

Application note

Low inrush current motors help to reduce disturbances to weak supply networks



Induction motors are used in a wide range of applications, and most are connected direct-on-line. When a motor like this is started the inrush current can typically reach 4–7 times the rated value.

With a weak supply network the high starting current can produce a voltage drop which may be large enough to disrupt the operation of other equipment. Weak networks are typically found in situations where power is produced on-site or at locations remote from the main supply grid, and are therefore most common in the marine and offshore sectors, and in mining, quarrying and similar operations.

What solutions are available to limit the inrush current?

Low inrush current (LIC) motors often represent the optimum solution. They are based on the “skin effect”: when a motor is started, the magnetic field only penetrates the surface or skin of the rotor and current only flows through the top part of the rotor bars. In LIC motors this phenomenon is exploited by means of special rotor designs to reduce the inrush current. LIC motors often have lower power factor and efficiency than the equivalent regular motors; they also tend to be larger but effective LIC design reduces the need for oversizing.

Auxiliary starting equipment, such as soft starters, star-delta starters, transformers and reactors, and variable speed drives (VSDs) can be used to reduce the inrush current. In many applications, however, there is insufficient space for additional equipment. In addition, starting auxiliaries are not available for higher powers, and the cost of VSDs is difficult to justify where motors are normally run at full speed. Slip-ring motors with variable starting resistors in the rotor circuit are also available, and can produce a high starting torque with low current.

How are low inrush current motors manufactured?

Three main rotor design solutions are used in LIC motors:

1. Deep, narrow rotor bars represent a straightforward solution that can be used in most applications with moderate current and torque requirements. Narrow bars present higher resistance to current and produce higher torque, but also give rise to increased losses through heating. Shaped rotor bars – where the bar width is varied at the top and bottom – make effective use of the skin effect to separate the motor's starting behavior from its rated operation.
2. Higher resistivity copper alloys can be used for the rotor bar material. These designs provide higher torque but also suffer from increased losses when starting and in normal operation. These materials are also more expensive and more difficult to source.
3. Double-cage rotors are still found to some extent today, having been widely used in the past. This solution produces high torque with low current when starting, but has no effect in normal running. In most cases the output power of the machine is reduced and the price is slightly higher. Two separate end rings are required, making the mechanical structure relatively complex.

What is ABB's approach?

Based on the rotor design techniques described above, ABB tailors LIC motors to meet the overall system needs of the specific application. This approach recognizes that all the techniques for producing LIC motors involve trade-offs between performance benefits and drawbacks. By working with the customer to gather information on the application, ABB's engineering team can ensure that each LIC motor meets its specific performance requirements while any necessary compromises only impact areas of performance that are less important for the particular application.

For this purpose ABB needs information about the network (maximum allowable voltage drop, maximum allowable starting MVA, or actual starting amps) and accurate load data (torque curve for open/closed valve starting, maximum overload to be tolerated).

What are the benefits of ABB's solution?

Flexible design and manufacturing procedures enable ABB to offer LIC motors across all size and speed ranges. All LIC motors from ABB are tailored for their specific application and represent the optimal design for the purpose. LIC motors provide a convenient, 'stand-alone' solution: there is no need for auxiliary starting equipment, making for major savings in cost and space and helping to increase reliability.

What about customer references for ABB's LIC motors?

Each year ABB supplies around 100 LIC high voltage motors, and hundreds of LIC motors delivered in recent years are operating around the world. ABB typically supplies LIC motors for the COG, marine, metals and minerals, power utility and pulp and paper sectors. The motors are most commonly used to drive pumps, compressors, mining equipment such as crushers and conveyors, and marine thrusters.

The following list shows examples of LIC motors delivered by ABB recently:

Pcs.	Is / In	Product	Power [kW]	Voltage [kV]	Pole number	Application	Industry	Year
60	3.5	AMA 450/500	900	4.1 - 7.2	4	Mining Industry	Metals & Minerals	1997-2006
4	3.1	AMC 900	9000	6.6	6	Fan	Power Utilities	2003-2005
1	3.6	AMB 710	9000	6.6	4	Compressor	Air Separation	2005
2	4.0	HXR 450	475	6.6	6	Compressor	Chemical, Oil & Gas	2005
4	4.0	AMD 500	540	6	4	Compressor	Chemical, Oil & Gas	2004
1	3.6	AMA 450	950	6.6	4	Pump	Chemical, Oil & Gas	2004
3	4.0	AMD 560	560	11	2	Pump	Chemical, Oil & Gas	2003
3	4.0	AMD 630	920	11	2	Pump	Chemical, Oil & Gas	2003
2	3.5	AMB 710	8000	10.4	4	Refiner	Pulp & Paper	2002
1	4.0	AMD 630	1980	4.16	4	Pump	Chemical, Oil & Gas	2002
5	4.0	AMI710	4000	10.5	4	Pumps	Chemical, Oil & Gas	2009
2	3.5	AMI710	4000	6.6	4	Pumps	Chemical, Oil & Gas	2009

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