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Applications of Reactor Starting for Asynchronous Motors

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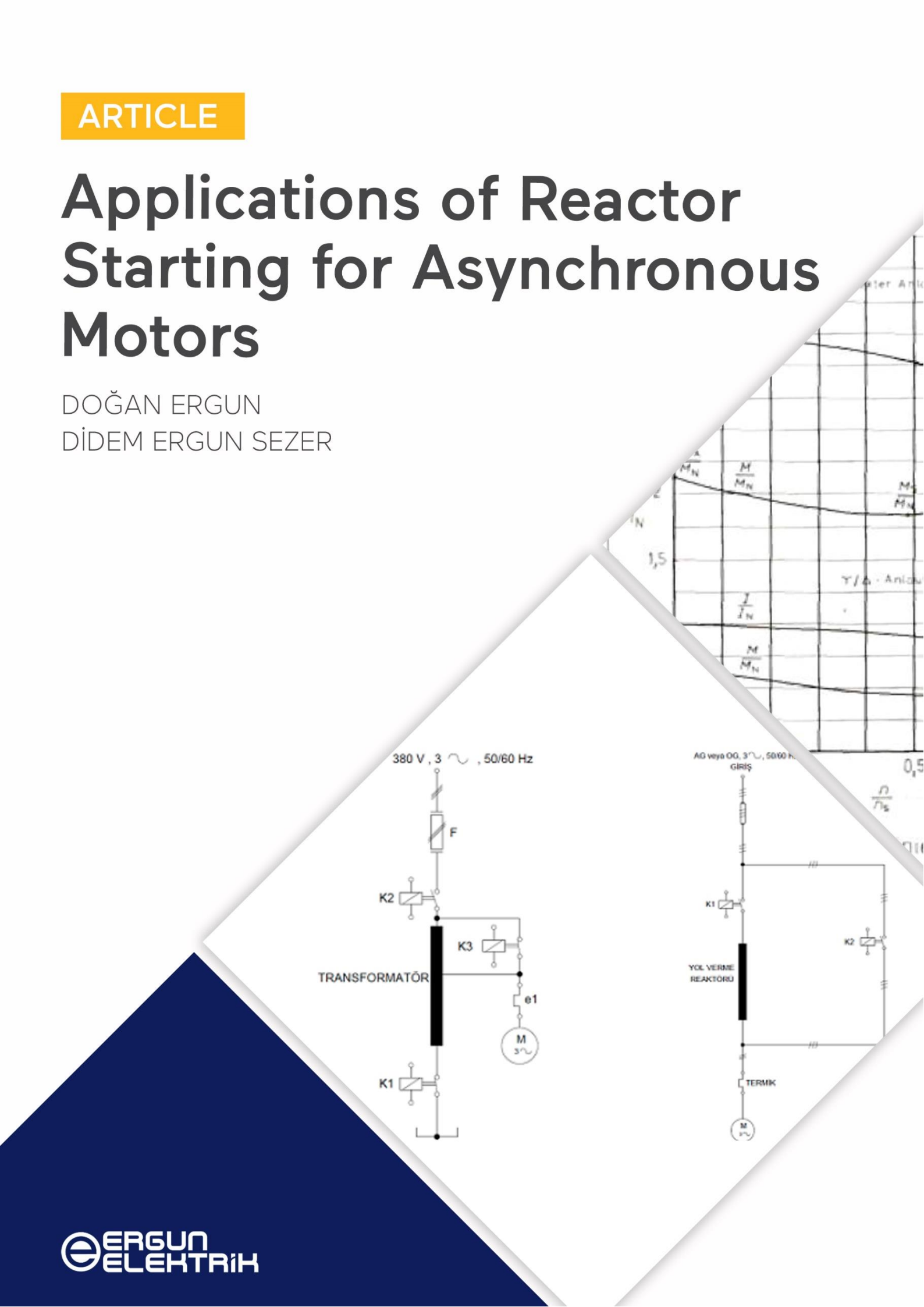


ERGUN ELEKTRİK

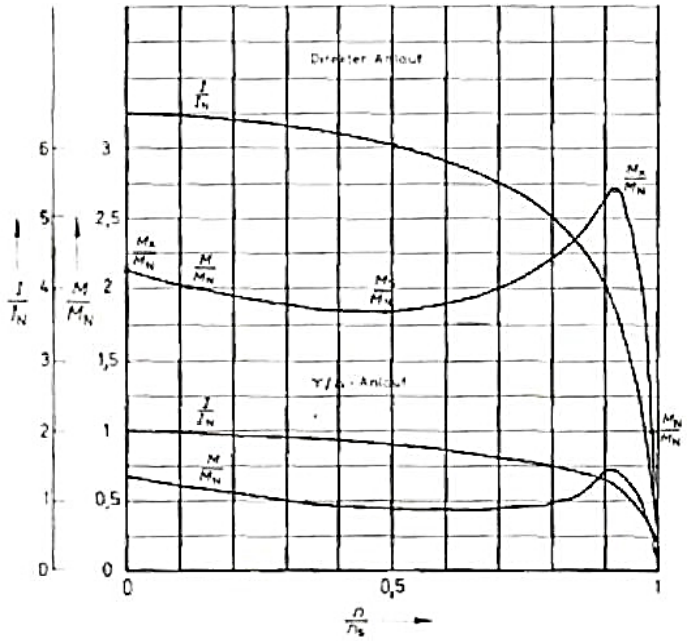
APPLICATIONS OF REACTOR STARTING
FOR ASYNCHRONOUS MOTORS

SUMMARY

Squirrel-cage asynchronous motors are commonly used in electric drive systems due to their ability to generate high current and torque during direct operation. However, these characteristics can have a negative impact on the electrical installation and the driven machinery. This highlights the need to explore potential solutions to mitigate these effects.

1. INTRODUCTION

In the field of drive systems and across various industries, squirrel-cage asynchronous motors are predominantly used, accounting for approximately 90% of cases. The reason for their widespread use is that they are the easiest to produce, most durable, provide the highest operational safety, and require the least maintenance. Below is a graph showing the current-torque-speed curves of the asynchronous motor.



Current-Torque-Speed Curve

When we examine the graph curves, we notice that the motor draws 5-6 times more current at starting, and the ratio of starting torque to nominal torque is approximately

2. MOTOR STARTING METHODS

During the motor starting process, drawing high current and providing high torque simultaneously can have several negative effects.

In summary :

- During motor starting, electrical installation components may struggle to handle the high starting current, leading to unnecessary oversized dimensioning and additional costs.
- Instantaneous voltage drops can affect other facilities.
- Motor coils can also be affected.
- During motor starting, the coupling of the machine is affected by high moment and can lead to damage, especially during rapid acceleration. Sudden changes in rotational direction can also harm the coupling.

The torque-speed curve acts like a pulley in direct drive on the diagram. The torque decreases depending on the applied voltage or the pre-reactor impedance when providing motion. It is important for the torque to stay below this curve for the driven machine. If it intersects with the belt-sensitive curve at two points, it causes oscillation in speed, leading to resonance and potential damage from excessive heat in the motor.

The following solutions are implemented to prevent the aforementioned negativity:

- The most common method for starting asynchronous squirrel cage motors is the star-delta starting method. However, this method comes with several disadvantages. One drawback is the short time interval, often in the millisecond range, during the transition from star connection to delta connection, resulting in unwanted voltage spikes. Furthermore, due to today's technology producing high switching speeds of contactors, there is a risk of short circuit even if it occurs for only milliseconds; hence requiring a special type of time relay. Additionally, when applying the star-delta starting method, two separate cables are needed to connect the motor which can lead to exceeding the cable budget especially in deep well pump applications where long motor supply cables are used. It's worth noting that while this starting method is commonly used for deep well motors in our country, it isn't frequently encountered in overseas applications.

- The soft starter device, an electronic device, incurs higher costs compared to electromechanical devices. Power electronic circuit losses occur if not bypassed, and the repair costs for power electronics are high in case of malfunction.

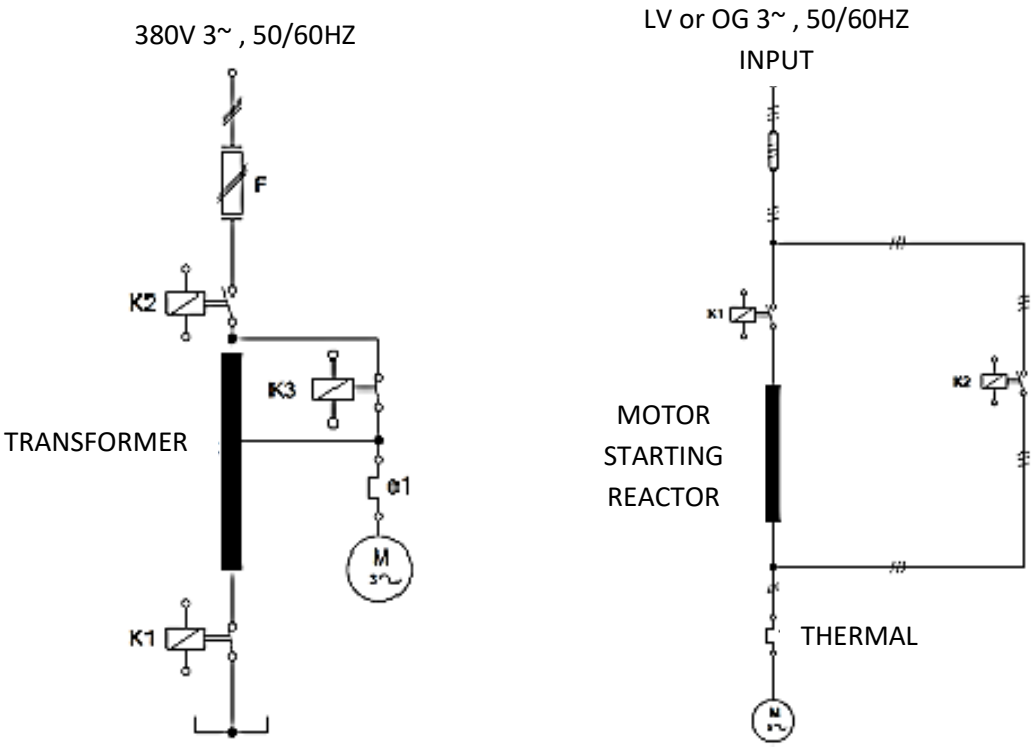
While there are advantageous applications for its use, accurate selection of those applications is crucial. Another starting method applied to asynchronous motors is using an auto transformer which has significant features when applied with a standard auto transformer and two switches. However, this results in a time interval during the transition from low voltage to nominal voltage similar to star-delta starting but offers advantages only in terms of cable installation. A special feature of the Korndorfer Scheme using the 3-switch method and starting with an auto transformer eliminates this time gap. An article by our colleague Mr. Nusret Arsel published in September 1995 provides valuable insights on this topic along with important information about the standard demand that has unique features formed with transformer and reactor winding used cases where starting conditions cannot be explained due to insufficient data for reactor calculation despite being costly.

3. MOTOR STARTING APPLICATIONS WITH SMOOTHING REACTORS

First and foremost, it is important to examine the starting moment of the machine to be driven. For instance, in centrifugal pump - deep well pump applications, the starting moments are low, making it suitable for application of the reactor method. Similarly, fan motor applications also have low starting moments but long starting times; hence the reactor method can be applied. In contrast, compressor applications typically have high starting moments and therefore all compressors come with manufacturer-produced unloaded starting arrangements (by-pass) that allow for the application of the reactor method.

A reactor is installed in the current path of an induction motor to limit the starting current. Typically, the motor's starting voltage is set at 60% to 70% of the grid voltage in practical applications. The starting time varies, with fan motors taking around 30 seconds and other applications requiring approximately 10 seconds. The impedance of this reactor is chosen based on specific application conditions as outlined above. As

it operates as an inductive resistance, there is no heat loss during the initial start-up phase. This starting method can be illustrated using the single-line diagram provided below.



When the motor starts, the C1 contactor will be energized, and as the current remains constant, the time relay will then energize the C2 contactor while de-energizing C1.

Significant cost advantages can be achieved by utilizing 2 contactors rather than 3, extending the lifespan of the C1 contactor through low current switching, and increasing the longevity of the C2 contactor by engaging it with a load of around 30%.

The motor will be connected with a single cable, rather than the use of two cables for contact connection in the star-delta application. In terms of cost, it is a highly economical option when compared to soft start using power electronics circuit. This method is suitable for effectively operating low and medium voltage motors.

One important technical detail to consider in the application is that a specific reactor value is valid for each power in the reactor method. It's not feasible to use a reactor with high power for a lower power motor; customs made production must be implemented based on the current of the relevant motor.

3. CONCLUSION

Starting LV and MV asynchronous motors with a reactor offers several significant advantages:

- It protects the facility and switchgear, ensuring a longer lifespan.
- It proves to be cost-effective.
- The use of a supply cable is a key feature.

RESOURCES:

[1] Our colleague Mr. Nusret Arsel's work published in September 1995

[2] the book "Die Prüfung Elektrischer Maschinen" by W. Nürnberg

[3] Industrie-Motoren Book by AEG–Telefunken company,

[4] Materials from Siemens Company

[5] Electric Motors by İlhami Çetin and W. Schusky