Electrification of Linear Motion

Facts and fabels about electric actuators in a modern market

MOTION ELTREX

Introduction

Linear motion plays a role in almost every machine. Think of systems that need precise movement to function properly. This motion must be controlled with the right force, speed, and accuracy. In most cases, hydraulic, pneumatic, or electromechanical drives are used. Each technology has its own advantages depending on the application.

Machine building is also changing. New electromechanical actuators are becoming increasingly powerful and precise. Energy savings, reduced maintenance, and digitalization are also becoming more important. That is why more and more engineers are choosing electric solutions instead of systems based on oil or compressed air.

In this whitepaper, we discuss why the use of electric drives in on the rise and debunk several common myths surrounding electric actuators.

Hydraulic, Pneumatic and Electromechanical Drives

When a machine requires linear motion, three main technologies are used: **hydraulic**, **pneumatic**, and **electromechanical** drives. Each of these solutions has its own characteristics and application areas.

Hydraulic systems use pressurized fluid to generate linear force through cylinders.

Advantages:

- Suitable for very high forces
- Robust in heavy industrial applications
- High power density

Pneumatic systems use compressed air to create motion via a cylinder.

Advantages:

- Simple and relatively low-cost components
- Suitable for fast movements
- Applicable in explosive environments

Electromechanical systems convert the rotation of an electric motor into linear motion.

Advantages:

- High precision and control over position and speed
- Energy-efficient due to on-demand motion
- Easy integration with modern control systems

Each technology has its own area in which it shines. In the following chapters, we explore why electrification is increasingly being considered, also in sectors and applications which have historically used pneumatic or hydraulic actuators.

Why Electrification Is Increasingly Considered

The requirements for modern machines are changing. Energy consumption, maintenance, flexibility, and integration with automation are playing an increasingly important role in the design of new installations. As a result, more machine builders and engineers are considering electromechanical drives as an alternative to systems that rely on oil or compressed air. In many applications, electrification offers advantages in efficiency, control, and maintenance.

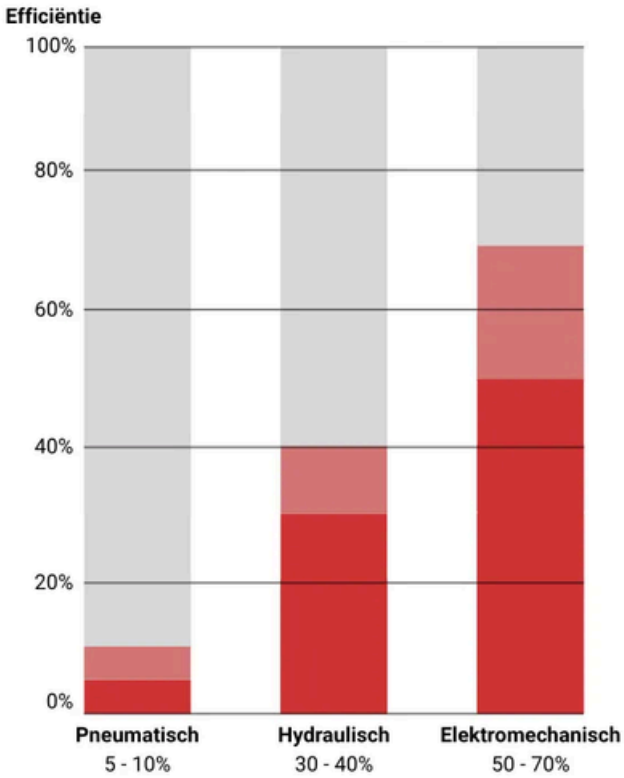
Precision and Control

In many modern machines, precise control of the motion profile is essential. This includes positioning, synchronizing movements, or adjusting speed during a process. Electromechanical actuators can accurately control position, speed, and force.

By using feedback systems and servo or stepper motors, the motion profile can be precisely tailored to the application. This allows for better process control and consistent repeatability of movements.

Energy Efficiency

Another key reason to consider electrification is energy consumption. In pneumatic and hydraulic systems, a large portion of the energy is lost during the generation and transmission of pressure (as seen in the graph). Electromechanical actuators, on the other hand, only use energy when motion is required. As a result, energy consumption can be significantly lower, which makes a substantial difference in operational costs.



Integratie met automatisering

Modern machines are increasingly part of an automated production chain. Therefore, actuators must not only but also communicate clearly and reliably with the control system. Electromechanical actuators offer an advantage in this regard: thanks to integrated sensors and electronics, they provide direct feedback on position, speed, force, and load. This data enables accurate control, process optimization, and predictive maintenance.

In addition, electric actuators can be easily connected to PLC control systems via industrial protocols such as CANopen, EtherCAT, or IO-Link. This allows settings to be managed centrally, status information to be read in real time, and motion profiles to be adjusted flexibly. As a result, actuators function not only as mechanical components, but as intelligent elements within the overall automation architecture.

Common Fabels

Electromechanical systems have developed significantly in recent years. As a result, they can serve as an alternative in an increasing number of applications that used to only operate using oil or compressed air. However, there are still various misconceptions about what is technically possible.

Fabel 1 – Electric actuators are not suitable for harsh environments

Fact: *Modern electromechanical actuators combine high performance with robust constructions, making them a reliable alternative to hydraulics in harsh environments.*

At the same time, the technology of electric actuators has developed rapidly. An important step in this development is the elimination of traditional wiring between the actuator and the motor controller. Instead, the connector is directly molded into the housing, allowing the control cable to be connected easily and safely.

This approach not only provides better sealing against moisture, dust, and dirt, but also protects the motor connection from mechanical damage. Thanks to these improvements, electric linear actuators specifically designed for off-highway applications are now just as robust and reliable as hydraulic actuators.

Fabel 2 – Electric actuators are more expensive

Fact: *Due to lower energy consumption and reduced maintenance, electromechanical actuators can actually lead to lower operational costs and a more favorable total cost of ownership in many applications.*

At first glance, an electric actuator often appears more expensive. As a result, it is sometimes assumed that an electric solution automatically costs more. However, when comparing drive systems, the focus is often only on the price of a single component, such as a cylinder or actuator. In practice, other factors also play a role, such as energy consumption and maintenance.

Hydraulic systems, for example, consume energy to build and maintain pressure, whereas electric actuators only use energy when motion is required. In addition, maintenance activities, such as replacing oil or detecting leaks, can affect the operational costs of a system.

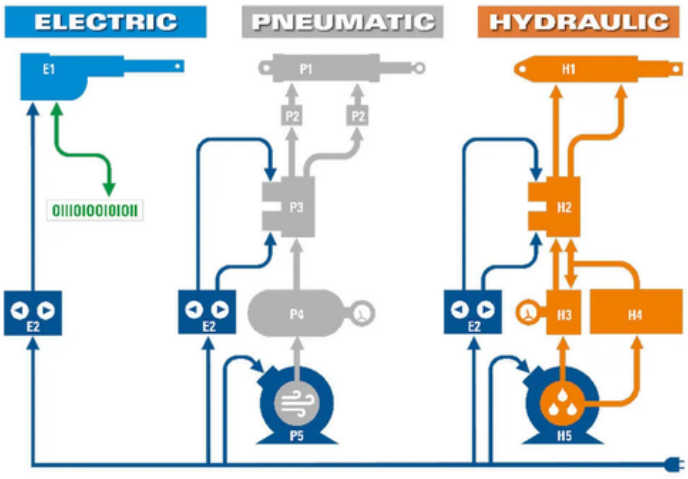
When these factors are taken into account, an electromechanical solution can be economically attractive in many applications over the full lifetime of the machine.

Fabel 3 – Electric actuators are less reliable

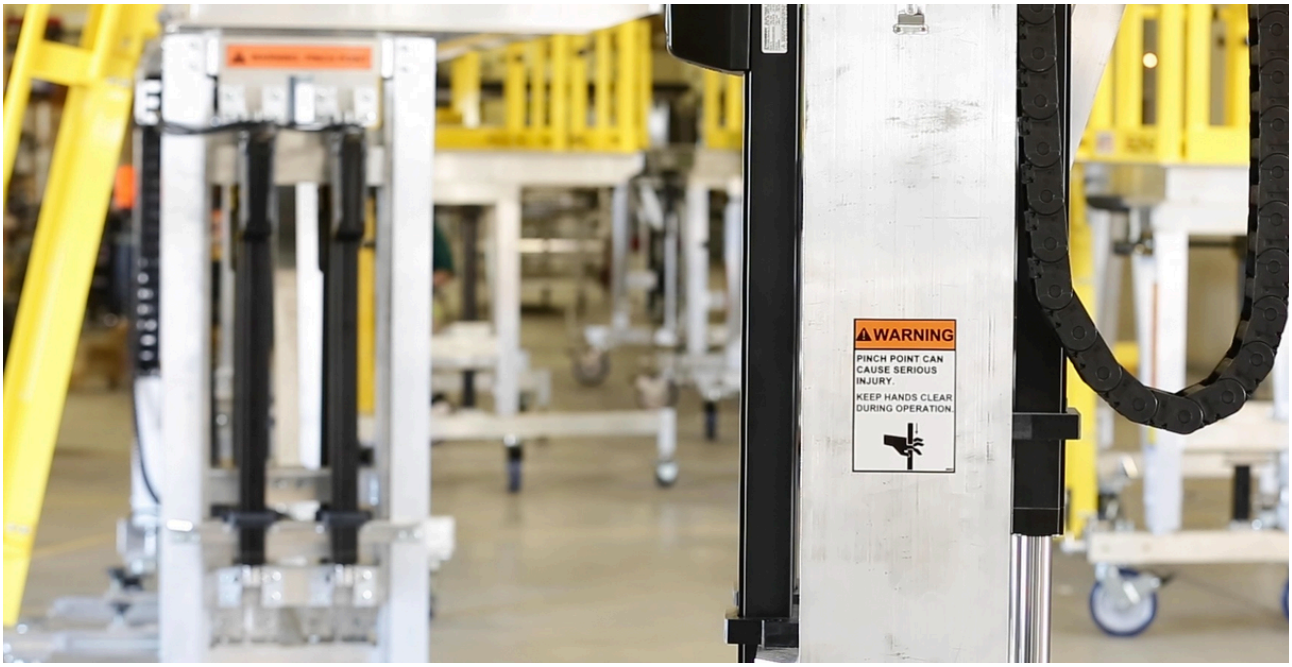
Fact: *Thanks to their integrated design and diagnostic capabilities, electromechanical actuators offer a maintenance-friendly and reliable solution for modern machines.*

A commonly heard assumption is that hydraulic and pneumatic systems are more reliable. This perception partly stems from experiences with older generations of electric actuators. However, modern actuators benefit from the strong development of electronic components and electric motors, which has significantly improved their reliability.

An important factor in this is system complexity. A hydraulic or pneumatic system consists of many separate components, including pumps, valves, hoses, and seals. Each of these components can be a potential source of failure.



Electromechanical actuators typically consist of a limited number of components, resulting in fewer points where failures can occur. In addition, electric actuators often operate independently of each other. Each axis of motion has its own motor. As a result, a failure in one actuator usually has no direct impact on other axes in the machine.



Conclusion

Hydraulic, pneumatic, and electromechanical drives each have their own place in machine building. The most suitable technology always depends on the application and the requirements placed on the motion profile.

At the same time, the technology of electromechanical actuators has developed significantly in recent years. As a result, they can now be applied in many more applications than before. It is therefore important not to automatically rely on existing assumptions or previous experiences as a starting point. What was not possible in the past can, with modern technology, in some cases provide a more efficient, cleaner, or better controllable solution.

Did we get you thinking about electrification?

Are you considering electrification, or would you like to explore the available options for your machine? Our specialists are happy to help you explore the possibilities and assess whether an electromechanical solution is suitable for your application.

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