Background, improvement, upgrade

In most steam turbines hydraulic actuators are used for operation of the steam control and emergency stop valves. Hydraulic actuators normally work without bigger problems. But in some applications we experience operational problems which are related to the design of the actuators:

- Oil leakage problems, especially if servo motor is located below oil tank level, and oil leakages due to axial forces on servo motor piston rods and subsequently worn out sealings
- Short period malfunction of electro hydraulic converters due to heat, or sticking due to debris in oil.
- Oil system flow capacity too small for fast control valve actions
- Contaminated ambience, for example sand in desert regions
- Problems with hydraulic devices like pilot relays, which are sticking or leaking, and there is a permanent
- Risk of fire in case of a control oil leakage at the hot turbine front end

To overcome the problems, which are mainly caused by the use of oil as medium for the power transmission, an electro mechanical actuator was developed, applicable for control valve drives. A drive for emergency stop valves is in development, so that in the near future all hydraulic drives at a turbine can be eliminated. This is also a step towards the oil free turbine.
**Design**

This servo motor is an intelligent and compact electromechanical unit, consisting of:
- Synchronous electro motor,
- Magnetic coupling,
- Belt drive,
- Circulating ball spindle,
- Return spring,
- Position sensor,
- And the piston rod.

The connection to the valve guide is identical to the connection of a hydraulic servo motor, so that the servos can be exchanged one by one. The valve coupling is a different design due to the different actuator piston rod.

![Diagram](image)

*Electro mechanic drive with control device and position control*

1. Belt gear
2. Magnetic coupling
3. Synchronous motor
4. Resolver
5. Control device
6. Circulating ball spindle
7. Return spring
8. Position sensor
9. Piston rod

In this drawing we can see the function of the electro mechanical actuator.

- The synchronous motor is connected to the belt gear by an electro-magnetic coupling.
- The belt gear drives.
- A circulating ball spindle.
- The ball spindle is connected to the piston rod, which drives the steam control valves.
- The return spring ensures that the piston rod returns to the safe position in case a trip or EMA failure.
- A position sensor and a resolver are installed to indicate the actual position and to give a signal for the integrated position control.

The electronic control device performs the following tasks:
- Frequency converter to feed the synchronous motor.
- Position control with feedback.
- Supervision of motor current and correct position.
- Alarming of non-optimal conditions.

The electro mechanical actuator (EMA) works oil free and has the same valve stroke, force moment and closing speed as the hydraulic valve drive.

**Application**

As the force of an electro mechanical actuator is limited due to the space available, the application is restricted to sliding valves, single seat valves like AEG or BBC group valves, adaptive stages and smaller multiple seat valves like the TUG or TUW valve bar design.

In principle the electro mechanical actuator can be used for all valve drives with small or medium operating and holding forces.

3 different sizes cover the whole range from smaller sliding valve drives to bigger valve bar designs with high operating forces.

![Diagram](image)

*Typical application for a valve bar design control valve*

Typical stroke is 70 to 210 millimeters, with an actuation force of 10 to 30 kilo Newton.

![Diagram](image)

*Typical application for a sliding control valve with two valve spindles*

Typical stroke in this application is 75 millimeters, with an actuation force of maximum 20 kilo Newton.
Service

The EMA is designed for up to seven years continuous operation.

Only a lubrication of the ball spindle is recommended every 2 to 3 years, which can be performed during operation.

The lifetime of the ceramic coated ball spindle is minimum 10 years.

Parts like motor, gear or coupling can easily be exchanged, also a complete spare drive can easily be installed. After setting of the stroke and the position sensor the drive can be taken in operation.

Advantages:

Technical benefits:

- Leakage problems are avoided
- No hydraulic piping in front of the turbine for hydraulic control valves is required, so there is less danger for fire caused by oil leakages.
- A direct electric signal is used for the desired valve position, so there is no conversion from electronic signal to hydraulic signal by a electro hydraulic device, which may become defective due to debris in oil or heat.
- Compared to the mechanical feedback of older hydraulic drives the EMA has a real position control and indication.
- The motor current can be take as a stroke force measurement, and can be used for preventive observance, for example a sticking valve packing.
- Sometimes the oil flow capacity is too low for faster valve actions. With an EMA this problem can be overcome without modification of the oil system.
- The oil system needs less power, as only approximately 4 bars oil pressure after pumps are needed for lubrication instead of 8 to 10 bars.
- The 2 out of 3 safety block is not needed, as the 2 out of 3 selection can be done electrically. This is valid if an electro mechanic actuator is used for the operation of the emergency stop valve.

Another advantage is the lower cost, as

- no expensive noninflammable hydraulic fluids are needed and also the
- insurance rate may be lower due to the reduced risk of fire.

Also the maintenance effort is lower, as there is

- no overhaul on hydraulic control and safety devices like servo motors, transducers, position feedback relays and control oil filters necessary.
- less wear and tear and following less maintenance on oil pumps, as they can be operated on a lower oil pressure.
- reduced cleaning efforts on oil piping and oil tank.
- experts are easier available: customers often have electric experts, but no hydraulic experts

Last but not least the availability is higher, due to

- reduced risk of fire at the turbine, as there is no more control oil piping at the hot turbine front area,
- and no servo valve or servo amplifier blocking due to dirt in oil.