applied in drive where the process starts at time T. And after sometime, the calculation of Reference Pressure is obtained and the actual pressure of the system will be obtained. Now, compare the actual pressure with the set pressure and after this the actual pressure and set pressure is compared. In this comparison, if the Actual Pressure is less than that of set Pressure, then the frequency or speed of the suction fan or motor will increased to a limit where it will be somewhat similar to that of the set pressure.

Similarly, if the Actual Pressure is more than that of set Pressure, then the frequency or speed of the suction fan or motor will decreased to a limit where it will be somewhat similar to that of the set pressure. Thus, the same process continues and will maintain the optimum pressure of the system. In this, the machine will run at variable speed or variable voltage with respect to pressure of the system, then it will finally give variable Power or energy consumption.

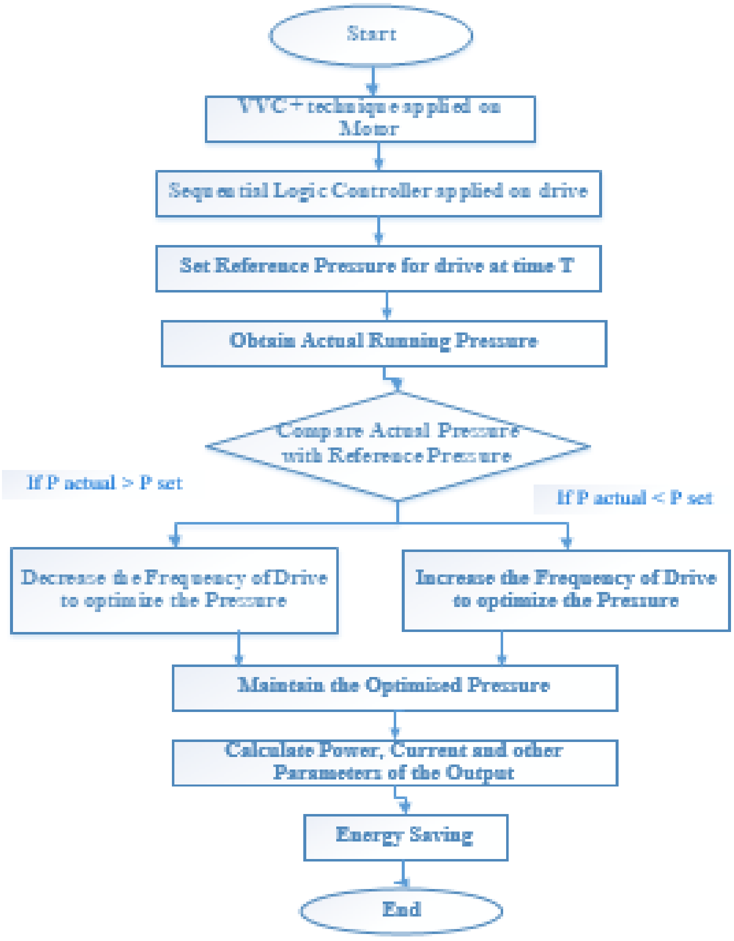

Figure 2 Proposed Methodology Flow Chart

IV. Results & Discussion

The results are taken at various pressure units such as 900 Pascal, 930 Pascal, 950 Pascal and 1000 Pascal. The various outputs have been taken out from this and will get electromagnetic torque, rotor current, rotor speed and voltage waveforms which are given below.

Figure 3 shows the Voltage and current waveform for the output section of Inverter. The starting current of this section is 68 Ampere and which will reduced to 21.5 Ampere. And in the similar manner, the voltage of the output section or the IGBT section will behave accordingly. It will be attaining a limit of 450 Volt.

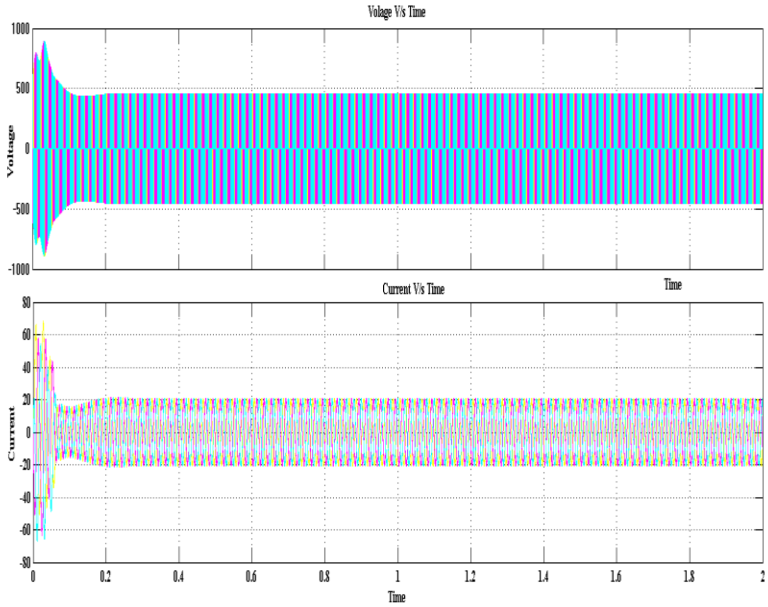

Figure 3 Voltage & Current at 900 Pascal Pressure

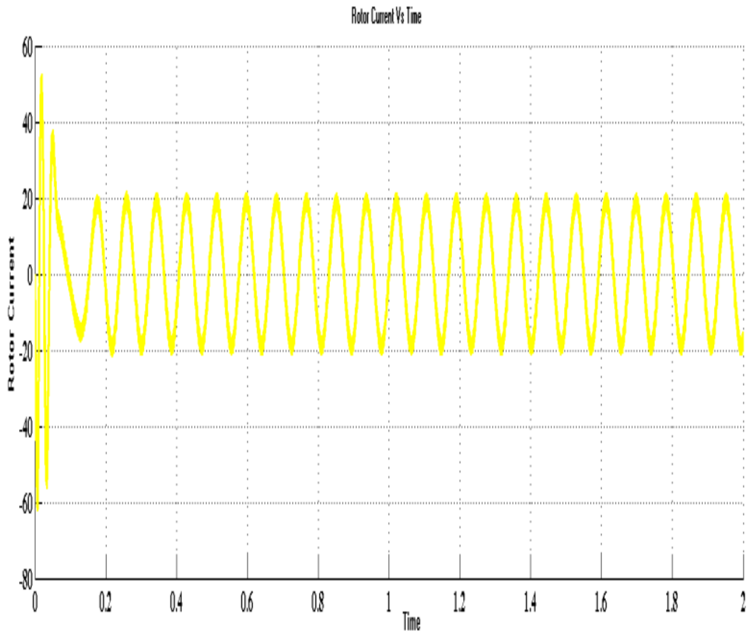

Figure 4 Rotor Current at 900 Pascal Pressure

Figure 4 shows the waveform for Rotor Current Vs Time. The rotor current of the motor is high when the motor starts from zero speed because as usual the motor requires high torque at the time of starting as it have to cross the friction limit of the rotor and stator of the motor. The rotor current while startup of IM will be approx. 52 Ampere while after settling down it will reduces to 21 Ampere.

Figure 5 shows the rotor speed Vs Time waveform. In this the motor speed will be constant after it gets saturated at a time. The Rotor speed will be 1305 rpm and will also reduce to 1145 rpm.

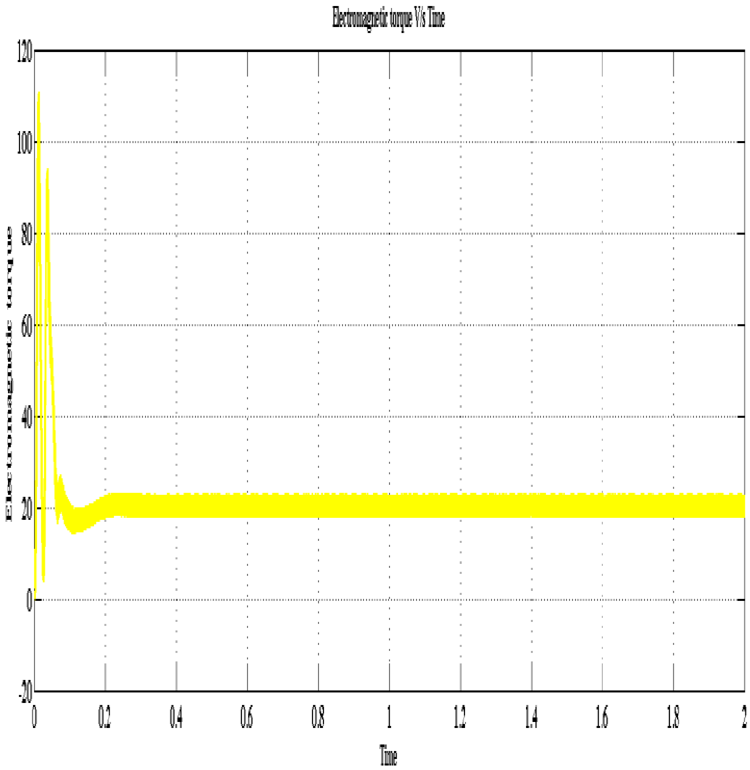

Figure 5 Electromagnetic Torque at 900 Pascal

Figure 6 shows the Electromagnetic Torque Vs Time graph. In this section also as discussed above, the starting torque is very high for the IM and after sometime it will settles down to a specific value and attains the constant torque at Newton meter. The torque is 112 N-m while starting and also attains to achieve 18.5 N-m to 22.5 N-m torque.

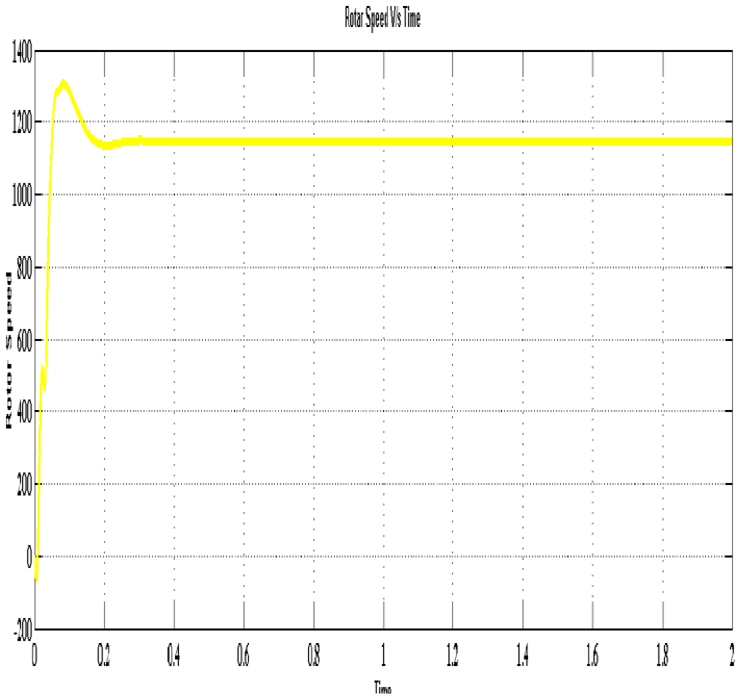

Figure 6 Rotor Speed at 900 Pascal

In the similar way, if we increases the set Pressure of the system by 100 Pascal, then the waveforms for rotor current, electromagnetic torque, voltage and rotor speed will be varied accordingly.

Figure 7 shows the Voltage and Current waveform for the output section of Inverter in which the maximum limit of the current is 73 Amp and reduces to 18 Ampere. And voltage will be approx. 495 Volt.

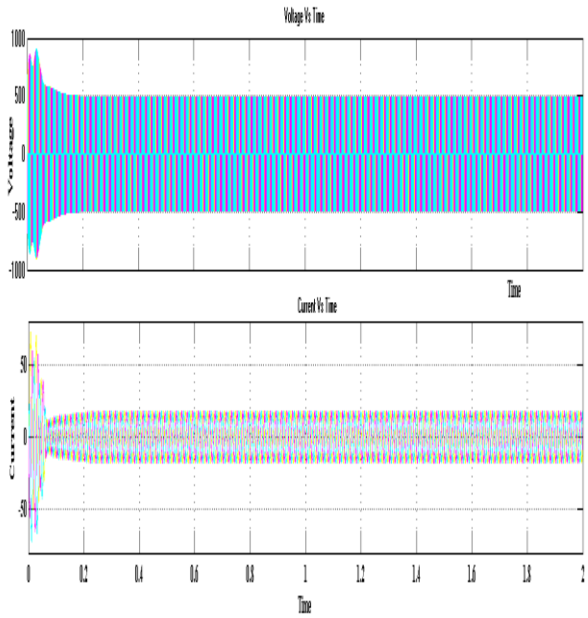

Figure 7 Voltage & Current at 950 Pascal Pressure

Figure 8 shows the waveform for Rotor Current Vs Time. At the starting of IM, the rotor current is approx. 53 Ampere and after sometime when it will settles down to 17 Ampere at its maximum value.

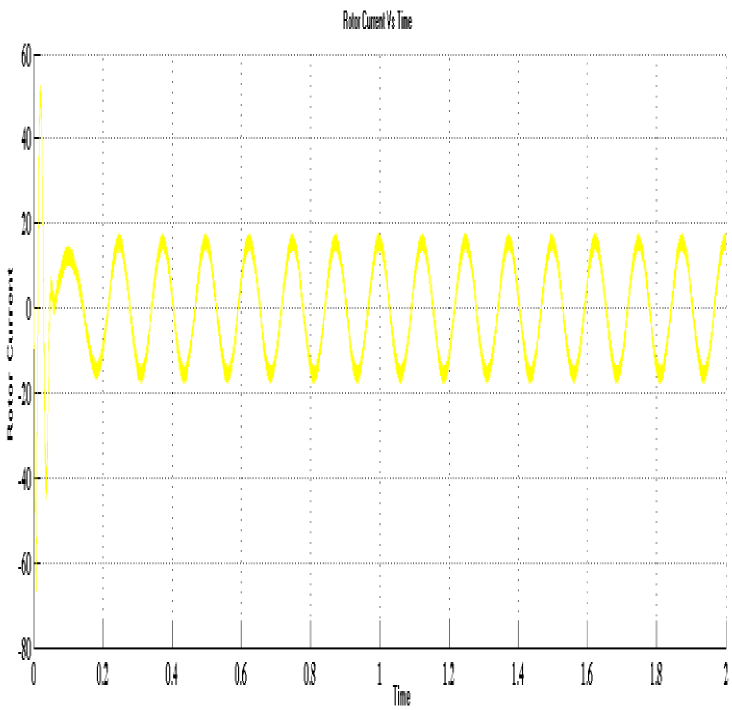

Figure 8 Rotor Current at 950 Pascal Pressure

Figure 9 shows the Rotor Speed Vs Time waveform. The rotor speed at the time of starting will achieves a limit of 1420 rpm and afterwards it will come down to 1260 rpm and continues to run at this speed only.

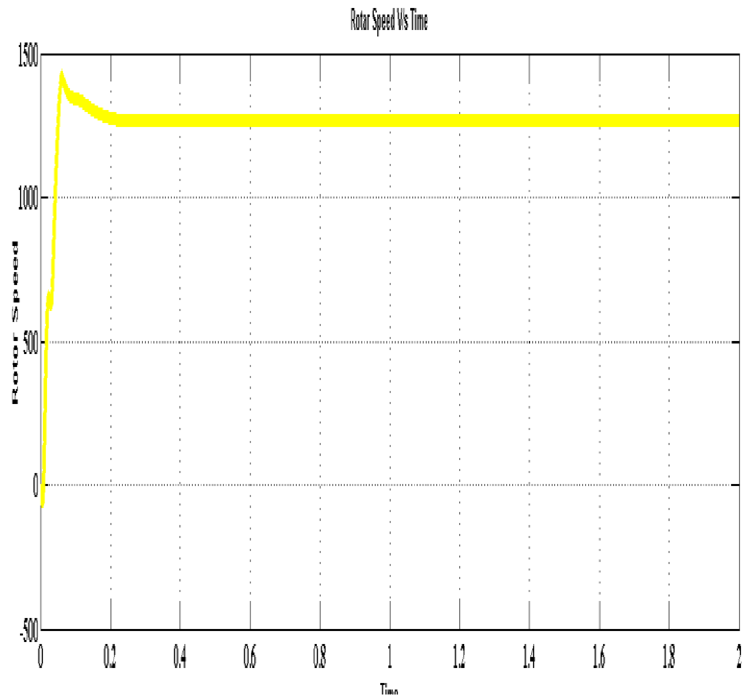

Figure 9 Rotor Speed at 950 Pascal

Figure 10 shows the Electromagnetic Torque Vs Time graph. The electromagnetic torque while starting the motor is approx. 127 N-m while after settling it will be down to 18 – 23 N-m which is higher than the torque at 900 Pascal but less than that of 1000 Pascal torque.

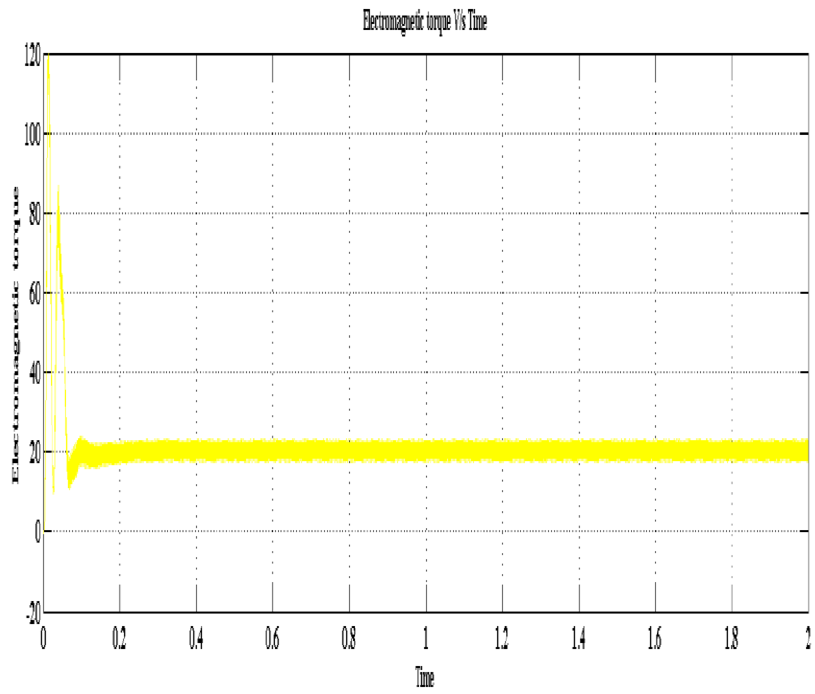

Figure 10 Electromagnetic Torque at 950 Pascal

Figure 11 shows the Voltage and Current waveform for the output section of Inverter which will be fed up into the motor. The maximum current drawn by the Inverter part is 78.5 Amp and after applying torque it will come to a constant value of 14 Ampere.

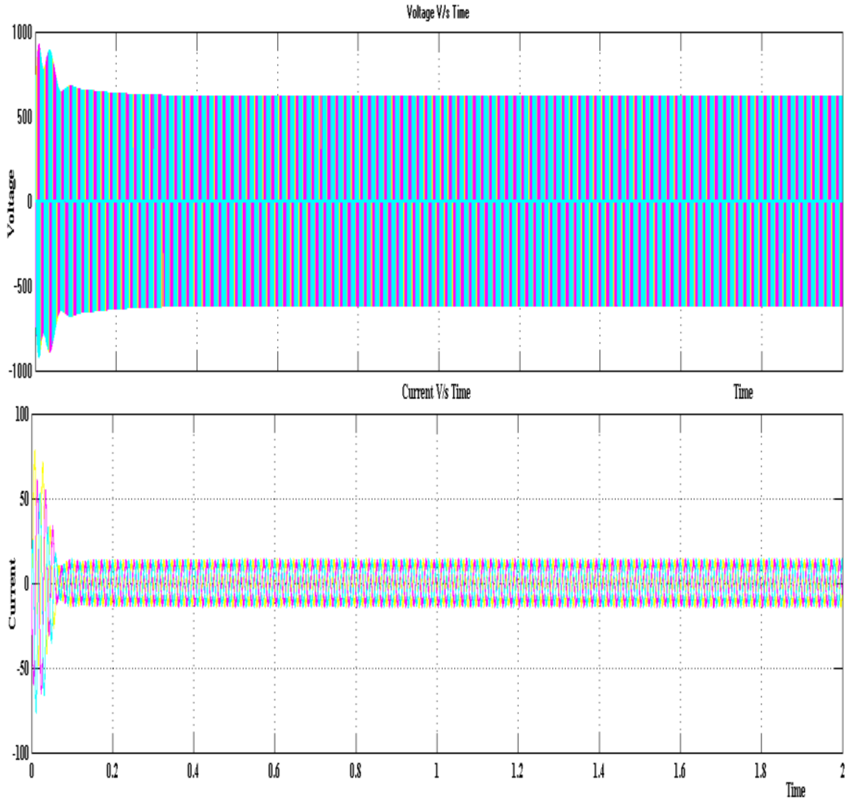

Figure 11 Voltage & Current @ 1000 Pascal

Figure 12 shows the waveform for Rotor Current Vs Time. The rotor current of the motor is high approx. 54.5 Ampere and afterwards it will be constant i.e. 13.5 Ampere.

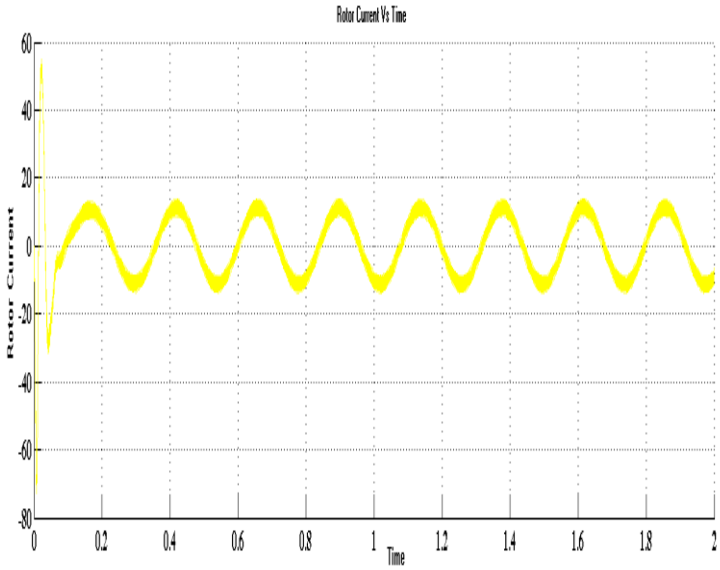

Figure 12 Rotor Current Vs Time @ 1000 Pascal

Figure 13 shows the Rotor Speed Vs Time waveform. In this the motor speed will be constant after it gets saturated at a time. The maximum speed of the IM is taken 1500 rpm but due to slippage issue it will come down to 1490 rpm and will attain a constant speed of 1375 rpm.

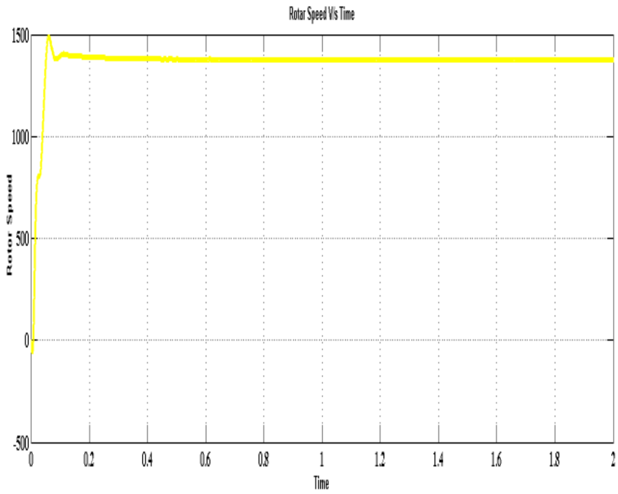

Figure 13 Rotor Speed Vs Time @ 1000 Pascal

Figure 14 shows the Electromagnetic Torque Vs Time graph. Firstly the torque is very high 143 N-m at the time of starting the IM and afterwards while applying **t**orque at 20 N-m, it will fluctuated at 15 – 25 N-m.

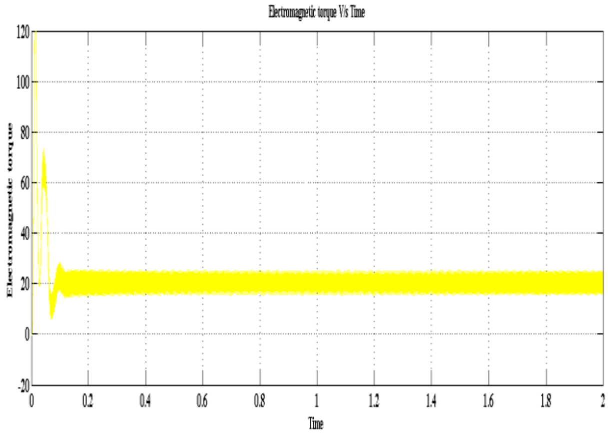

Figure 14 Electromagnetic Torque Vs Time @ 1000 Pascal

Table 1 Comparative Analysis of Different Parameters at 900, 950& 1000 Pascal Pressure

Pressure	**900 Pascal**	**950 Pascal**	**1000 Pascal**
Rotor Current (max.)	52	53	54.5
Rotor Current (at stable condition)	21	17	13.5
Rotor Speed (max.)	1305	1420	1490
Rotor Speed (at stable condition)	1145	1260	1375
Electromagnetic Torque (max.)	112	127	143
Electromagnetic Torque (at stable condition)	18.5 – 22.5	18 – 23	15 – 25
Voltage (at stable condition)	450	495	510
Current (max.)	68	73	78.5
Current (at stable condition)	21.5	18	14

V. Conclusion

From the above figures, it is concluded that the pressure of the system will varied as per the variation in voltage and frequency of the drive. In this case, if the set pressure is less than that of the obtained pressure then the frequency or the speed of the drive increased upto a limit where both the pressure will same or optimization of the pressure achieved. In the similar way, if the set pressure of the system is more than that of the actual pressure then the speed of the drive will decreased to the point where it will obtained the optimized limit. This will work for energy saving purpose.

References

[1]. Mohammed T. Lazim, Muthanna J. M. Al-khishali, Ahmed Isa. Al-Shawi, "Space Vector Modulation Direct Torque Speed Control of Induction Motor", Procedia Computer Science 5 (2011).

[2]. Jirasuwankul, N., "Simulation of Energy Efficiency Improvement in Induction Motor Drive by Fuzzy Logic Based Temperature Compensation", 3rd International Conference on Energy and Environment Research, ICEER, 7-11 September 2016, Barcelona, Spain, 2016.

[3]. Ali Saghafinia , Hew W. Ping , M. Nasir Uddin , AtefehAmindoust, "Teaching of Simulation an Adjustable Speed Drive of Induction Motor Using MATLAB/Simulink in Advanced Electrical Machine Laboratory", 13th International Educational Technology Conference Procedia - Social and Behavioral Sciences 103, 912 – 921, 2013.

[4]. Chitra ,Razia Sultana. W, J. Vanishree, Sreejith. S, Sherin Jose, Alphons J Pulickan, "Performance Comparison of Multilevel Inverter Topologies for Closed Loop v/f Controlled Induction Motor Drive", Science Direct Energy Procedia 117, 958–965, 2017.

[5]. RinchenGeongmitDorjee, "Monitoring and Control of a Variable Frequency Drive Using PLC and SCADA", International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169 Volume: 2 Issue: 10

[6]. Kiran Kumar GR, Shivakumar LN, Marulasiddappa HB, "Precision Motion Control with Variable Speed AC Drives Using PLC", International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-2, Issue-6, January 2014.

[7]. MuawiaMagzoub, NordinSaad, Rosdiazli Ibrahim UniversitiTeknologi PETRONAS, "Efficiency improvement of induction motor variable speed drive using a hybrid fuzzy-fuzzy controller", The 7th International Conference on Applied Energy – ICAE2015 Energy Procedia 75, 1529 – 1535, 2015.

[8]. NarongritPimkumwonga, AmornOnkronga, TirasakSapaklomb, "Modeling and Simulation of Direct Torque Control Induction Motor Drives via Constant Volt/Hertz Technique", Elsevier International Conference on Advances in Computational Modeling and Simulation, Procedia Engineering 31, 1211 – 1216, 2016.

[9]. Peter Vas. Sensorless Vector and Direct Torque Control. New York: Oxford University Press; 1998. [10] Andrzej M. Trzynadlowski. Control of Induction Motors. San Diego: Academic Press, 2001.

[10]. Chee-Mun Ong. Dynamic Simulation of Electric Machinery Using Matlab / Simulink. New Jersey: Prentice Hall, 1997.

[11]. R.L.lin, M.T.Hu, "Auto torch cutting system using PLC and variable speed AC drives for high speed application," IEEE conference on steel plant application, Vol.1, PP.637-642, 2001.

[12]. Patrick A. Brady, "Application of AC motors with variable speed drive, "IEEE, Vol.89, 978-1-4245, 2009.

IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) is UGC approved Journal with Sl. No. 4198, Journal no. 45125.

Mr. Atul Mandniya "Precision Control of Induction Motor Drive through Pressure Transducer." IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) 13.4 (2018): 05-13.