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# Motor Starting Analysis Using ETAP Software

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## ABSTRACT

This paper investigates the preliminary at the early phase of a project, dynamic behaviour of induction motors during start-up of the induction motor drives fed from single generator unit. It is important to ensure that plant generators operate safely and consistently, so power system studies are required at the planning and conceptual design stage of the project. The most widely recognized and studied effect of motor starting is the voltage dip that is experienced throughout an industrial power system as the direct online result of starting large motors. The dynamic behaviour of the motor terminal voltage, acceleration torque, and slip during Direct-on-Line start-up of the induction motor drives fed from stand alone generator source is also discussed here. Motor starting analysis is used to determine if a motor can be started and how much time is needed for the motor to reach its rated speed, as well as to determine the effect of voltage dips on the system are ensured with the help of Electrical Transient Analyzer Program (ETAP).

**Keywords:** Motor starting analysis, effects of starting Induction motor, evolution criteria, ETAP software.

## I).INTRODUCTION

Generally Induction motors are used in Industrial for various drive applications. When large induction motor started can cause severe damage to the motor. In general squirrel cage induction motor is used to drives Industrial load. During the motor starting period, the starting motor appears to the system as small impedance connected to a bus. It draws a large current from the system, about six times the motor rated current, which therefore results in voltage drops in the system and imposes disturbances to the normal operation of other system loads. Since the motor acceleration torque is dependent on motor terminal voltage, in some cases the starting motor may not be able to reach its rated speed due to extremely low terminal voltage.

A frequent problem arise failure to start when the motor coupled to its load is energized for the first time. Typically the motor appears to start initially smoothly, then is tripped off line by relay action before it reaches full speed. When the starting time is prolonged enough to exceed the permissible locked rotor time, the relay can operate even though its time current curve is at all operating points above the motor starting curve.

## II).EFFECTS OF STARTING LARGE MOTOR

A variety of the effects of starting a large motor are represented below:

### A) Motor terminal voltage:

During the starting, the motor terminal voltage should be maintained at approximately 80% of the rated voltage for motors having standard 150% starting torque at full voltage with a constant torque load applied. A 81.6% rated voltage will develop a torque.

$$T = 0.816^2 \times 150\% = 100\%$$

Also, in every case the starting time has to be evaluated for the $I^2t$ damage limit of the motor.

**B) Large Motor starting effect on other running motor:**

When large motor is started voltage drop occur on system so other motors that already running normally will slow down. the running machines must be able to reaccelerate once the machine being started reaches the operating speed. If the voltage drop is very severe than loaded running machines may exceed the breakdown torque at reduced voltage. The decelerating machine may cause heavy current to produce excessive voltage drop.

**C) Flicker:**

Power system loads such as computer, equipment ,power electronic equipment and sensitive control devices may be affected during motor starting. there is a wide variation in the magnitude of the voltage drop by electronic equipment. voltage fluctuations may cause also objectionable light flicker in domestic applications.

## III). EVALUATION CRITERIA

According to the IEEE standard 399 a motor starting study should be performed if the motor horse power exceeds approximately 30% of the supply transformer base kVA rating if no generators are present. for smaller horse power motors a study is needed depending on daily fluctuation of nominal voltage, size and length of the cable, load rating, regulation of the supply voltage, transformer impedance and tap ratio, load torque and motor torque. If generation is present & no other sources are involved a study is required if the motor horse power exceed 10% to 15% of generator kVA rating. the acceptable minimum voltages under various operating conditions are listed below:

| Description | Voltage |
|---|---|
| Acceptable system voltage | 95% to 105% |
| Acceptable voltage for motor starting | 85% |
| At the starting motor terminal | 80% |
| At the terminals of other motors | 71% |
| AC contactor pick up voltage | 85% |
| DC contactor pick up voltage | 80% |
| Contactor drop out voltage | 60% to 70% |
| Solid state control devices | 90% |
| Noticeable flicker | 3% |

## IV). STARTING METHODS

If a normal supply voltage is applied to an induction motor at standstill, the starting current will be on the order of 6 times the rated current. The starting torque is also limited and can be improved by inserting a resistance in the rotor circuit in the case of slip ring motors.

However, there is need to limit the inrush current during the starting. There are several starting methods used for large motors.

A) **Series impedance starting:**

A resistance or reactance can be used in series with the motor winding during starting. Then by using a contactor, the series impedance can be short circuited. If a series reactance is used in the starting, the power factor

will be poor and produce significant disturbance in the line. If a series resistance is used, then the power factor will be better, but the losses in the resistance will be high. Standard reactors are available to limit the starting voltages at the motor terminal to 50%, 75% and 90% of the terminal voltage at the instant of starting.

### B) Auto-transformer starting:

In this method, a reduced voltage is applied to the motor using an auto-transformer and the voltage is increased to the nominal value after the starting. With auto-transformer starting, the acceleration time of the motor is longer, if a constant torque is produced during the starting.

### C) Wye/delta starter:

For small and medium size motors, the wye/delta starter can be used. The stator winding is connected in wye during the starting and in delta for the running. This starter is the simplest form of mechanical equipment and is suitable for small and medium size motors.

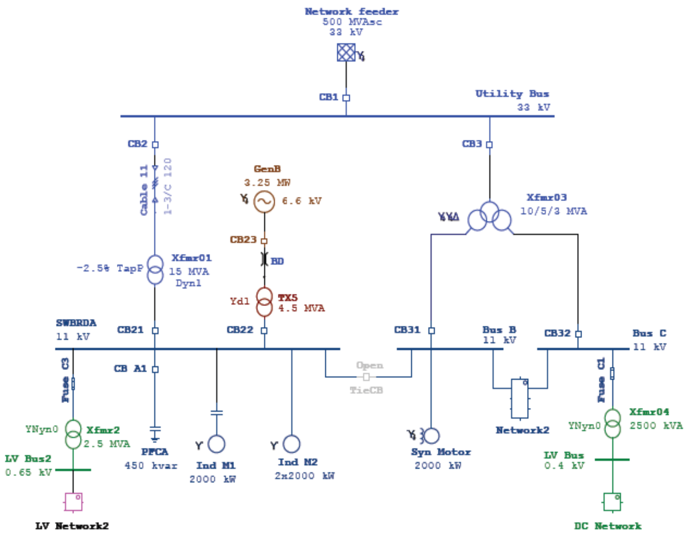
The disadvantage of this method is: when there is Star-connection during starting, stator phase voltage is *times of line voltage. Consequently, starting torque is *times the value it would have with D-connection. This method becomes rare for a large motor due to large reduction in starting torque.

### D) Shunt capacitors to reduce the starting current:

The shunt capacitors can be used across the motor terminals to reduce the reactive component of the current during the starting. Experimental results on a 2-hp, 220 V, 7 A, 3,600 rpm, wye connected, three-phase induction motor show significant reduction in the line Currents.

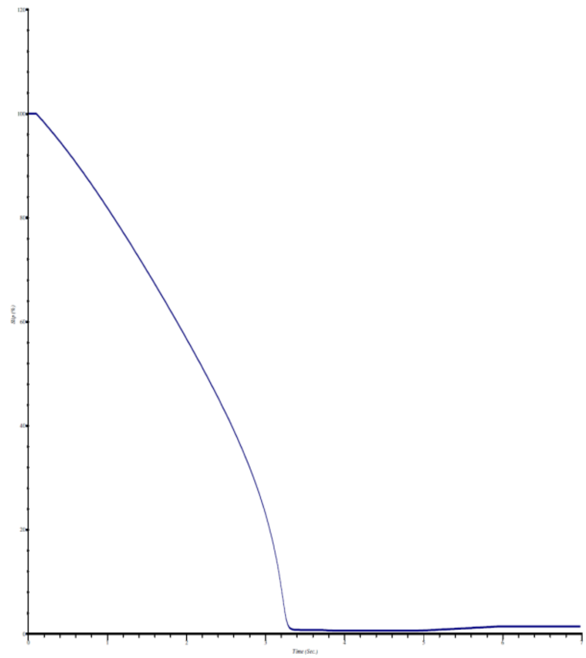
The shunt capacitors can cause ferroresonance when interacting with the magnetic circuit of the induction motors. Therefore, the shunt capacitors has to be switched off as soon as the starting is completed.

## V).CASE STUDY

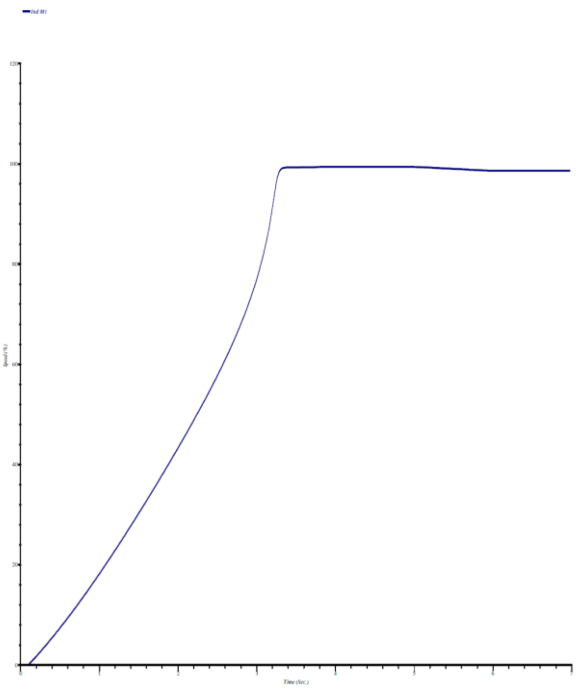



## VI). ANALYSIS & SIMULATION:-

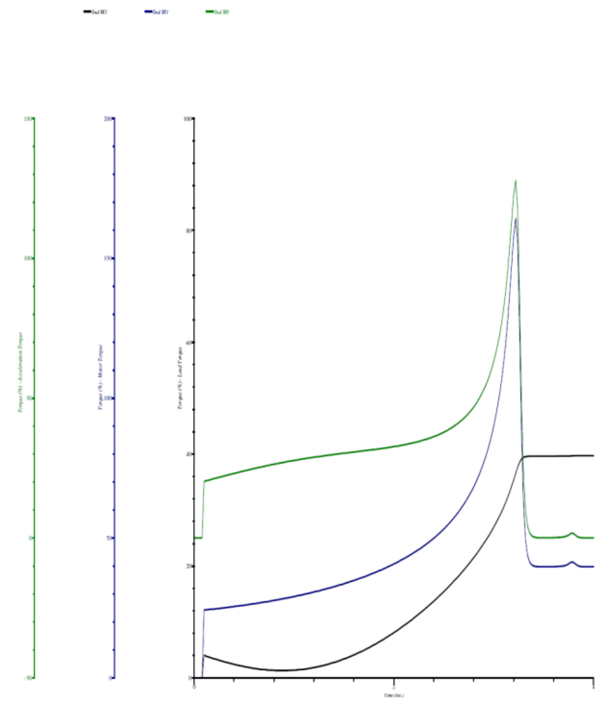
### 1) MOTOR SLIP CURVE:-



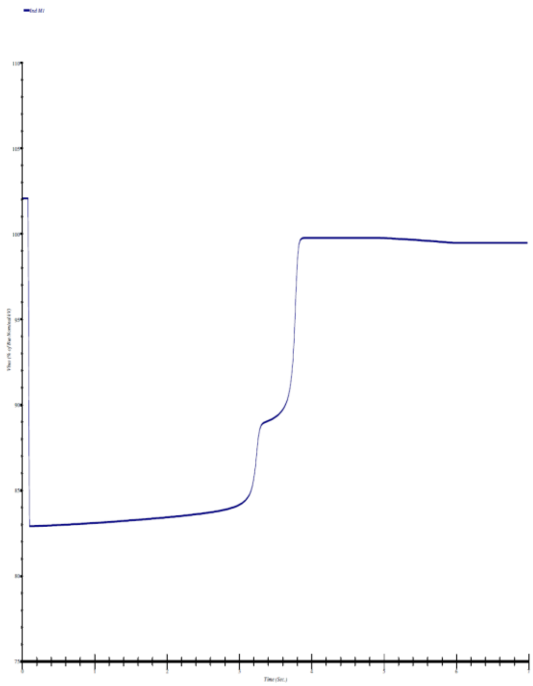
2) MOTOR SPEED CURVE:-



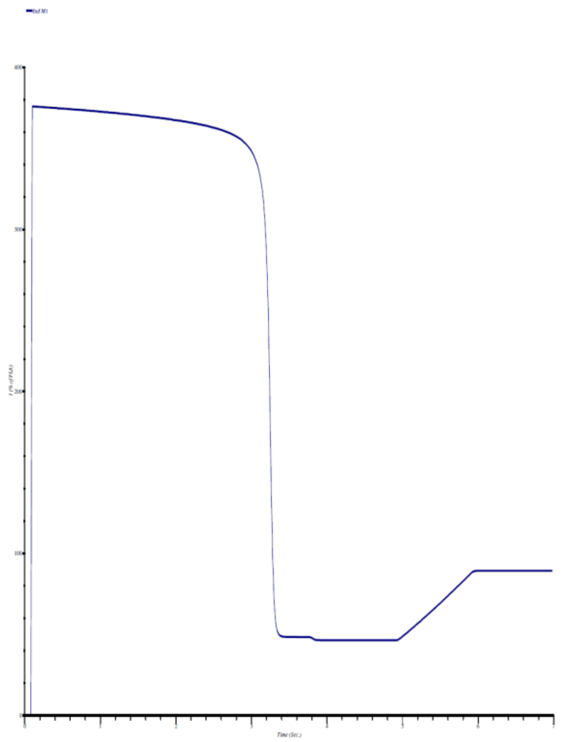
3) MOTOR TORQUE CURVE:-



4) MOTOR BUS VOLTAGE CURVE:-



5) MOTOR CURRENT CURVE:-



## B).RESULT & CONCLUSION:-

Starting of 2000kW motor against STG and Grid power. The motor is supplied through 6.6/11kV 4.5 MVA TR via Auxiliary Switchgear. It is considered that STG is running at capacity of 2MWprior to motor starting. At the instant t=1s starting of Ind M-1 motor takes place and simulated results have been plotted for the simulation period of 7s for appropriate diagnosis of results .ETAP results of Motor starting study reveals that voltage at 11kV,SWBRDA dips to 84 % which is above the acceptable limit of 80% and also recovers to its nominal value. Further reactive power requirement during starting period does not cause operating point of the generator to cross the capability curve limits. There is a negligible drop in grid voltage observed. Motor starts successfully and reach to its rated speed within about 3.3s of time duration.

## VII).REFERENCES


1. John H. Stout " Capacitor Starting Of Large Motors " IEEE Transactions On Industry Applications, Vol. Ia-14, No. 3, May/June 1978, pp. 209- 212
2. A Jack Williams & M. Shan Griffith," Evaluating The Effects Of Motor Starting On Industrial And Commercial Power Systems" IEEE Transactions On Industry Applications, Vol. Ia-14, No. 4, July/August 1978, pp. 292-305
3. John A. Kay, Richard H. Paes, J. George Seggewiss, Robert G. Ellis "Methods For The Control Of Large Medium-Voltage Motors: Application Considerations And Guidelines " IEEE Transactions On Industry Applications, Vol. 36, No. 6, November/December 2000, pp.1688- 1696.
4. Solveson M.G. "Soft-Started Induction Motor Modeling" IEEE Transactions On Industry Applications Vol.42 No.4, July/August 2006,pp 973-982
5. Rezek A. J., "Energy Conservation With Use Of Soft Starter" IEEE 2000, pp 354-359
6. Blaabjerg F. "Can Soft Starters Help Save Energy", IEEE Industry Applications Magazine Sep/Oct 1997 Pp 56-66
7. Blaabjerg F. "Comparative Study Of Energy Saving Benefits In Soft Starters For 3ph Im", IEEE Industry Applications Magazine Sep/Oct 1995 pp 367-373
8. AC Induction Motor Fundamentals by Rakesh Parekh, Microchip Technology Inc
9. "Induction motor - protection and starting by viv cohen" – Circuit Breaker Industries, P.O. Box 881,Johannesburg 2000, South Africa.
10. httpsss://etap.com/