NHP

TECHNICAL NEWS

Issue 15 October 1995

Please circulate to

Quarterly Technical Newsletter of Australia's leading supplier of low-voltage motor control and switchgear.

START IN THE CORRECT GEAR

IN THIS ISSUE

Which starter to buy

The cage induction motor is the most common type of electric motor. It is simple in construction, reliable and has only one moving part. The major difficulty though with this type of motor is that it can draw quite large currents during starting.

The starting current can be as high as eight times the normal running current and this may cause stress on the electrical supply system.

There are a variety of different systems used to reduce this initial current and each system has its own features which can make it suitable in one application but not another. It is normal to try and select a system which offers the most economic solution.

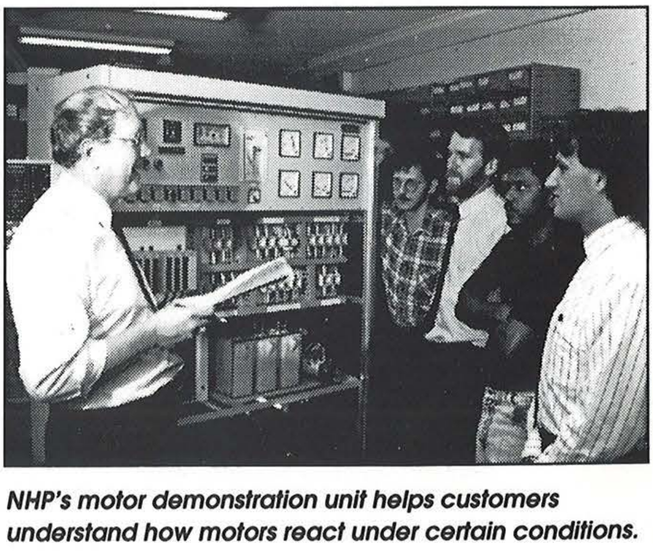
Motor current

The current drawn by an induction motor depends on the speed of the motor and not the load. The driven load will determine the rate of acceleration and the final speed, (and therefore the running current), but the initial current and those during acceleration are independent of load.

The other point to remember is that usually 80% of the maximum speed must be reached before the current drawn starts to drop at a significant rate.

Supply

To accommodate Direct-On-Line starting (DOL) the capacity of the supply system must be significantly larger than the motor rating. This may not be a problem with small motors but it will create problems as the motor rating increases.



NHP's motor demonstration unit helps customers understand how motors react under certain conditions.

Supply
(continued from page 1)

Consider a 500 kW motor with a locked rotor current of eight times rated full-load current, fed from a 500 kVA transformer of 5% impedance. During starting the transformer voltage would drop to about 75% of its rated value. While this is fairly extreme it is possible for motor starting currents to cause voltage fluctuations greater than 5% to other consumers of the distribution network. These fluctuations are not acceptable and the supply authority may insist in some areas, that motors over a particular size must be fitted with some form of reduced voltage starter to control starting currents. Even if no blanket restriction is enforced there are set limits to the degree of disturbance at the point of common coupling to the network.

Australian standard AS2279.4, *"Limitations of voltage fluctuations caused by industrial equipment,"* permits the fluctuating load component to be up to 0.002 times the system fault level at the point of common coupling without the need for detailed investigation.This produces a relative voltage change of less than 0.2% and can be difficult to comply with when motor loads are considered. Fortunately, it is unusual for motors to be started at rates exceeding several starts per hour and it can be seen from the graph in **Fig 1** (derived from AS2279.4) that for this duty voltage fluctuations up to 5% are permitted.

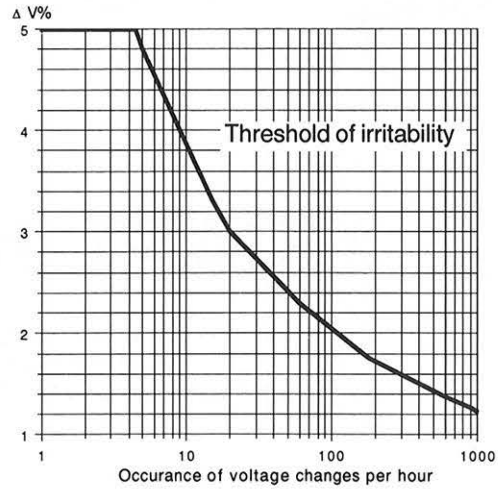


Fig 1

The graph represents the point where lamp flicker produced by voltage fluctuations becomes irritating.

Mechanical consideration

For some drives the excess torque during starting can cause damage or at least reduce the expected life of the system if the torque is not limited. The acceleration caused by the excess torque may also cause problems for the driven load. An example would be a conveyor system carrying a material up an incline. Rapid acceleration could cause a back rolling of the material.

Reducing start current

Torque is reduced in proportion to the square of the current. For many applications this limits the amount that the starting current can be reduced while still achieving successful acceleration.

In **Fig 2** the torque produced by several different starting methods is shown against the torque required by two typical load profiles. When the load torque equals the available torque from the motor acceleration stops. It can be seen that for this example the Star - Delta and 60% Auto Transformer would not accelerate the motor to a sufficient speed before changeover to the running state. The current profile is shown in **Fig 3** for this situation.

The solution to this problem may require a different motor (motors characteristics vary greatly), a different method of starting or a means of reducing the load during run up.

Selecting the starter

It is possible to use any of the common starters and the motor will achieve operating speed. The final stage of the starter sequence connects the motor DOL and this ensures the final acceleration.

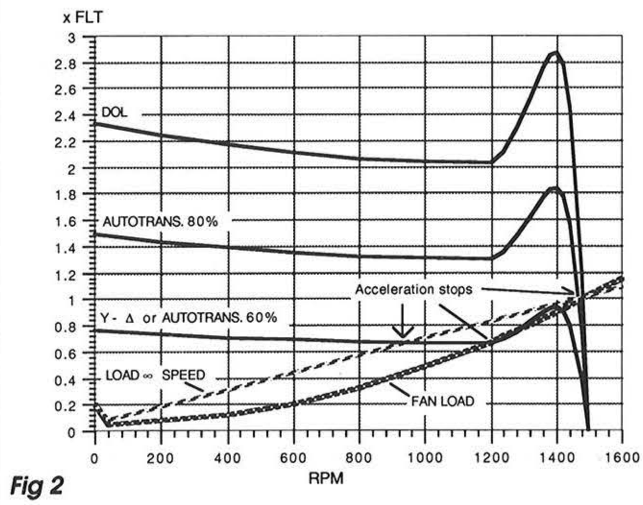


Fig 2

Selecting the starter
(continued from page 2)

If inadequate speed has been reached before the final stage, excessive current and torque peaks may result, but can go unnoticed. It is essential that the current is monitored during the start sequence to check that sufficient torque is available during the reduced voltage stage and that the timers are set with sufficient delays. Problems with the starter selection or timer setting often appear as a short operational life from the contactor required to break the initial starting current. This contactor will normally have been selected on the basis that it will be breaking currents much lower than what it actually is.

Table 1, can be used as a rough guide to selecting a starter, but it is preferable to compare the motor performance against the load torque, as in **Fig 2** if the particular combination of motor, starter and load have not been proven.

Starter exclusion

Listed below are some of the basic reasons why a particular form of starting should not be used.

DOL

* The motor is too large compared to the capacity of the electrical supply.
eg. Motor current is greater than 25% of the supply rating.

* Supply Authority imposes limits to DOL starting.

* The driven load will not accept high start torque.

* Controlled stop is required.

Star delta

* The driven load will not accelerate to above approximately 80% maximum speed in star connection. (Requires examination of motor characteristic vs load).

* The motor does not have six terminals to allow star connection.

* The motor has six terminals but is not rated for 415 volts in Delta.

* Controlled stop is required.

Auto transformer

* The motor may be started with a DOL or with a Star delta.

* Motor less than 11 kW (normal lower limit).

* Controlled stop is required.

Primary resistance

* The motor can be started with a DOL or with Star delta.

* Motor less than 11 kW (normal lower limit).

* Controlled stop is required.

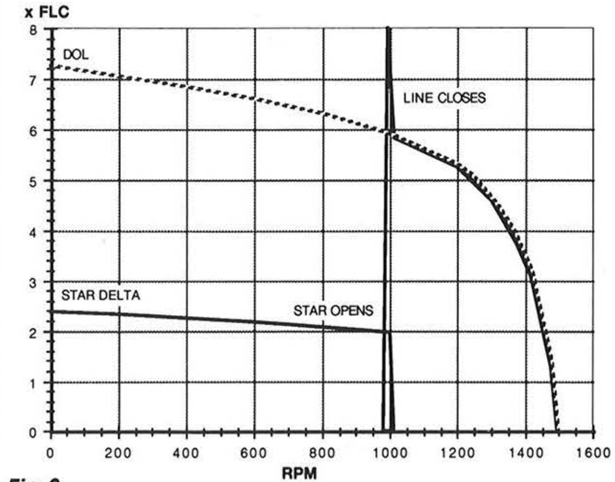


Fig 3

Starter exclusion (continued from page 3)

Electronic soft starter

* The motor can be started with a DOL or with a Star delta.

* Line current restrictions only solved by an auto transformer.

* The improved start and stop characteristics are of no advantage.

Conclusion

It is essential that the correct selection of motor starter is made if correct performance is to be obtained. While it may seem confusing as to which starter to select there is usually a precedent for most applications. Manu-factures of the motors, driven loads or the starting equipment can provide assistance in the selection process.

Future articles

Technical News will feature in detail the common forms of motor starters.

	DOL	Star delta	Auto transformer			Statormatic	Electronic
			50%	65%	80%		
Starting currents x FLC	6 [2]	2	1.5	2.5	3.8	3 - 4.5	3 - 6
Starting torque x LRT	1	0.33	0.25	0.42	0.64	0.25 - 0.56	0.25 - 1
Relative cost. approx. [1]	1	1.5	3			3.5	4.3
Ideal for	Starting when current or torque not limited.	Reducing start current on lightly loaded motors.	Reducing start current in applications where adjust-ment may be required.			Smooth start with low peak from close of last contactor.	Critical loads requiring good torque control.

Notes: [1] Relative cost is based on enclosed starters and will vary depending on kW rating and actual units compared.

[2] Actual starting current depends on motor design

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