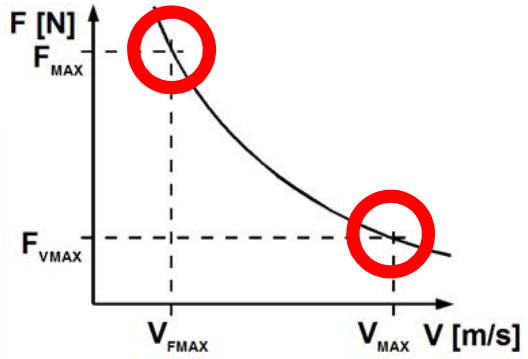
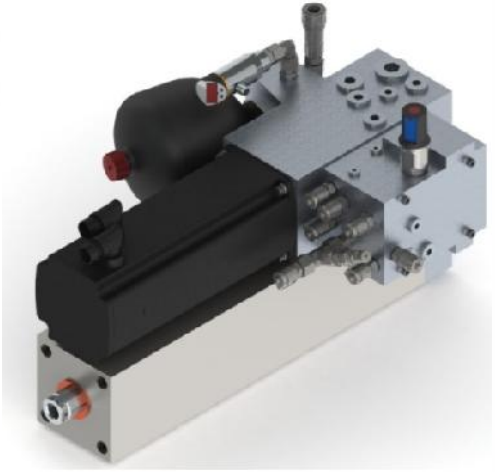
On Adaptive Electrohydrostatic Actuators

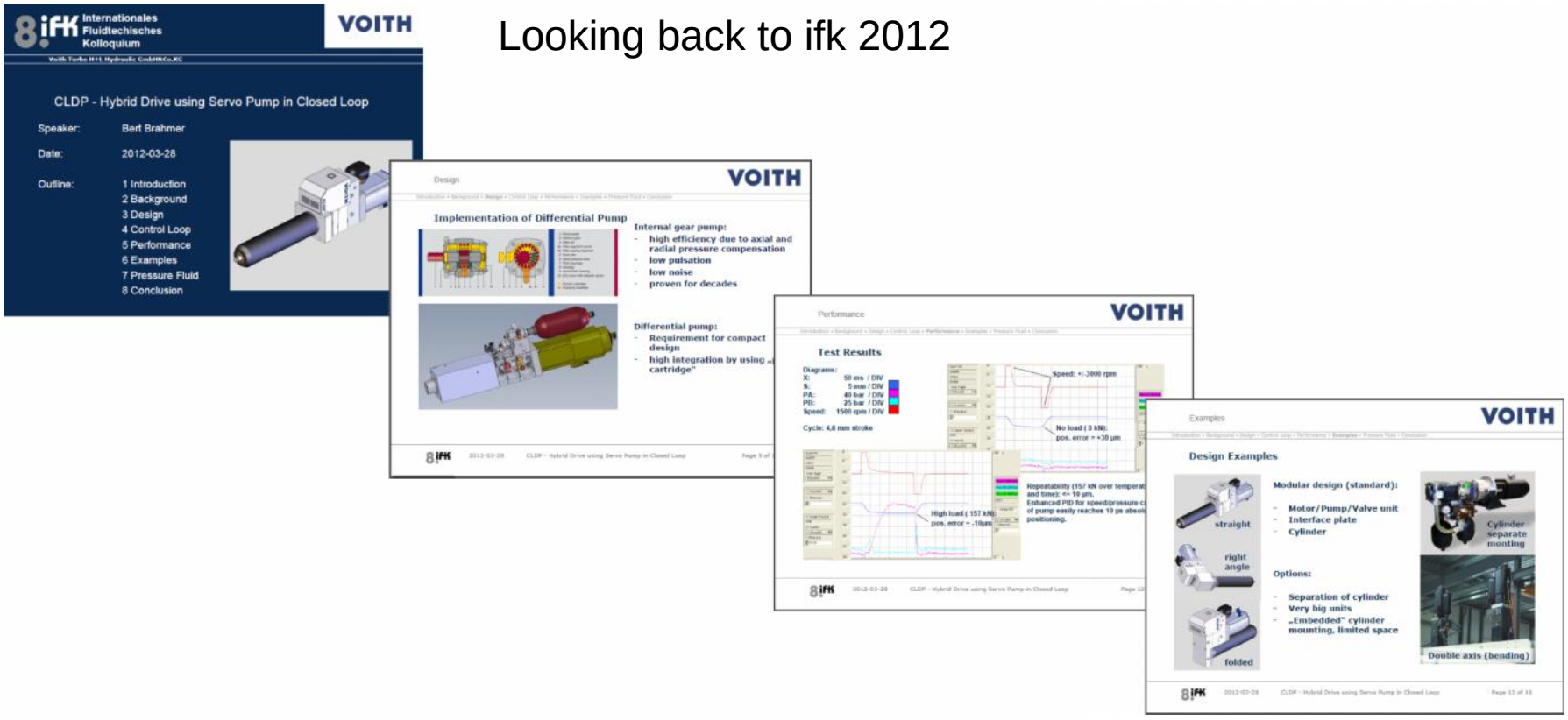
Brahmer, Bert





1. EHA - Introduction

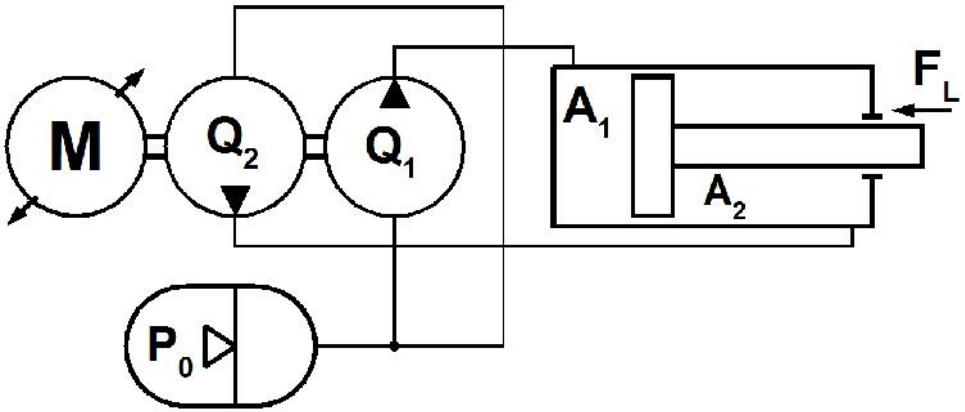
Time Machine



Looking back to ifk 2012

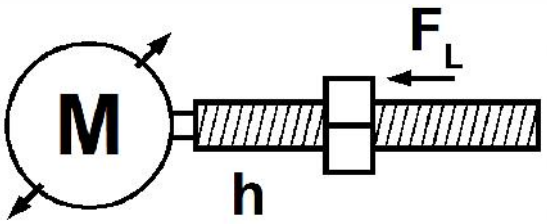
Operating principle of EHA

Differential cylinder and “differential” pump



$$h_{EHA} = \frac{Q_1}{A_1} = \frac{Q_2}{A_2}$$

Spindle drive



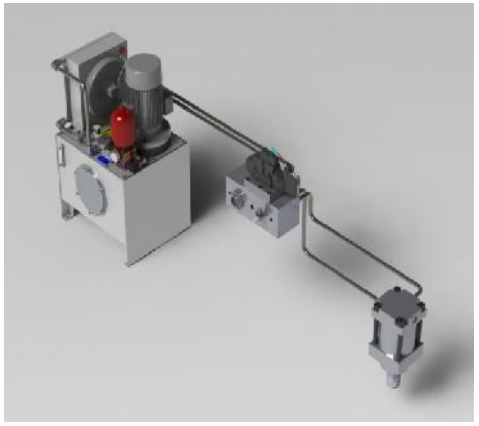
$$V_{LIN} = \frac{\omega_{MOT}}{2 * \pi} * h_{MEC}$$

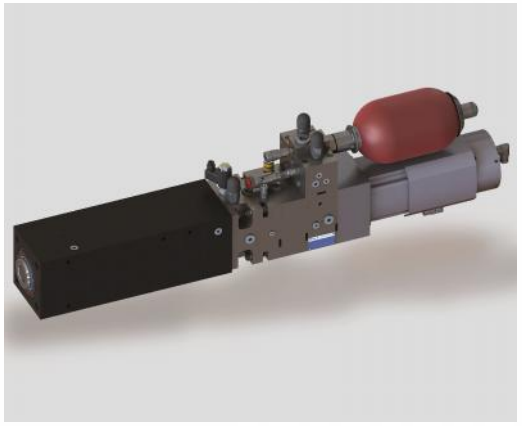
$$F_{LIN} = \frac{M_{MOT}}{h_{MEC}} * 2 * \pi$$

1. EHA - Introduction

Benefits of EHAs

Compactness	no visible powerpack, pipes, hoses
Power on demand	no idle consumption in powerpack
Power efficiency	no throttling losses in servo valves
Ruggedness	easy to protect against overload
Safety	implemented easily with logic valves





Dimensioning

Requirements (speed, force) defined by particular machine cycle.

Production equipment:	a) feed operation	⇒	high speed, low force
	b) material processing	⇒	low speed, high force

Examples: Bending, forming, riveting, cutting, punching

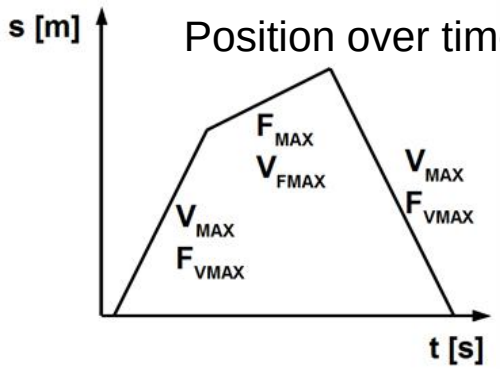
http://www.pragmaconindia.com

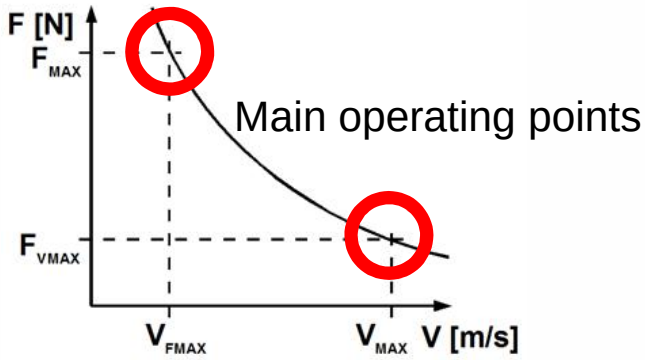
http://www.jfycnc.com

https://automotivemanufacturing solutions.com

Dimensioning

Typical work cycle





We need two motors in one:

- low speed and high torque
- high speed and low torque

High torque ⇒ high inertia

High torque ⇒ high current, big inverter

Approach:

Move operating point F_{MAX} into F_{VMAX}

Use smaller motor, inverter.

Implementation:

Use adaptive pitch: $h = \frac{Q}{A}$

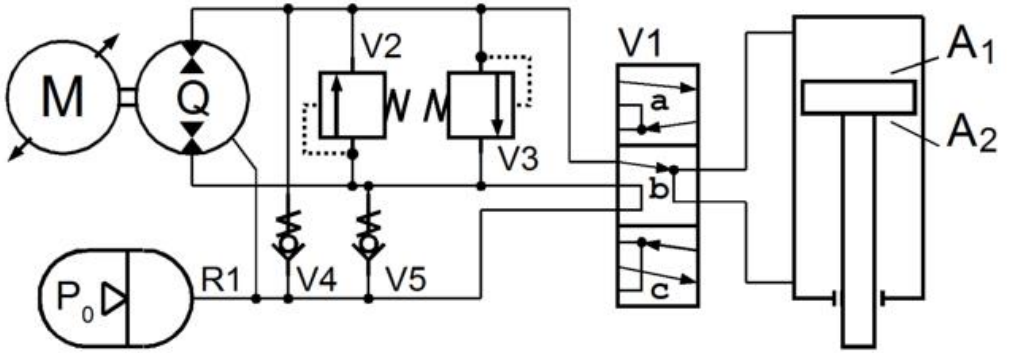
2. CLSP – Adaptive Light Weight EHA

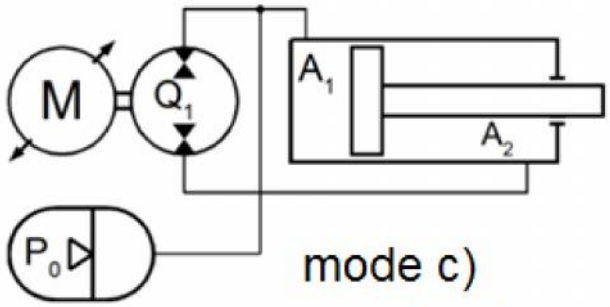
Target Application

a) low moving mass.
b) discontinuous speed during adaption.
c) continuous process force.

\+ riveting
\+ cutting (low weight tool)
\+ bending (low weight tool)
\- punching (c)
\- heavy press machine (a)

Function Principle



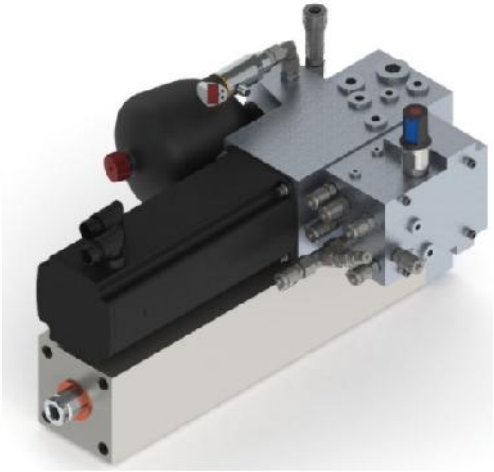


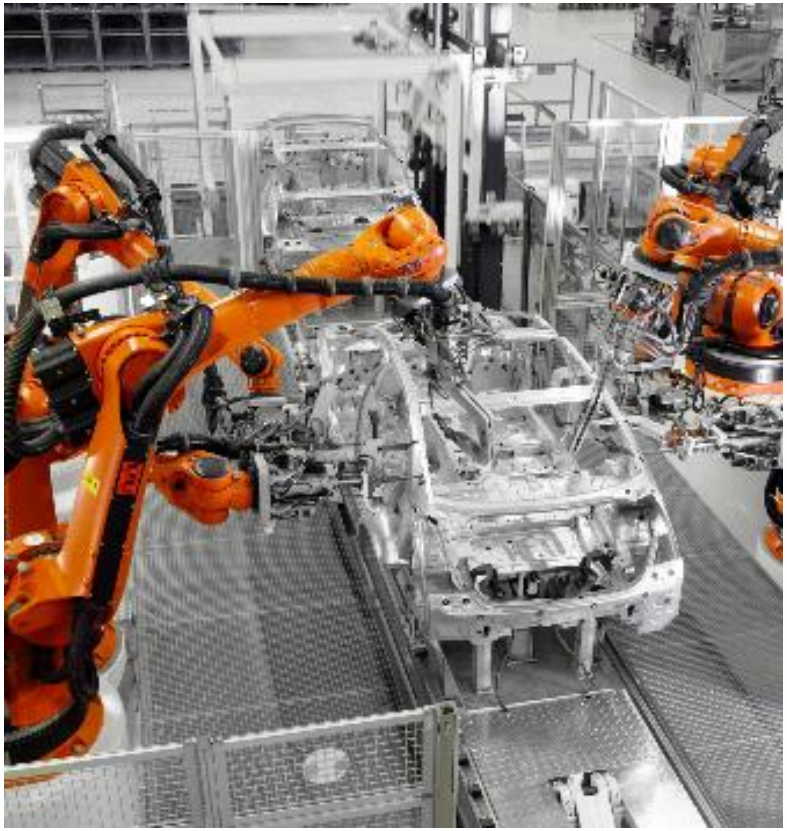
mode c)
neg. feed

2. CLSP – Adaptive Light Weight EHA

Application Solution

F_{MAX}	85 kN
V_{FMAX}	0,09 m/s
V_{MAX}	0,37 m/s
mass	60 kg





http://www.kuka.com

3. PDSC – Adaptive Heavy Press EHA

Target Application

a) high moving mass.
b) discontinuous speed during adaption.
c) continuous process force.

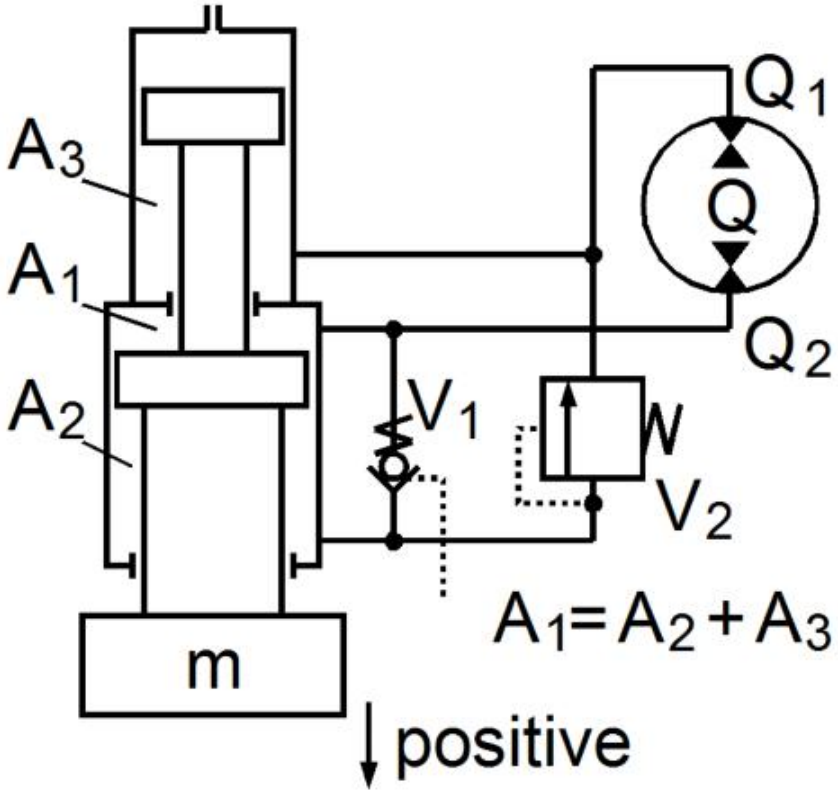
\+ heavy press, forming
\+ cutting (high weight tool)
\+ punching (low speed)

Parameter	Value
F_{MAX}	4 MN (400 to)
V_{FMAX}	0,03 m/s
F_{VMAX}	400 kN (40 to)
V_{MAX}	0,27 m/s

http://www.power-press-machine.com

3. PDSC – Adaptive Heavy Press EHA

Function Principle



Mode	V_1	V_2	Q_1	Q_2
No load positive		W	A_3	$A_1 - A_2$
No load negative		W	A_3	$A_1 - A_2$
Full load positive		W	$A_2 + A_3$	A_1

3. PDSC – Adaptive Heavy Press EHA

Hardware Implementation

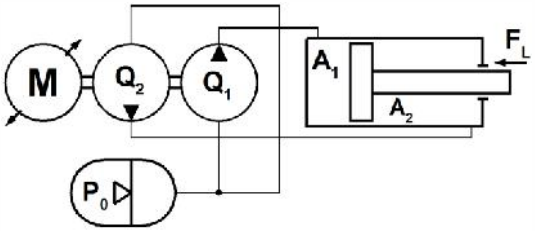
Parameter	Value
F_{MAX}	4 MN (400 to)
V_{FMAX}	0,03 m/s
F_{VMAX}	400 kN (40 to)
V_{MAX}	0,27 m/s

Load power: 120 kW
Feed power: 108 kW
Installed power: 88 kW

4. Mobile Service Unit

Requirements on Fluids for EHAs

Closed loop operation



\+ No fluid pollution through athmospere

\- Filtering (inline/bypass) will add cost and complexity

\- No tank for de-aering

\- Fluid must be clean upon startup

Pressurized tank

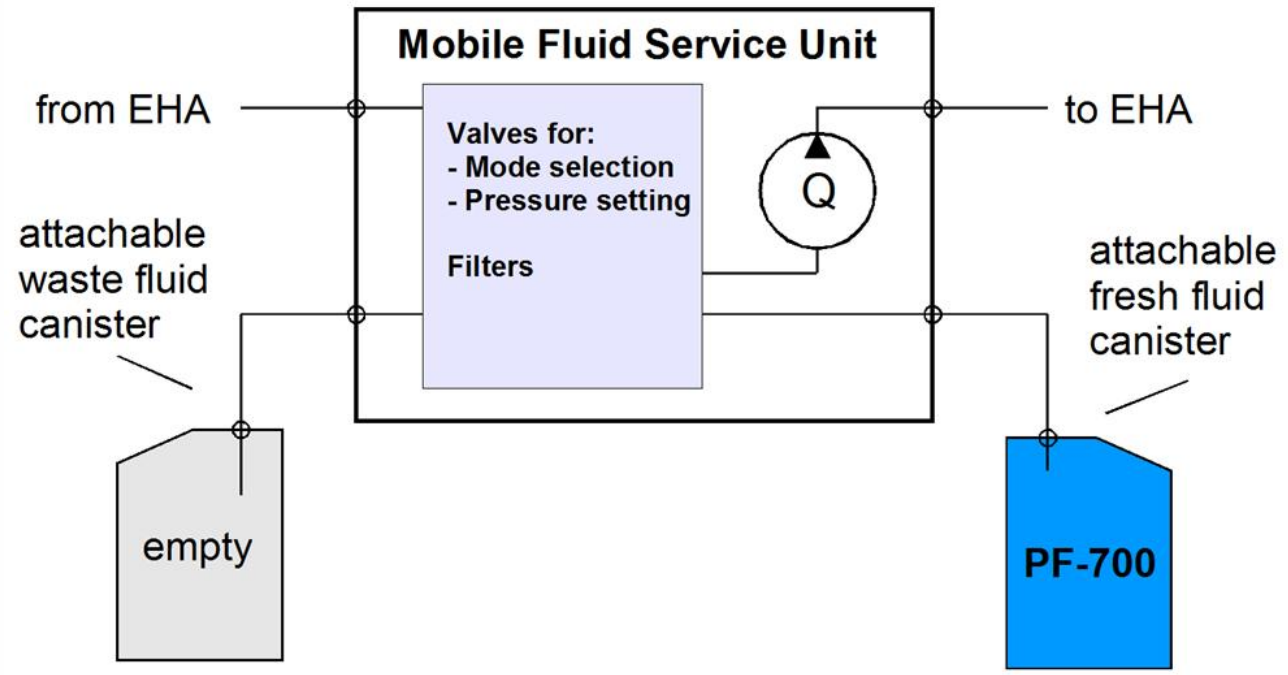
\+ Good suction conditions for pumps

\- Not easy to replace components / fluid

➡ Fluid care must be supported in system assembly but also in the field!

4. Mobile Service Unit

Implementation



4. Mobile Service Unit

Implementation

5. Conclusion

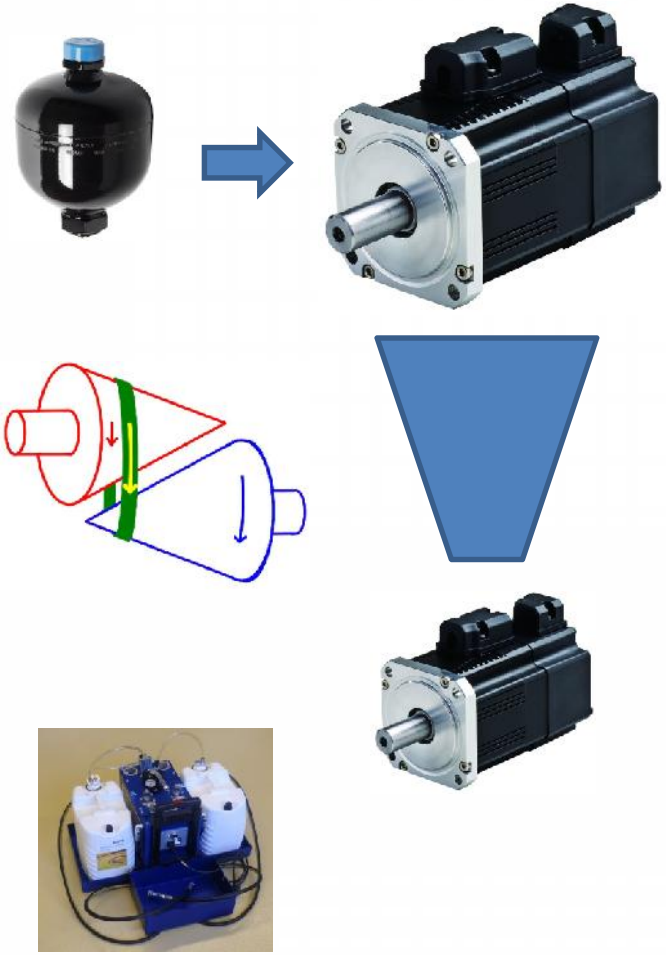
EHAs increase user acceptance and ease of use.

Power-on-demand means giving up averaging input power by use of accumulators.

In contrast to electro mechanical drives, hydraulics allows to create adaptive pitch solution.

Downsizing motor and inverter offers benefits in size, weight and hardware cost.

Closed systems with pressurized tank require special tools for commissioning and service.



Thank you for your attention!

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