How the electrification will impact the Fluid power business?

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Introduction

Hydraulics : most important technologies in off-road machines
(in lifting applications or very high power requirements…)

Electrification: a trend in recent years **(tools and mobility function)**

Combination of hydraulics and electricity ➔ Electrohydraulic :

- Greater precision and dynamics
- Compactness
- Energy efficiency and confort in use
- Simplicity and flexibility




Challenges

Sustainable development (all concerned by the migration towards the electrification of vehicles/transport)

- Support the technological disruption linked to the reduction of energy consumption, which has a strong impact on the technological building blocks used in power transmission
- Strong regulatory and normative constraints on the use of fossil fuels
- Identify new solutions for the reduction and acceptability of noise in electricity

Industry of the future

- Take up the challenge of **modelling** by developing hybrid simulation (Model Base Design) and test methods for system design processes
- Develop experimental methods generating physical data and quantities upstream of the IOT value chain

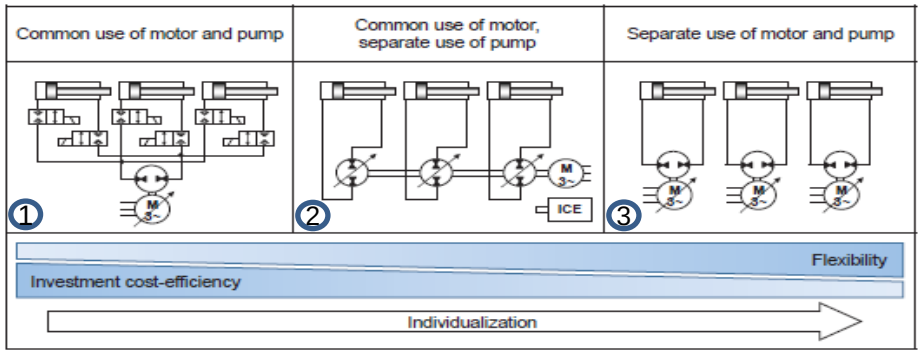
Principle of electrohydraulics

Individualisation of power sources

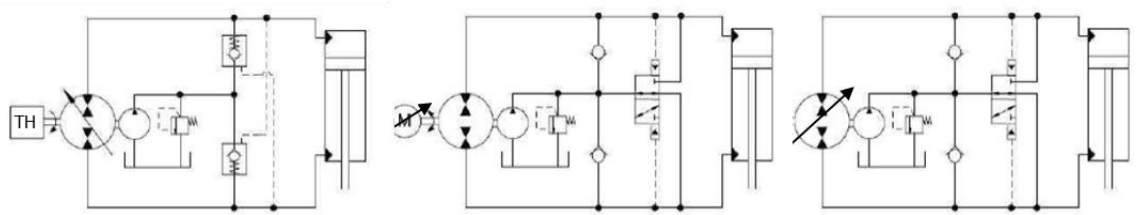
- Conventional versus individualised architecture

$$P_{installed} = max_t((\sum_n Q_n) * (\max P_n + P_{LS}))$$ versus $$P_{installed} = \sum_n (\max P_n * \max Q_n)$$

- Pumps Individualisation: 3 architectures



- Control by variable pump



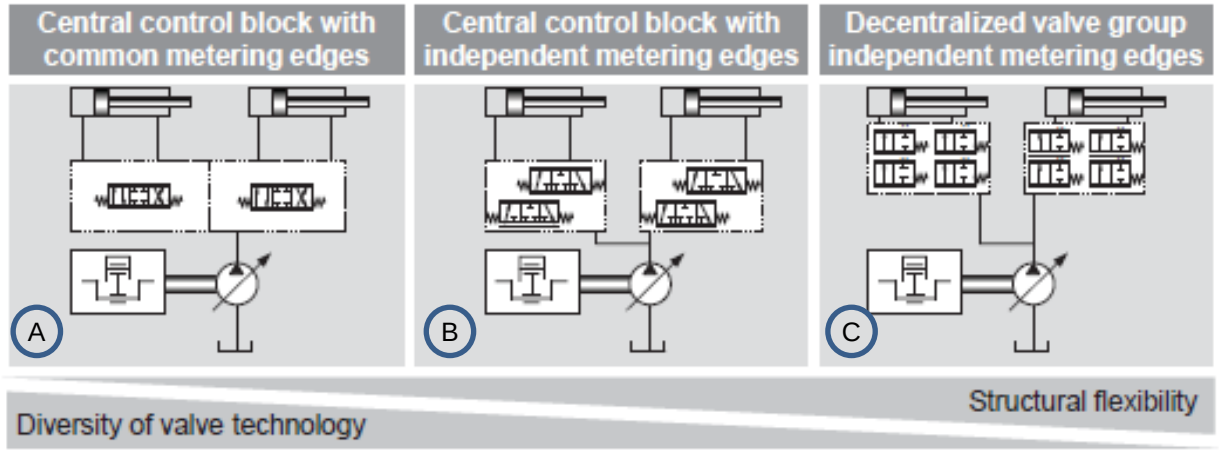
Advantages of using several variable pumps:

- Limitation of losses due to load sensing
- Improved efficiency by optimising the operating point
- Energy savings (e.g. ~20% for the HydroGear system)
- Improvement of the flow rate rise time while lowering the maximum speed

Source : IFK 10

Principle of electrohydraulics

Individualisation of the distribution components



Advantages :

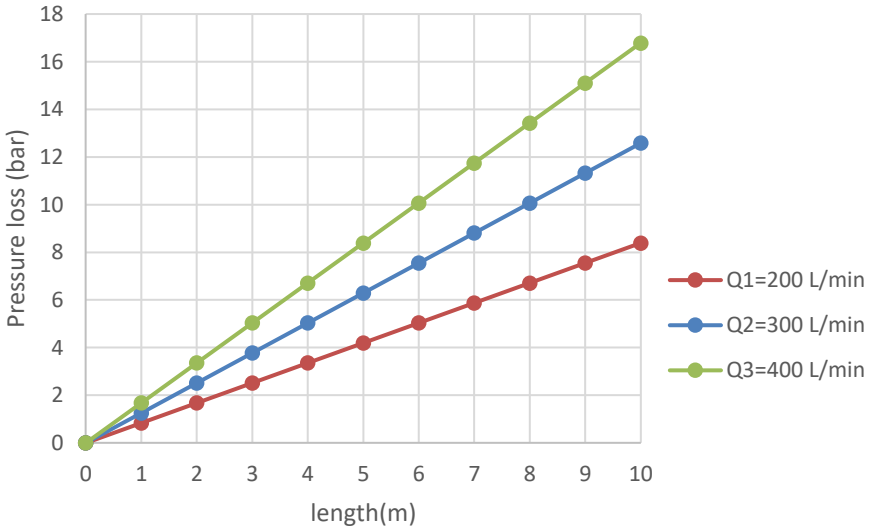
- Increase in the number of valves
  - Separation of actuators
  - Independent control of input and output
  - Optimisation of control
  - Energy-saving operation (recovery)
- Simplification of valve technology
  - Use of 2/2-way valves
  - Standardisation of technology
  - Flexible system configuration (decentralised layout)

Source distributions

Principle of electrohydraulics

Decentralisation

- Definition:
  - Decentralisation requires individualisation (the reverse is not true)
  - Moving sources closer to applications
- Impacts:
  - Reduction of pipe length
  - Impact on pressure losses
    - Regular: less length
    - Singular: fewer fittings
  - Impact on size
    - Diameter reduction possible but not necessarily very significant
  - Thermal behavior need to be check



Evolution of regular pressure loss in laminar flow as a function of length

Principle of electrohydraulics

Conclusion on Individualisation and decentralisation

- Energy saving
  - Reduction of pressure losses
  - Working at the best efficiency point (motor and pump)
  - Energy recovery
  - System optimisation for each function
- Obstacles
  - Cost
  - Integration effort
  - Potentially higher installed power
  - Larger total mass

Concurrence of hydraulic components

- Linear actuators
  - Hydraulic solutions → Industry and off-road machine
  - Electrical solutions → For positioning use and small effort
  - Electrohydraulic solutions : EHA → Aero and new generation of electrohydraulic off-road machine
  - Pneumatic solution → Industry and very high speed process
- Rotation actuators
  - Hydraulic motor (open circuit, closed circuit)
  - Electrical motor + reducer or e-Axle
- Noise aspects
  - Closely Linked to speed of hydraulic components
  - 3 main sources of noise on electrical component : mechanical (bearings, gear…), aerodynamic (ventilation, turbulence…), magnetic noise

Current R&D project and further work

Implementation in a real case study

2. Impact on high speed

Component Migration
Noise/Vibration
Lubrification

3. Electrification of a machine

Efficacity
Cost
Integration
Noise/Vibration
CEM
System

Conception
Validation
Noise/Vibration
Composant

1. Electrical power source

Current R&D project and further work

Problems arising from the "real world" :

- Point of vigilance on the total electrification of functions (brakes, brake holding, heating, dimensioning, mechanical integration, energy, etc.).
  - Power compromises:
    - Power and speed ranges to be adapted
    - Use of a variable speed drive
      - » Allows the speed of the electric motor to be adapted to that of the hydraulic pump
      - » Check the reversibility requirement of the application (Define the drive architecture)
  - Evolution of the voltage levels
    - Possibility of using 48V and/or 700V (DC)
  - Cooling system
    - Liquid cooling & possibility to individualise the cooling (Allows deportation)
  - Autonomy and energy recovery
    - Combination of electric and hydraulic : Better regeneration capacity
- Problems encountered, either by removing hydraulics or adding electricity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