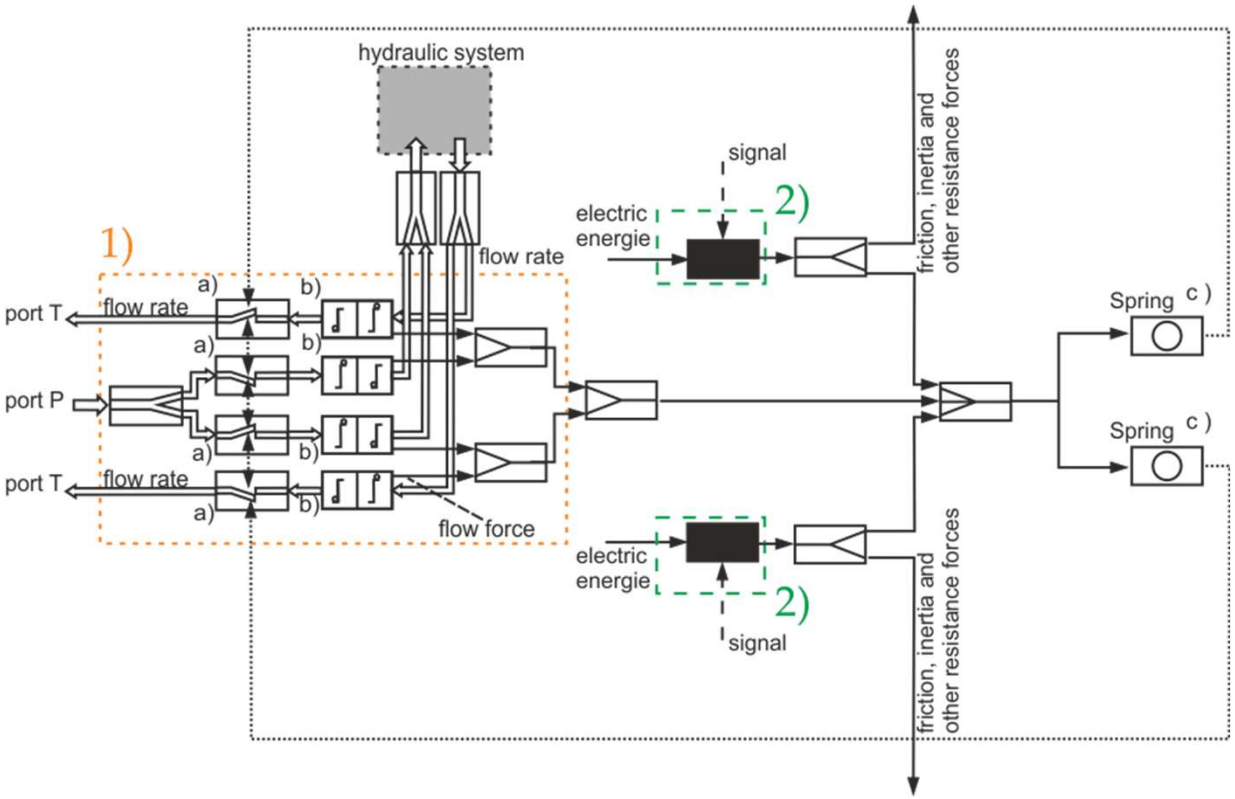
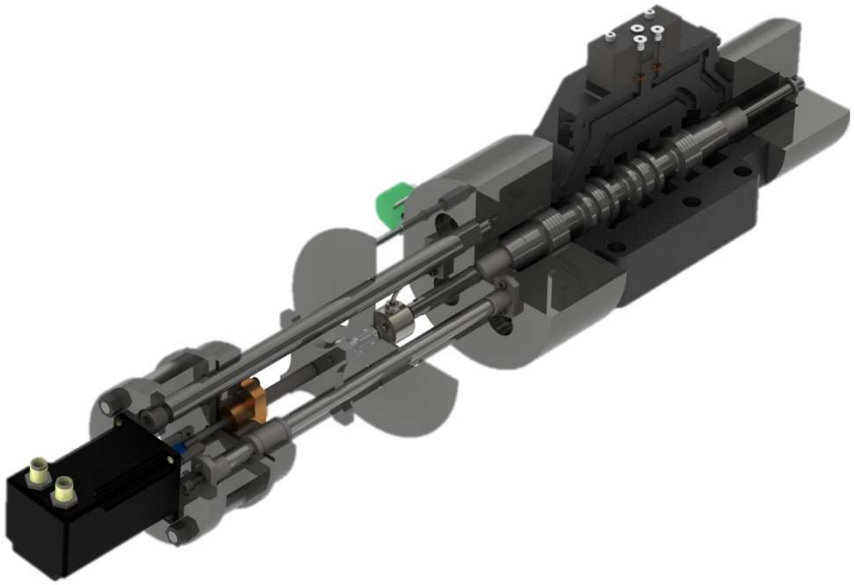




Design of electromechanical actuators for large sized valves

ifas Institute for Fluid Power Drives and Systems | RWTH AACHEN UNIVERSITY

Agenda

1. Main function of hydraulic control valves
2. Functional structure of hydraulic control valve
3. Electromechanical valve actuator design
4. Extended functional structure of hydraulic control valve
5. Conclusion

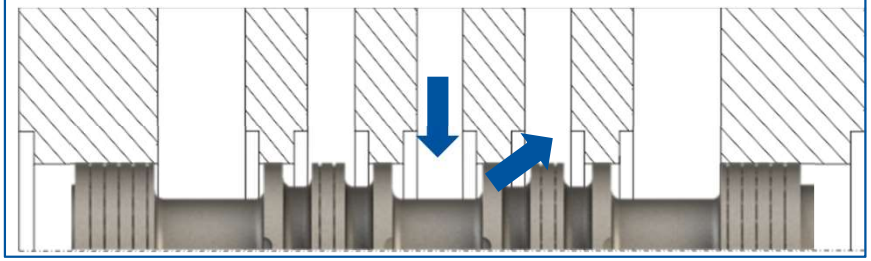
Agenda

Main function of hydraulic control valves

Main function

- Opening/Closing of different flow paths [1] according to an electric control signal

Conduction of hydraulic energy according to the position



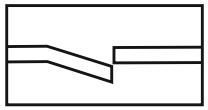
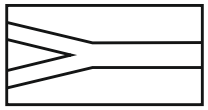
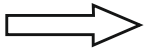
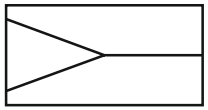
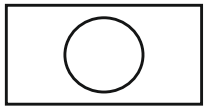
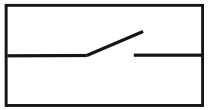
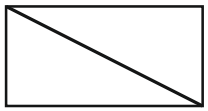
Positioning of the spool according to an electric signal

- Position is controlled by a force
- Directional control valves
  - Force applied/not applied
- Applying force at the spool according to an electric signal

Agenda

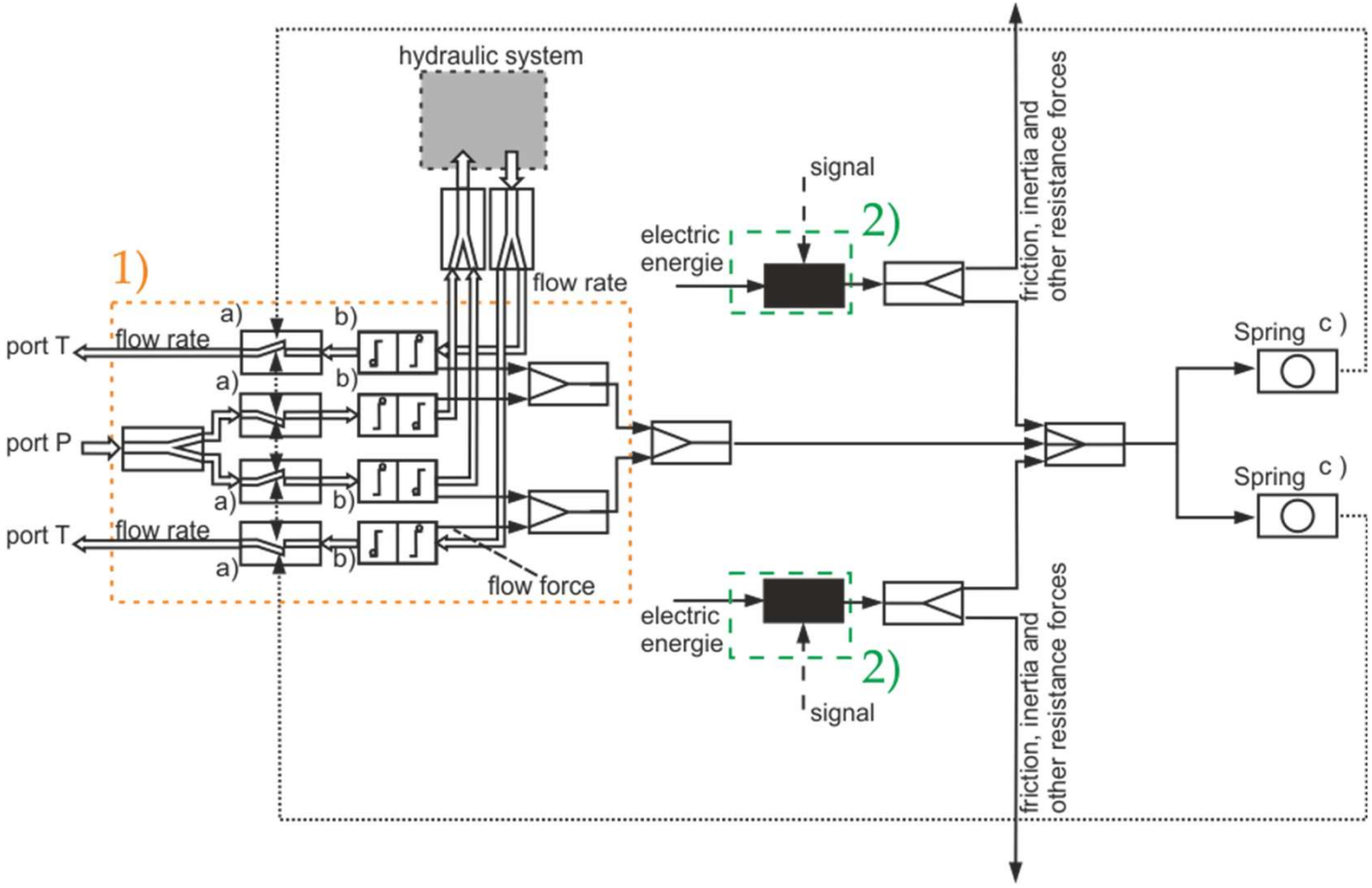
1. Main function of hydraulic control valves
2. Functional structure of hydraulic control valve
3. Electromechanical valve actuator design
4. Extended functional structure of hydraulic control valve
5. Conclusion

Symbols of functional structure

	separate/connect material flow		energy flow
	link/divide material flow		material flow
	reduce/increase energy of material flow		information flow
	link/divide energy flow		store energy
	separate/connect energy flow		subsystem
	convert energy flow		not further specified hydraulic system

[2],[3],[4]

Functional structure of hydraulic control valve

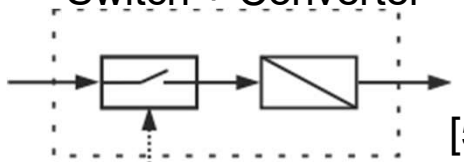


Subsystem 1)

- Conduct flow rate by the geometry

Subsystem 2)

- Switch + Converter



[5]

Agenda

Electromechanical valve actuator

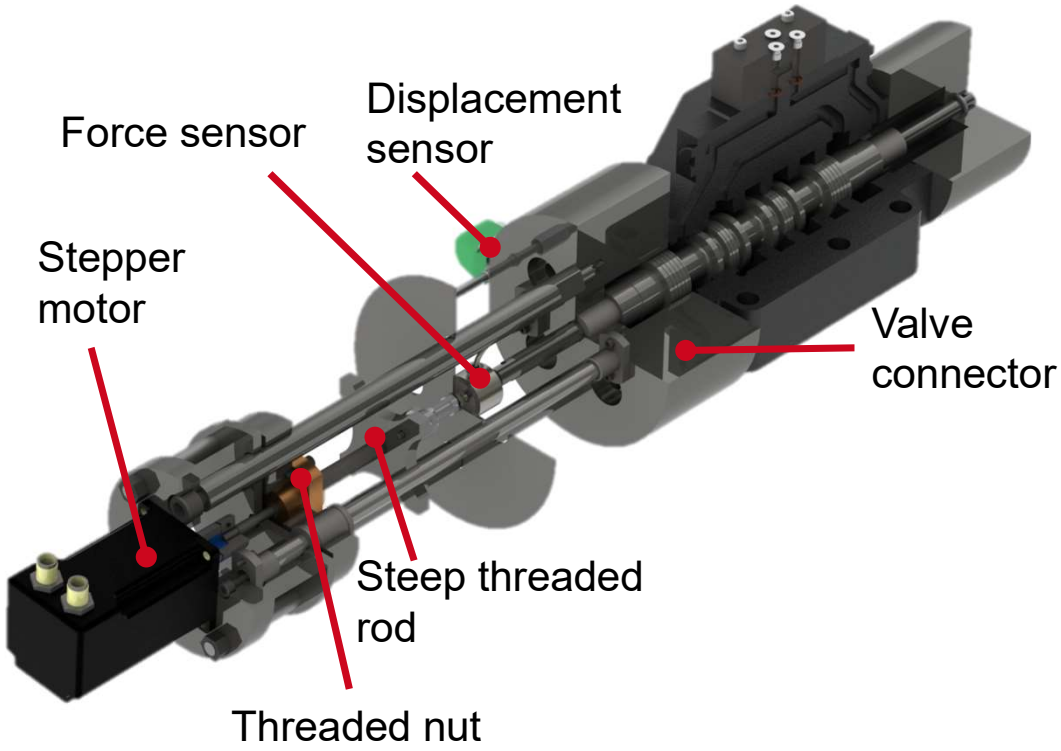
Design process

- Evaluation of different electrical converter
  - Electric motor
- Mechanical converter is necessary
  - Steep threaded rod
  - No energy conversion → not illustrated in functional structure

General conditions

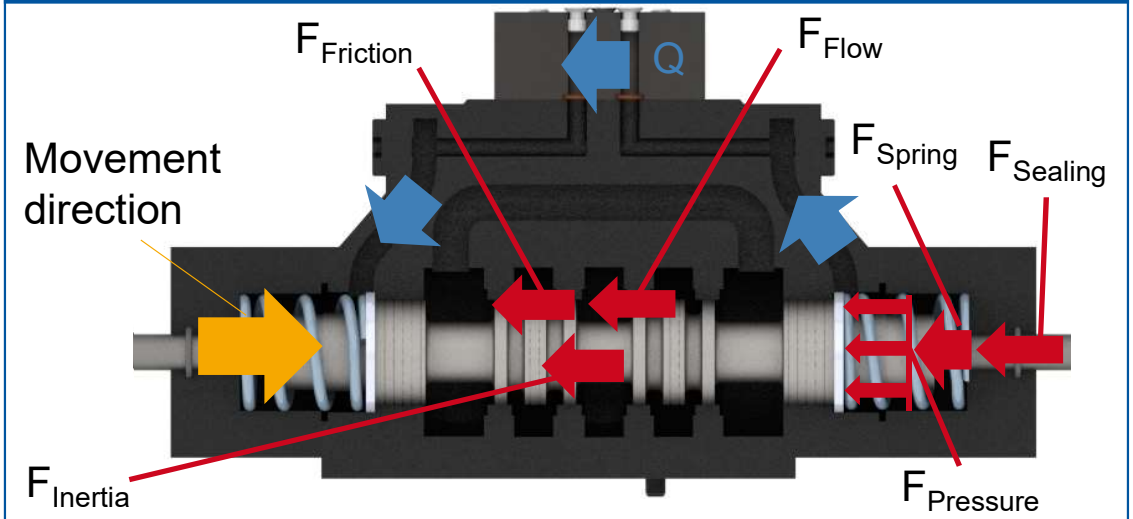
- Designed for large sized directional control valves
  - Nominal size 25
- Externally attached
- Definition of force requirements based on common pilot operated hydraulic valve

Sectional view



Forces at direct electromechanical actuated valves

Acting forces



[6]

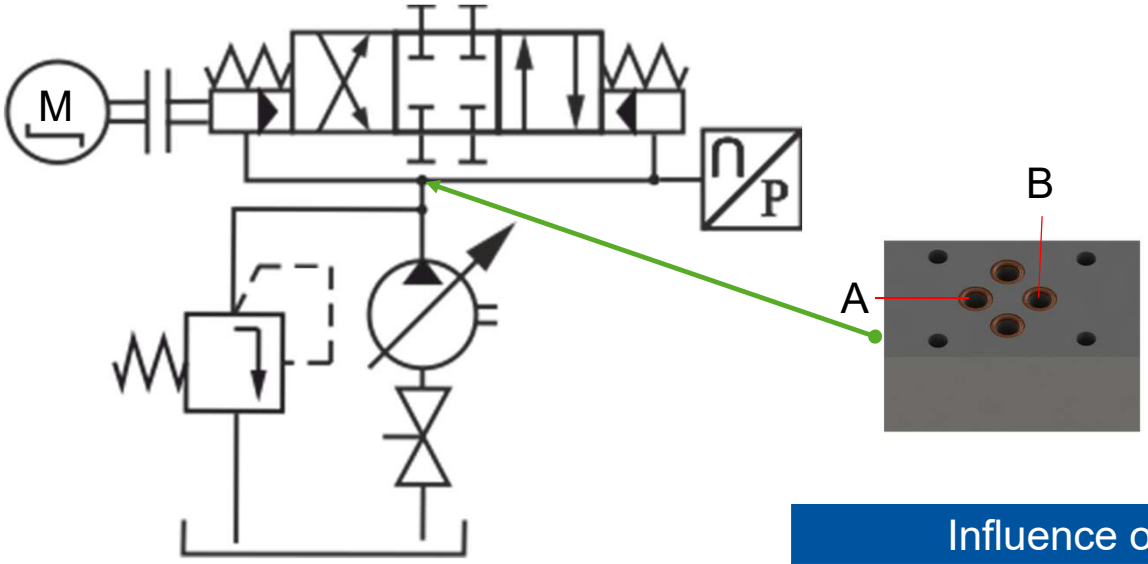
Additional sealing

- Actuator force is transmitted mechanical to spool
  - Additional sealing
    - External leakage
  - Friction force $F_{Sealing} = f(p)$

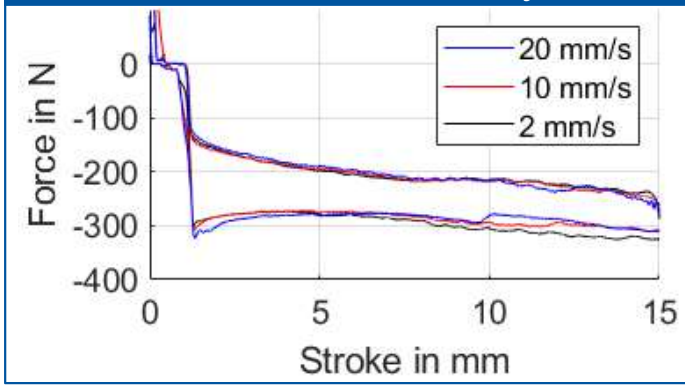
Adapter plate

- Adapter plate attached instead of pilot valve
  - Short circuiting of both pilot chambers
  - Constant volume
- Reduced resistance force
  - No pressure rise in the pilot chambers
    - $F_{pressure}$ nearly negligible

Measurements of effects in pilot chambers



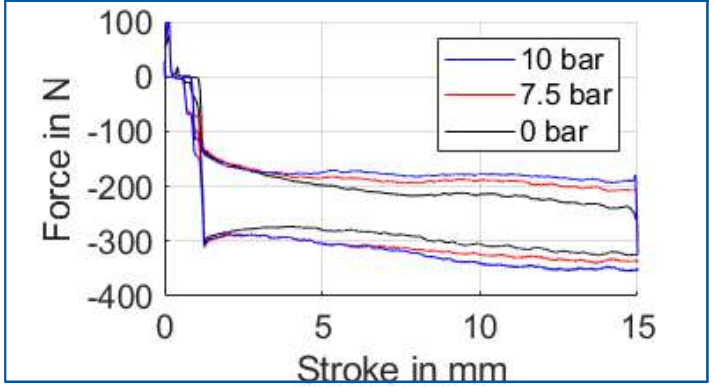
Influence of velocity



System

- All ports closed
- Adapter plate attached
- Measuring port in adapter plate pressurized
- Pressure and velocity varied

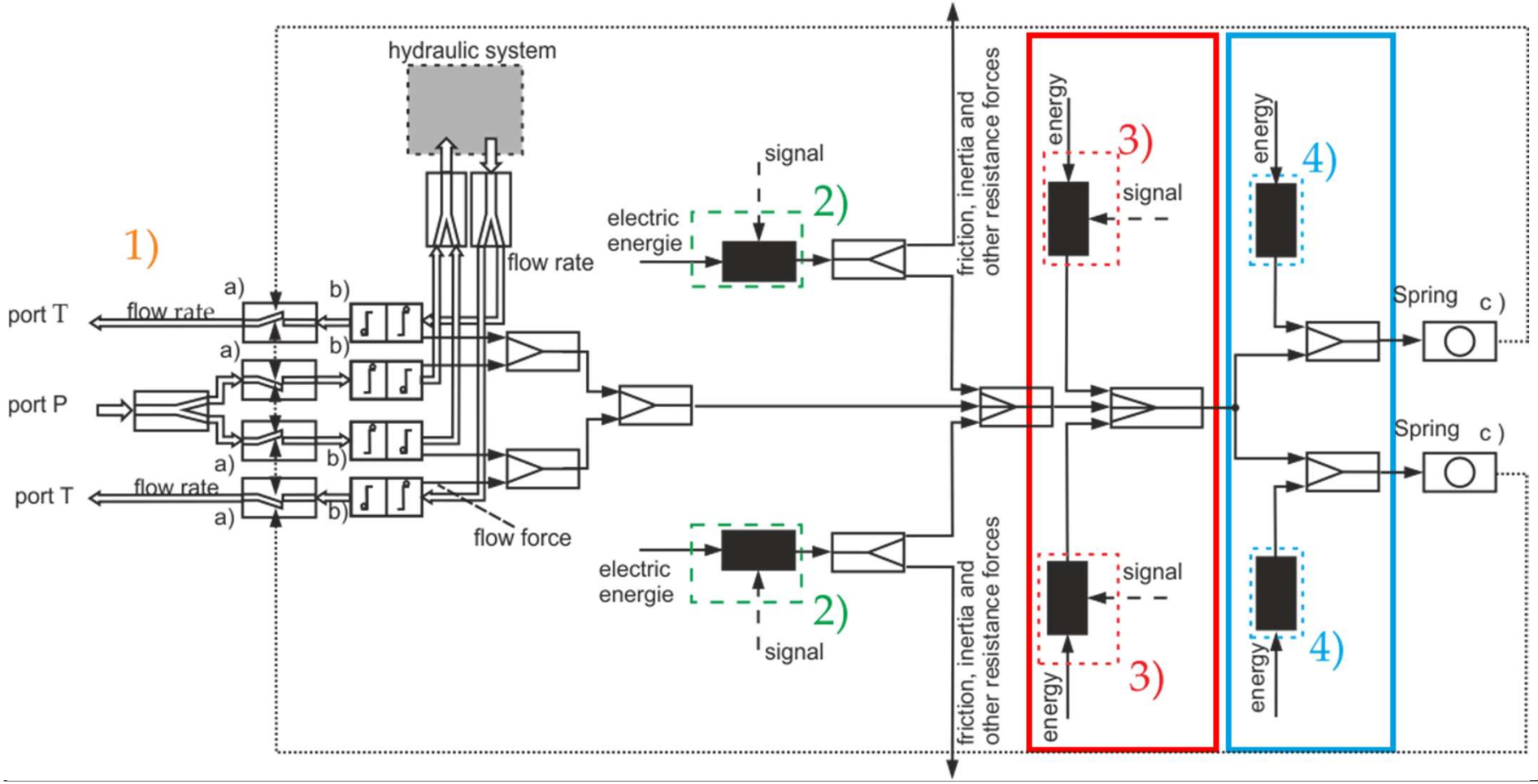
Influence of pressure



Agenda

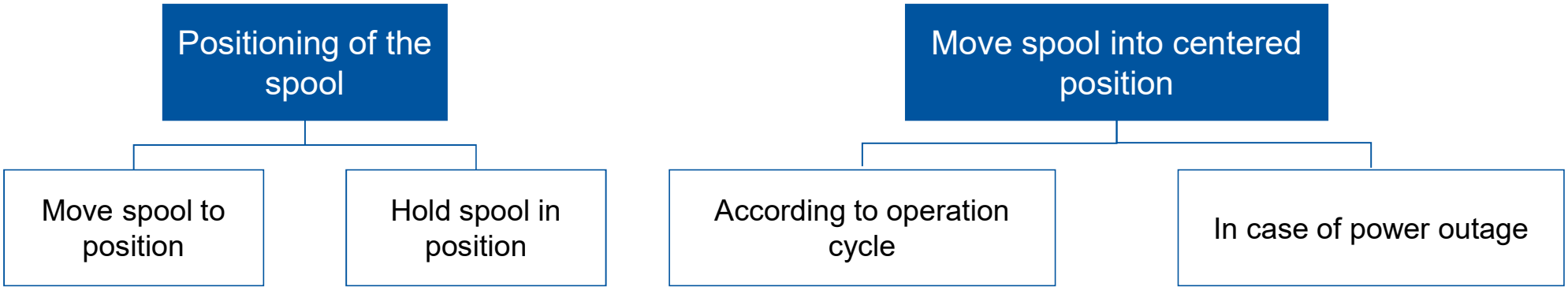
1. Main function of hydraulic control valves
2. Functional structure of hydraulic control valve
3. Electromechanical valve actuator design
4. Extended functional structure of hydraulic control valve
5. Conclusion

Extended functional structure of hydraulic control valves



ifas Institute for Fluid Power Drives and Systems
RWTH AACHEN UNIVERSITY

Innovative valve actuation systems



Separation and redistribution

- Peak operation of main actuator
- Hold spool in position by second actuator
- Reduces requirements
  - Clamping
  - Orthogonal movement direction

Separation and redistribution

- Active centering
- No centering in case of power outage
  - Mechanical storages (springs)
- Preload springs
  - Additional actuator is necessary
- Holding of preloaded springs
  - Small necessary strokes

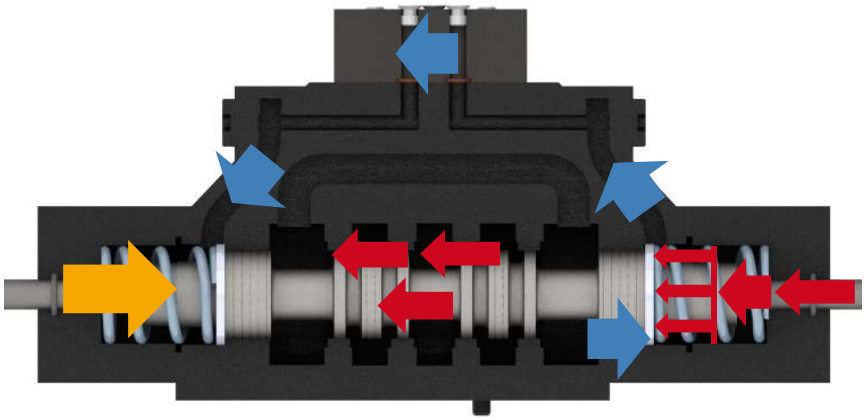
Agenda

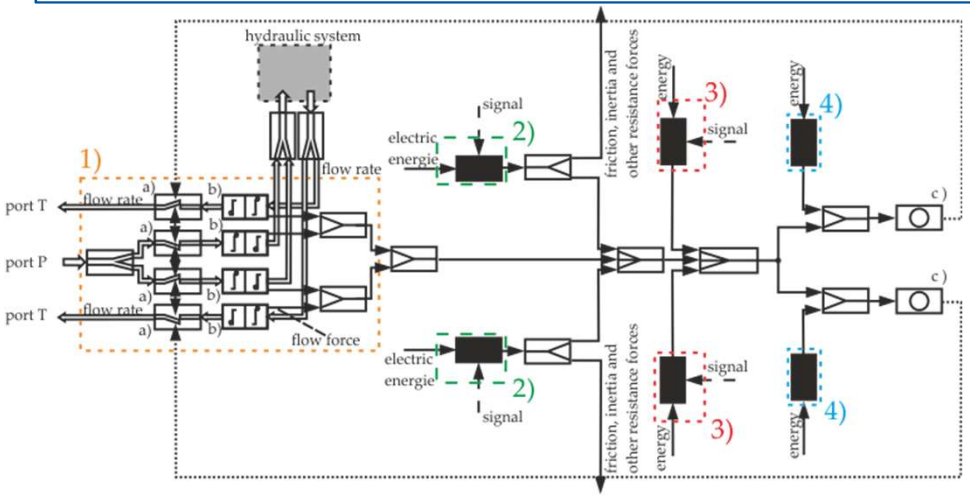
1. Main function of hydraulic control valves
2. Functional structure of hydraulic control valve
3. Electromechanical valve actuator design
4. Extended functional structure of hydraulic control valve
5. Conclusion

Conclusion

Electromechanical actuator design

- Investigation of presented actuator
- Externally attached
  - Effects by additional sealing
  - Pressure in pilot chamber need to be avoided
    - Adapter plate





Functional structure

- Expansion lead to innovative actuators
  - Combination
  - Reduction of requirements
- Proposed solution
  - Preload springs

Thank your for your attention

Contact

Tobias Vonderbank,M.Sc.
Academic staff

e-Mail: tobias.vonderbank @ifas.rwth-aachen.de
Phone.: +49 241 80 47722

References

[1] W. Backé and W. Hahmann, *Grundlagen der Ölhydraulik: Umdr. zur Vorlesung*: Institut für hydraulische und pneumatische Antriebe und Steuerungen der RWTH (IFAS), 1974

[2] Konstruktionsmethodik, 2222. 1997

[3] J. Feldhusen and K.-H. Grote, Eds., *Pahl/Beitz Konstruktionslehre: Methoden und Anwendung erfolgreicher Produktentwicklung,* 8th ed. Berlin, Heidelberg: Springer-Verlag GmbH, 2013

[4] R. Koller and N. Kastrup, *Prinziplösungen zur Konstruktion technischer Produkte*: Springer-Verlag GmbH, 2013

[5] H. Janocha, *Unkonventionelle Aktoren: Eine Einführung*. München: Oldenbourg Wissenschaftsverlag GmbH, 2010.

[6] K. Schrank and H. Murrenhoff, “Beschreibung der Strömungskraft in Längsschieberventilen mittel Impulserhaltung,” O+P Journal, no. 4, pp. 4–15, 2013.