

Study of Smooth Starting for LT/HT 3-phase Induction Motors by Using HFSR Starter Method for Specially Pumping Application

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Abstract: When three phase induction motor greater than 50 kW take very large currents with surge started directly from a 3phase supply. Actually soft starts are used for reducing this problem and to achieve smooth starting of large capacity induction motors. This will be a very useful strategy especially in Industries where various induction motors of large capacity are regularly started from a 3-phase supply. The control of soft starting is useful for prolonging the life of electric contact and helping the machinery requirements on different occasions. Motor of 50 kW and above rating draws very large current when started direct-on-line (DOL) affecting supply voltage dips which can adversely impact other equipment connected to the power grid. Sustained of large current through the motor during starting can causes climb temperature rise resulting in damage of the insulation of the motor windings. Therefore, the starting control of the motor needs to be operated thereby limiting its starting current. The conventional reduced voltage starting methods, such as star-delta starting and impedance starting, causes stepped variation of voltage whereas a soft-start derivative the voltage applied to the induction motor in a smooth Manner. A 3-phase reactor coil is normally employed as a soft-start. Time of soft start and stop is suitable. With this air core reactor coil soft starter voltage can be flexible to different loads. Provide motor with smooth and gradual starting current as per loads conditions

Keywords: HFSR (Harmonics free series reactor) motor starter, Air core coil, Torque Without Harmonics & losses

I. INTRODUCTION

Soft-starts are specially employed in large capacity induction motors to limit the starting current and also to achieve smooth starting. Any induction transition, causing a surge during starting, this soft start starting method can be applied to H.T. Motors since proper modification will have to make in soft starter. a) Autotransformer starting results a better solution. b) The series impedance method consists of introducing overall proper design impedance of appropriate value in series with the motor winding during starting and then bypassing it the when motor finally reaches full speed. For a minimum energy loss the series reactance air core reactor is always recommended. For Low voltage (415 V) the Reactor air core can be introduced in line side of motor winding and against for HT motors, the reactance can be introduced into the line side or neutral side of induction motor winding. [1]

II. MOTOR STARTING

Induction motor is the most applicable drive in industry. However, starting of this motor has always been a complicated issue. The starting techniques that are universally employed fall into two basic divisions.

A.FULL VOLTAGE (DOL) STARTING:

Direct on Line (DOL) starting is the regular and the cheapest method for starting induction motor but affected from the effect of high starting current & associated torque jerk.

B.REDUCED VOLTAGE STARTING:

Reduced Voltage starting is implemented by star-Delta / Autotransformer / series Impedance starting. A Start Delta method needs three power contactors and is always open the motor terminal voltage from the initial lower value to the line voltage in a smooth slope manner. The simple and elegant construction of HFSR makes it the most attractive, economical and convenient device for starting of cage induction motors, specially for low starting torque and involve mode are inertia. The air cored Reactor remove iron losses and saturation effect caused by magnetic core and result perfect linear characteristics, totally free from harmonics. The Series reactance is designed to withstand surges & fault levels accepted on the line sides as neutral side of motor winding. [2]

III. HSFR SOFT STARTER

HFSR soft starter falls in the division of series impedance type of starter current & enable gradual increase in the motor terminal voltage from the initial lower value to the line voltage in a smooth slope manner. The simple and elegant construction of HFSR makes it the smoothest, stable and convenient device for starting of induction motors, especially for high starting torque and involve mode are inertial load.

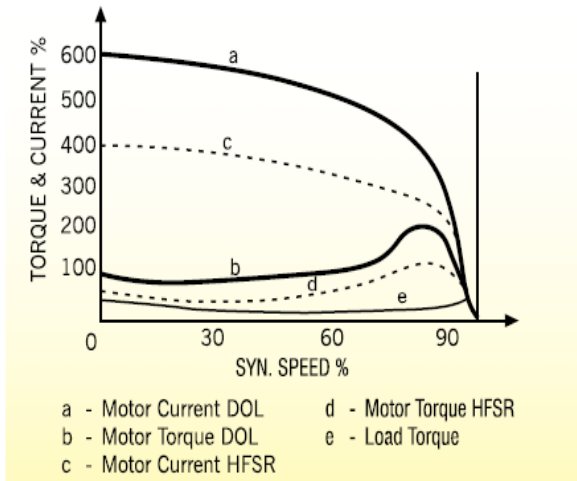


Figure 1

IV. PRINCIPLE OF OPERATION

The HFSR acts as impedance in series with motor b) the series impedance method consists of introducing overall proper design impedance of appropriate value in series with the motor winding during starting and then bypassing it the when motor finally reaches full speed. For a minimum energy loss the series reactance air core reactor is always recommended. For Low voltage (415 V) the Reactor air core can be introduced in line side of motor winding and against for HT motors, the reactance can be introduced into the line side or neutral side of induction motor winding. [1]. The HFSR acts as impedance in series with motor winding and permits only a part of the voltage to be Applied at the motor terminals at the time of starting torque as comparative with the DOL values. The Reactor parameters are so design so as to allow the motor to generate proper starting torque to overcome the load torque and friction to enable smooth acceleration. The starting current minimizes well below DOL value, the actual permissible value rely on the starting torque speed characteristics of the Existing load. As the motor accelerate the current taken by motor goes on reducing, as a result of generation of back EMF in the motor winding. This in turn result fewer drops across the motor terminals hence increasing the torque gradually. The Reactor is bypassed after starting time delay near to Motor full speed by required rated Contactor. This complete process of reduction in current, with gradual

increase in motor voltage, takes place in a slope manner from zero to full speed. This attains very soft and smooth starting. [3-6]

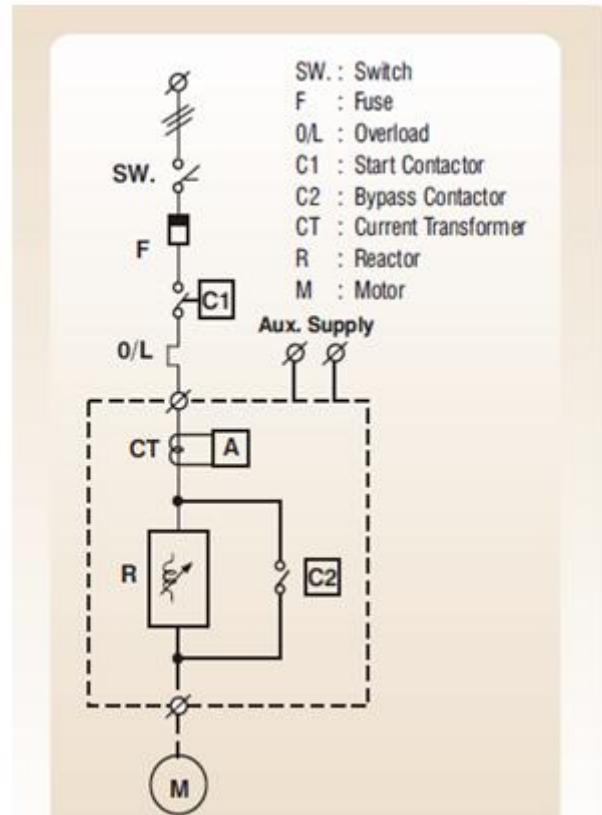


Figure 2

V. STANDARD SPECIFICATION

1. Operational Voltage: 415V/3300V/6600V/11000V
2. Controlling Voltage: 110VDC/240VAC.50Hz
3. Auxiliary supply: 240V AC
4. Insulation: Class H/F
5. Duty Cycle: 2 start from cold condition and 1 hot start or 4 Equidistance start/ hour. For more duty cycles, as per reference to works.
6. Method of cooling: Natural cooled.
7. Operation Condition: 55 C Max + altitude up to 1000m

VI. THE ELECTRICAL EFFECT

The electrical impact of large starting current can leads severe enough to causes:

- Large voltage dips and surge damage to computers & other electronic equipment on the line disturbed.
- Supply voltage drops in case of weak supply and thus impacted the entire operation in pumping.
- Damaging and burning of switching contacts due to high inrush currents which are many times the motor full-load current.

- Increase in line losses.
- Risk of overloading sanctioned maximum demand.
- Electrical losses in the stator and feeding cables are heated.
- Motor performance is degraded.

VII. THE MECHANICAL EFFECTS

The sudden mechanical impact at starting on the motor load, followed by the rapid acceleration to full speed result in excessive wear on:-

- Belts and pulleys
- Gear train and chains
- Couplings and bearings :-
- Cavitations formation in pumps etc.
- At the time of start-up, there is an unwanted heavy power surge on both the electrical supply and the mechanical drive pump components. [7]

These unnecessary Mechanical & Electrical effects can result in substantial additional cost for the company due to:-

- Most frequently and unscheduled maintenance.
- Greater tendency of unscheduled shutdowns – productivity loss
- Oversized mechanical and electrical components to develop for the power surge on start up.
- Decreased in component life

VIII. UTILITY RESTRICTIONS

As utility power systems frequently under the maximum capacity, the effect of starting motors across the line can develop stress on the factory's power distribution system. The lights go dim, process control systems cannot sustain or trip out and end-user restricted as to when and how often you will be liable to start the motor. And this all happen because of the heavy current drawn by the motor initial starting.

IX. CURRENT PROBLEMS

In early day a great problem was associated with the starting of induction motor because of sudden voltage dips and large fluctuating torque development. At peak time due to tripping of relay motor voltage becomes unbalance and due to under voltage or over- voltage the motor may fail to start result in burns or internal winding may get damaged. In this paper we will have to discuss about remedy of all above types of problems by using soft starter. Soft starting of induction motor is acquired by using HFSR method. Soft starter provides to smooth start by delivering a controlled release of

power to the motor, resulted providing step less acceleration and deceleration. Motor life will be building as damage to windings and bearings is reduced.

X. HFSR ADVANTAGES

- By continually monitoring the motor to improve the part-load efficiency so reducing the degree of over-fluxing of the stator.
- The part load pF of the motor is increased.
- This result a significant reduction in KVAR and KVA also a useful reduction in kW.

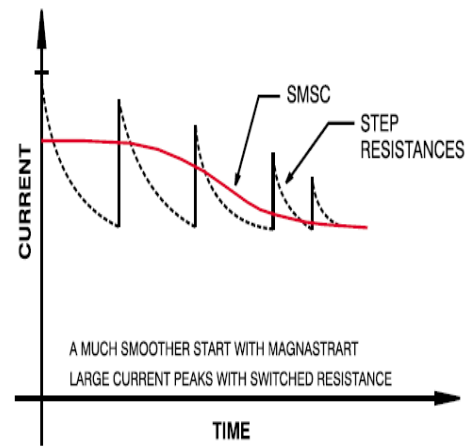


Figure 3

Induction motor which benefit from the fitting of a soft-starter.

- In specially, pumps and pumping systems from the soft start-stop feature and the reduction in cavitations effects.
- reduced mechanical stress
- increased the power factor
- reduced maximum demand
- mechanical maintenance will be less
- avoid voltage dips and spikes
- no heat and vibrations quiet
- 100% copper so no losses.
- Linear, stable, S-1duty, operation of motor-pump set.
- Harmonic free, so no saturation and eddy current creations.

XI. TYPICAL APPLICATIONS

- large capacity centrifugal pump set in water utility
- High torque inertia Fans
- Crushers Grinders conveyor belt
- Pulp, Paper & packaging industry
- Press work
- Mixers & grinding

XII. COMPARATIVE RESULT

As shown in result diagram figure 4 & 5, comparison between step resistance & soft starter well differentiated for control of motor. [8]

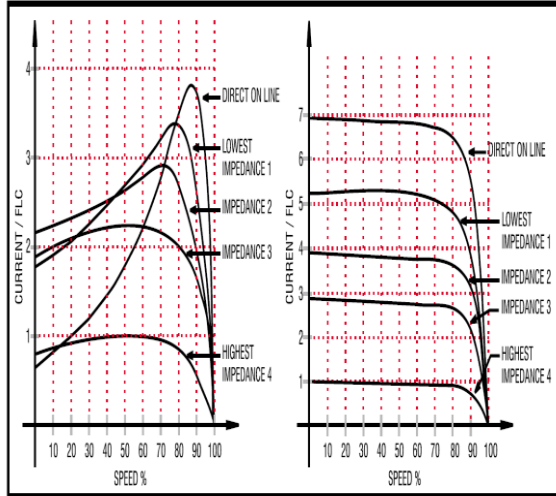


Figure 4

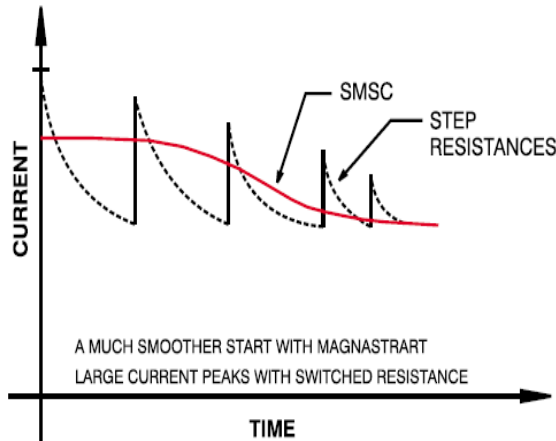


Figure 5

XIII. CONCLUSION

Municipal water pumps are predominantly centrifugal pumps and vertical turbine pumps. Low, Medium, high Elevated water storage as per head requirement, Reservoirs

in the distribution system water stored with proper level. Power quality issues as various disturbances like interruption, sag, voltage dips, fluctuations, harmonics, etc, can be avoided by using harmonic free serious air core reactor for motor starter by using suitable specially designed **HFSR** soft starter installed and implemented in water industry.[9] **HFSR** Starting technique implemented in majority of water pumping station are well suited because of

it avoids unnecessary interruption without affecting various zones of water distribution network system. Good Electrical power quality maintained.

REFERENCES

1. B.L. THERAJA, A.K. THRAJA, A Text Book of Electrical Technology – Volume II AC & DC Machines. Volume III Transmission Distribution & Utilization
2. U.A Bakshi – Electrical machines – Technical Publication pune
3. R. C. Dugan, M. F. McGranaghan, S. Santos a, and H. W. Beatty, Electrical Power Systems Quality, 2ndedition, McGraw-Hill, 2002.
4. GUIDE BOOK - Em-ea.org
5. Soft Starter In Industrial Applications | EEP *electrical- engineering-portal.com* Technical Articles
6. Jayashree Electron Pvt. Ltd. EL – 34, 'J' Block, M.I.D.C., Bhosari ...PUNE 26
7. British Pump manufactures Association
8. Alternating Current Machines- M.G. say (1936) ISBN 0273 36197X
9. Electric Motor Guide – Edwin (1968)

BIOGRAPHIES



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