Actuation and Control systems for Petrochemical process valves Best practice and new trends

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Flexibility through Reliability

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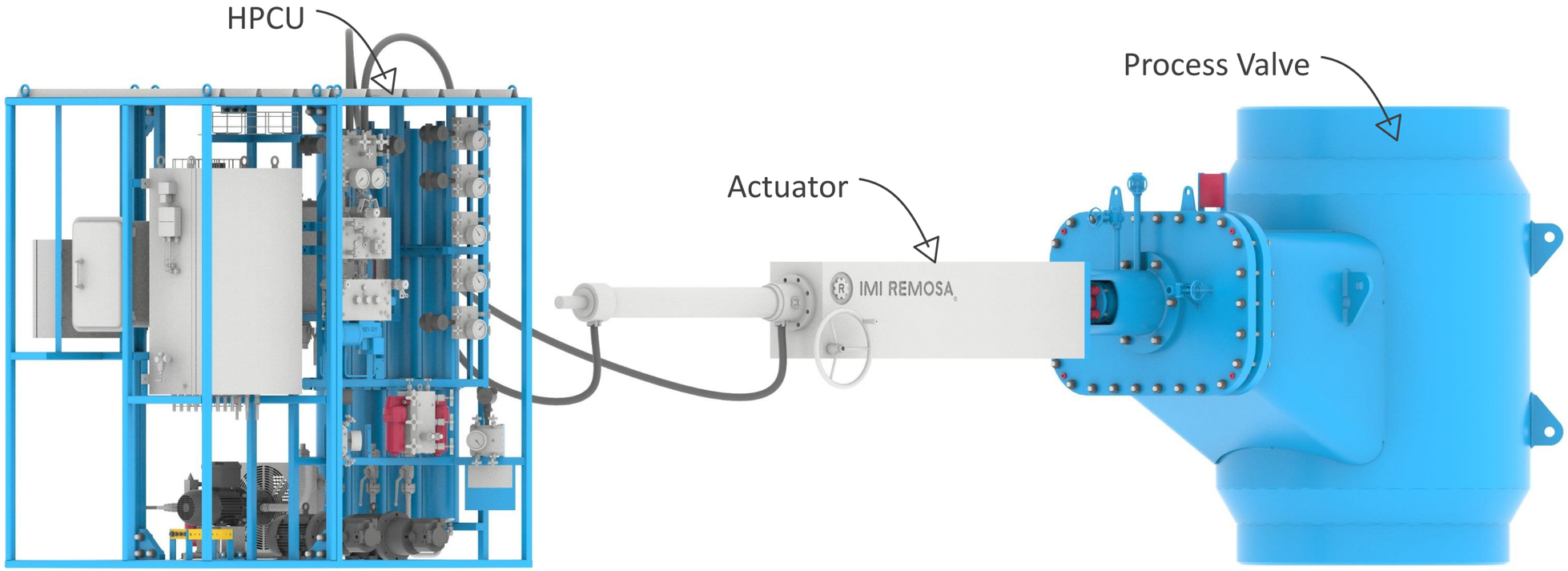
Actuating system for process valve



- HPCU provides accurate valve positioning control for process through hydraulic valve directed by a control system.
- The system should provide full redundancy of the most critical items and functionalities in order to guarantee high reliability during normal and emergency operation

Flexibility through Reliability

Hydraulic Units description

- HPCU: Hydraulic Power Control Unit
  - *Power*
    - *HPU transforms electric energy supplied to pump motors, into the hydraulic pressure needed for valve operation. Furthermore, it ensures oil cleanliness and temperature control*
  - *Control*
    - *Hydraulic power (pressurized oil) is stored in the accumulators, and directed to the hydraulic cylinder to change the slide valve disc position. This position can be changed automatically (DCS and PLC control system) or manually by the field operator.*

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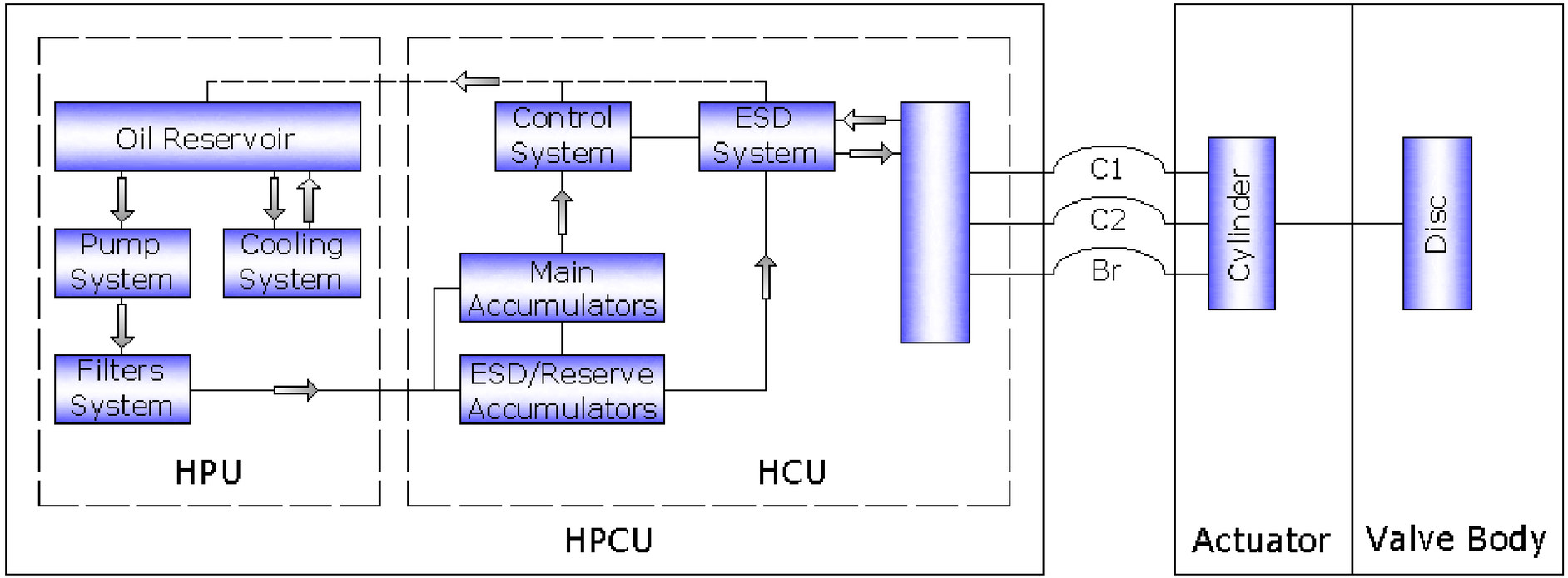
Hydraulic unit description

HPCU: Block Diagram



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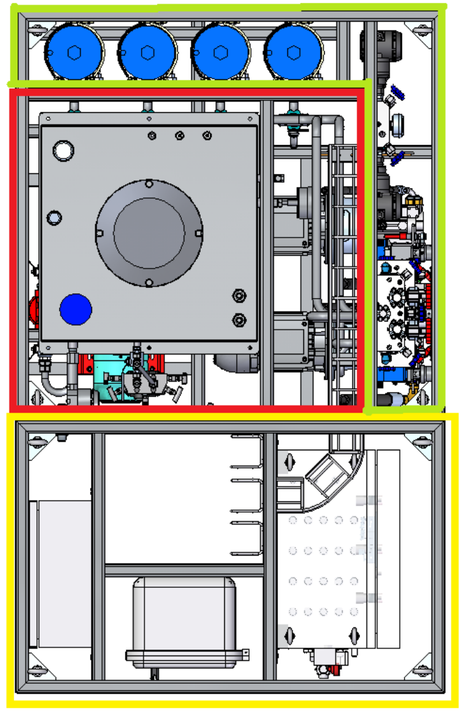
HPCU layout
Current state – integrated HPCU



PLC cabinet/EJBs
HPU
HCU

PLC cabinet HPU+HCU

Especially old installations are based on integrated layout

Each valve has its own control system, HPU and HCU

Advantages

- *Commissioning*
- *Logistics*

Disadvantages

- *Ex-proof installation (Exd Exp)*
- *Dimension of HPCU*
- *Limited Choices*

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HPCU layout
Alternative and new trends – Splitted HPCU

New installation prefers to have control system splitted to hydraulics and installed in safe area

This solution is applied especially when a package with more than 4 valve is provided

Disadvantages

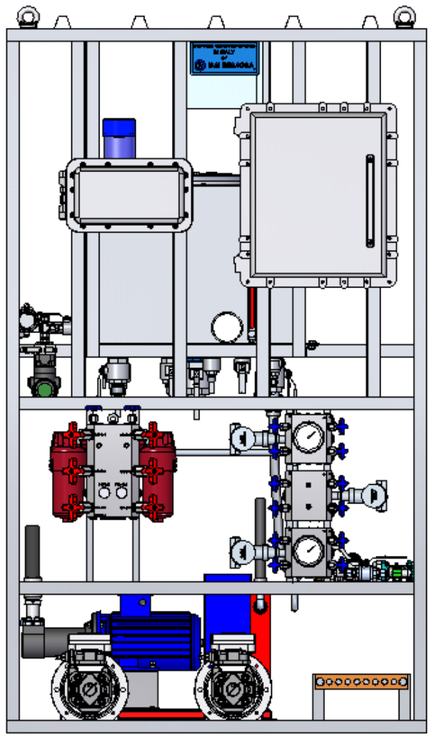
- *Commissioning*
- *Logistics*

Advantages

- *No Ex-proof*
- *Dimension of HPCU*
- *Numerous Choices*

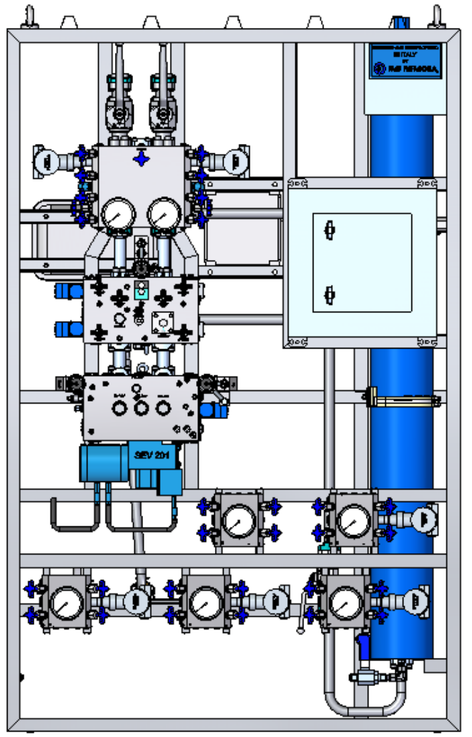
PLC cabinet rack

Installed in safe area



HPU

Installed on ground or with HCU



HCU

Installed on platform

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Control system – From Old to New Technology

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Available Features:

Analog controller

PLC

- **Valve positioning control**
- Monitoring HPCU by means of analog transmitters and digital switches
- **Management of main equipment (pumps, reservoir, accumulators)**
- Generating alarms
- **High performance valve positioning control and advanced system management**
- Providing user with detailed informations about HPCU status
- Dealing with faults and abnormal events by actively adjusting HPCU operation in real time
- Touch screen HMI
- **Increased diagnostics and remote assistance**

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PLC vs analog controller

PLC System key features (vs ana g controller)

- Performance
- Easy reprogramming an ting system upgrade or optimization
- Interchangeabi ity
- Easy Maintenance
- Low Power C
- Small physical S
- Several Commun
- Human Machine Inte
- Communication module remotely monitor HPCU status!

PLC has become a MUST for HPCU control system

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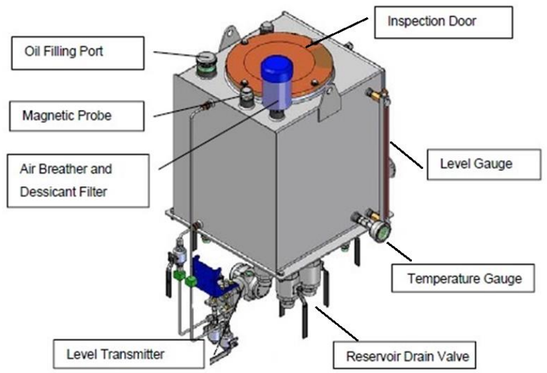
HPU – Current technology

Purposes

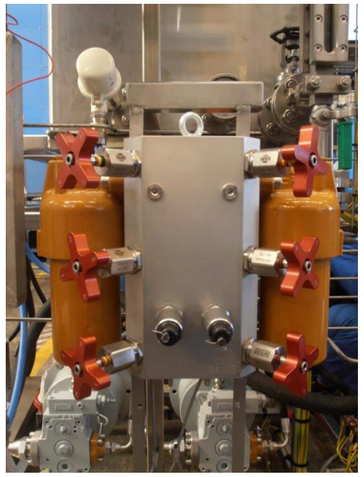
- Stores the hydraulic fluid and protects it against contamination particles and moisture
- Pressurizes the oil to be used in the HCU for valve positioning / ESD
- Controls the oil temperature

Main Elements:



Oil Reservoir

Pressure pumps
Variable displ. type



Filter-PSV manifold

Cooling&Recirc. system

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HPU – Alternative and new trends

Increase the system pressure

In the past normal hydraulic pressure was 100-120 barg.

E.g. Some licensors still require system pressure <125barg in its specs

System pressure can be increased up to 160 bar without any negative impact and with the following benefits:

- Smaller cylinder (means small flow rate)

↓

- Smaller components in general (servo, accumulators, valves, etc)

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- HPCU are smaller and more standardized

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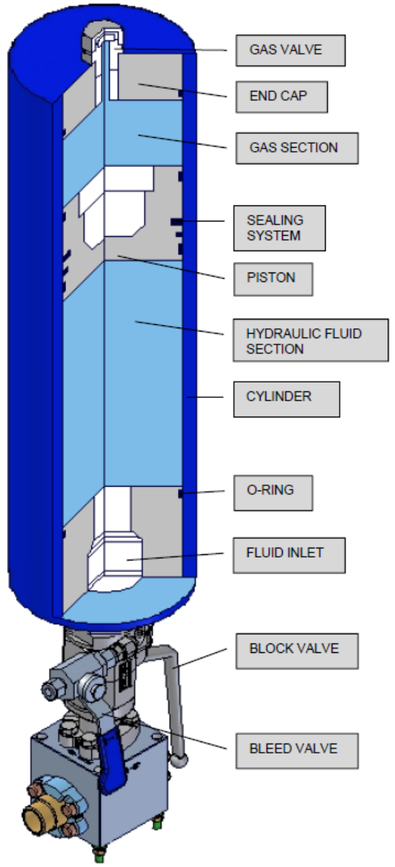
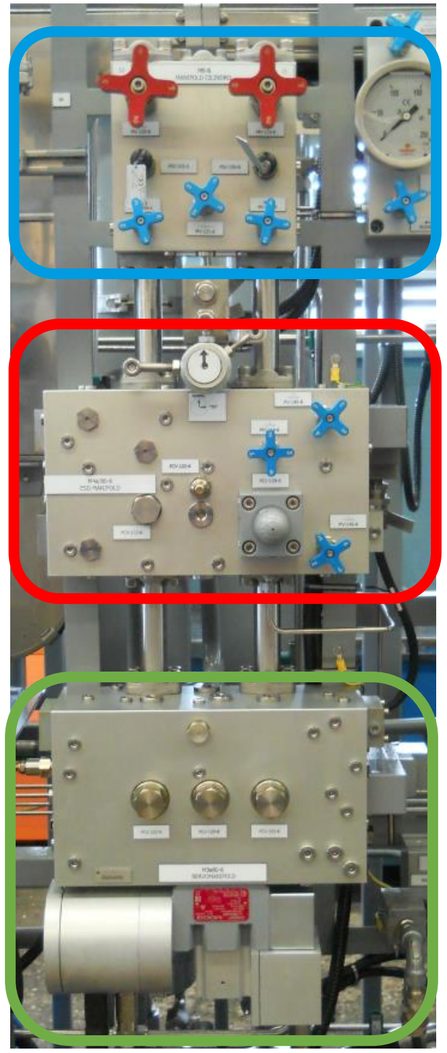
HCU – Accumulators



Accumulators:

- Store energy (in the form of pressurized oil), to give required operating performance (valve closing time in operation or ESD, strokes in case of pump failure, etc.) according to Licensor specification
- Piston Type Oil/Nitrogen Accumulator
- Main (or reserve) accumulator battery is connected to the main hydraulic system
- Emergency accumulator battery is connected to the ESD hydraulic system
- Accumulators sized for min. 2 full strokes @ normal operating thrust, with Safety Factor 2
- Dedicated isolation and bleed valve
- Can be equipped with ultrasonic position switch or position or N2 pressure transmitter upon request

HCU – Manifolds



Cylinder I/F manifold

- Provide interface connection to the actuator cylinder
- Equipped with block and bleed of the main cylinder hydraulic line

ESD Manifold

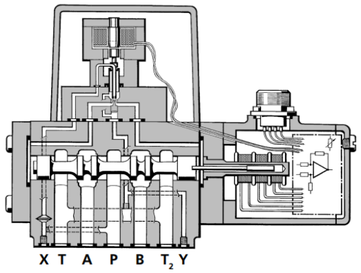
- Solenoid operated, fail to close, ESD action.
- Solenoid valve poppet type. possible configuration in 1oo1, 1oo2, 2oo2, 2oo4
- SOV powered by Emergency Interlock System or independent power source
- Manual ESD Test Valve
- Design ESD closing time is normally less than 2 secs for SV

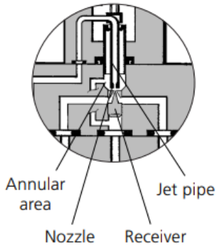
Control Manifold

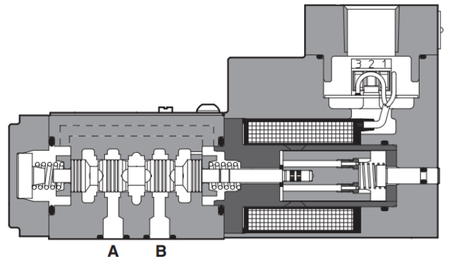
- The “heart” of the HPCU, transforming the electrical command into oil flow regulation to the actuator
- The control is provided by a servovalve
- Manual Operator 3-Position Valve (Open-Auto-Close)
- Solenoid Valve for lock in position and energy saving mode

HCU – Alternative and new trends

Servovalve vs Proportional Valve







There is no clear distinction between servovalve and proportional valve. Different vendors tend to give different definition

The spool is hydraulically piloted by a jet pipe or similar	Solenoid is used to provide infinite positioning of the spool
Existing from 1940s	It is required dedicated electronics to drive the solenoid
Zero overlap	Positive overlap
Response time < 18ms	Response time < 60ms
Max current 300mA	Max current 2.5 A
Hysteresis 0.5-3%	Hysteresis < 5%
High sensibility to oil contamination	Less sensibility to oil contamtination

Are you asking if proportional valves are suitable for FCC control valve application? The answer is yes!

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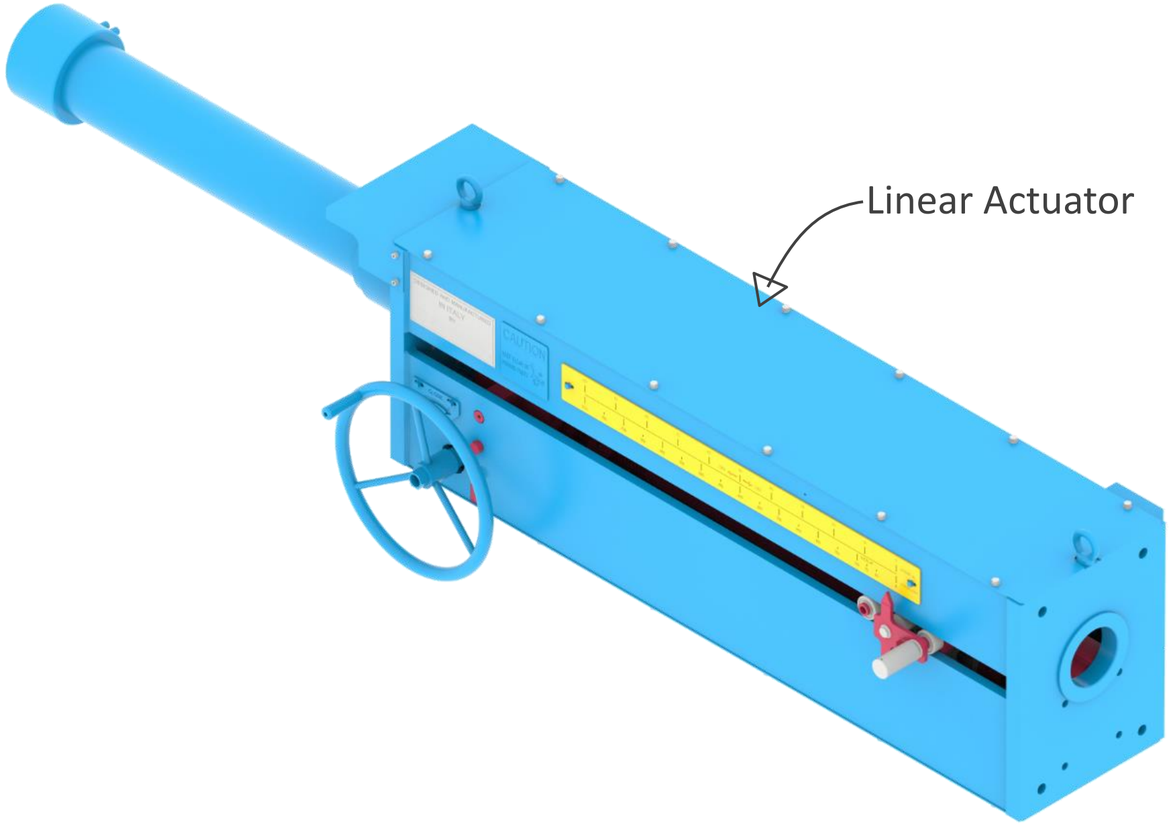
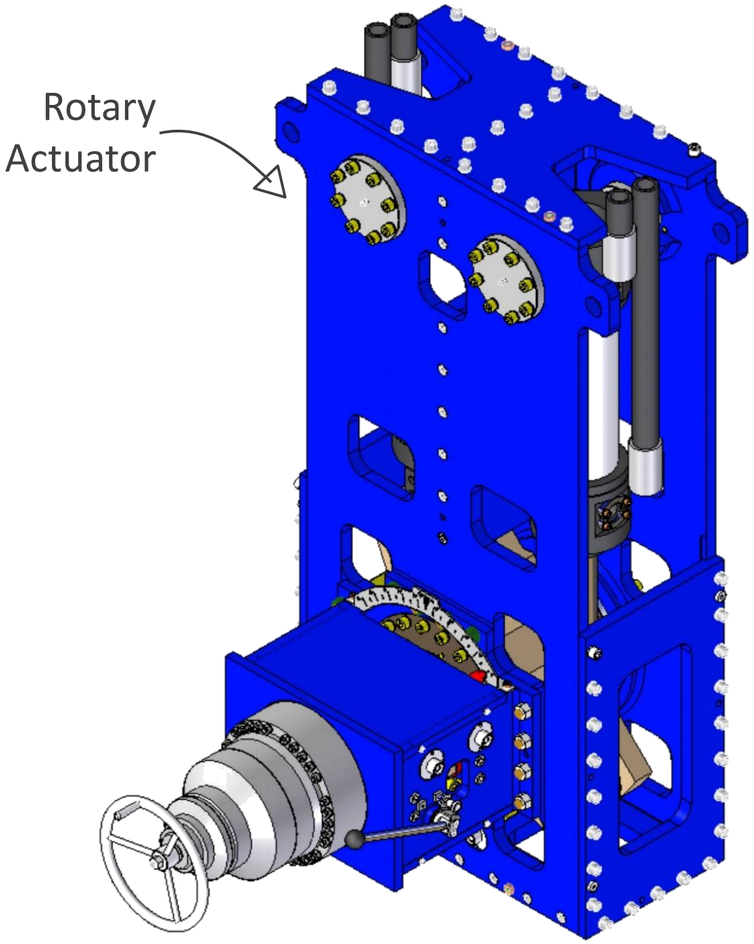
Actuator – Current Technology

Slide valve and butterfly valve are equipped respectively with linear and rotary actuator.

IMI Remosa designs and manufactures several sizes of actuator in order to meet the most stringent customer performance requirements





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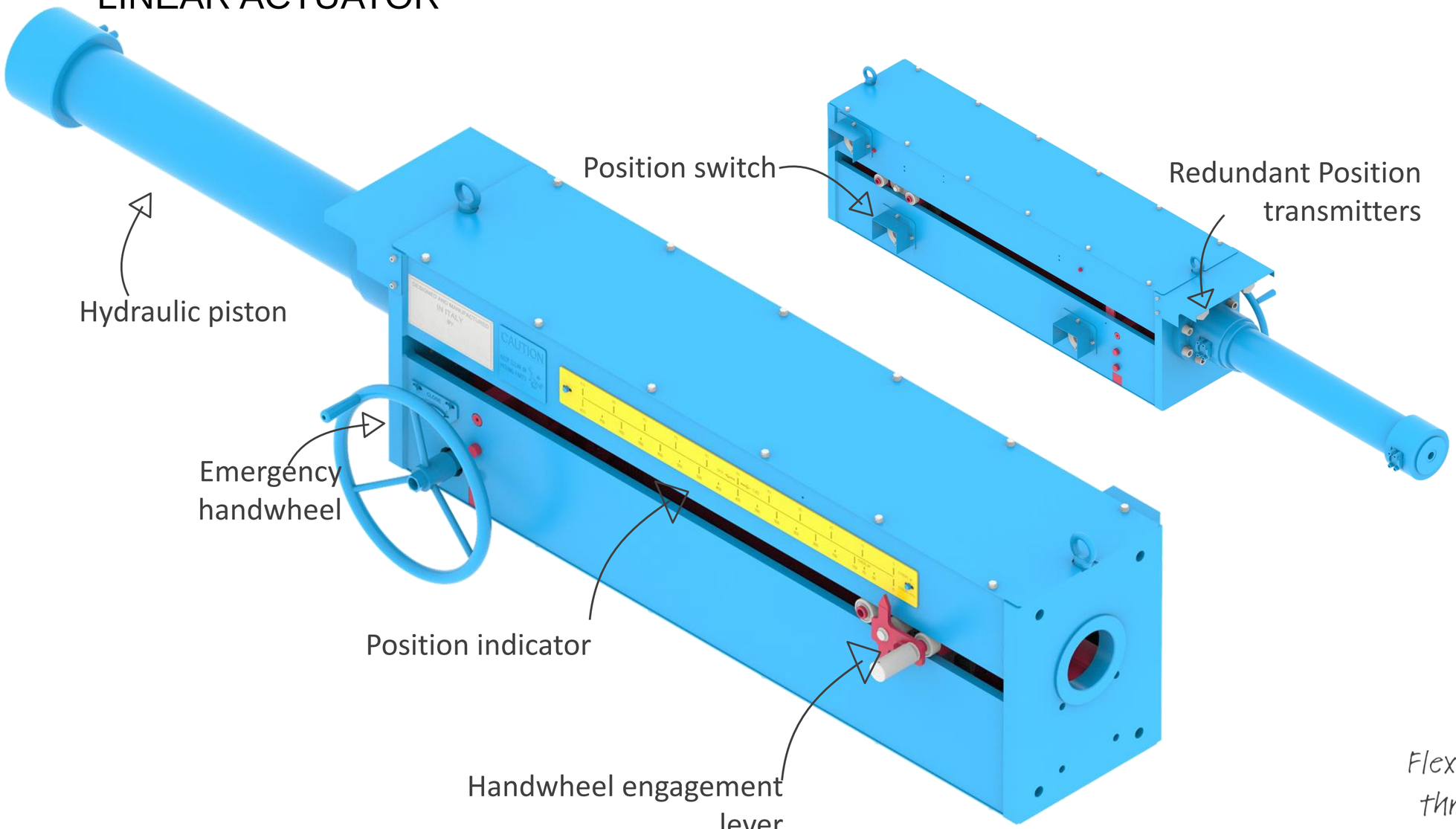
Actuator – Current Technology

LINEAR ACTUATOR



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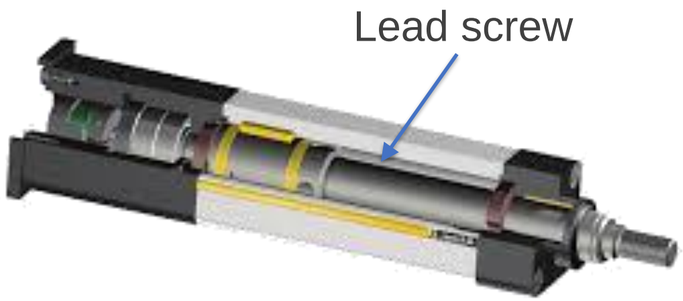
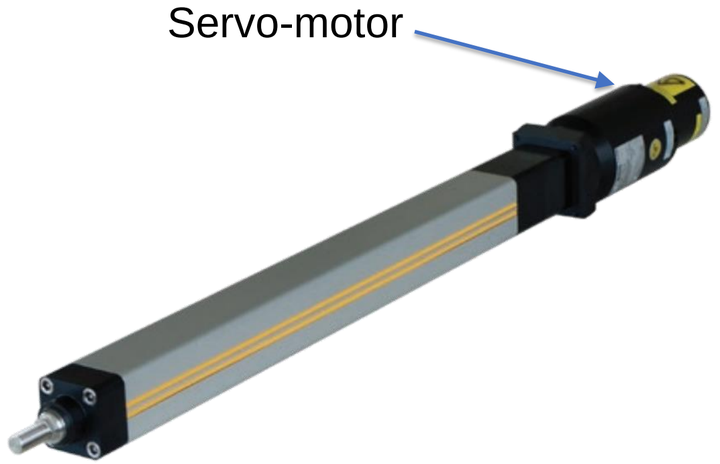
Actuator – New trends

Although hydraulics is still the best solution for providing high force at high speed, the technology of electrical cylinder is growing fast.



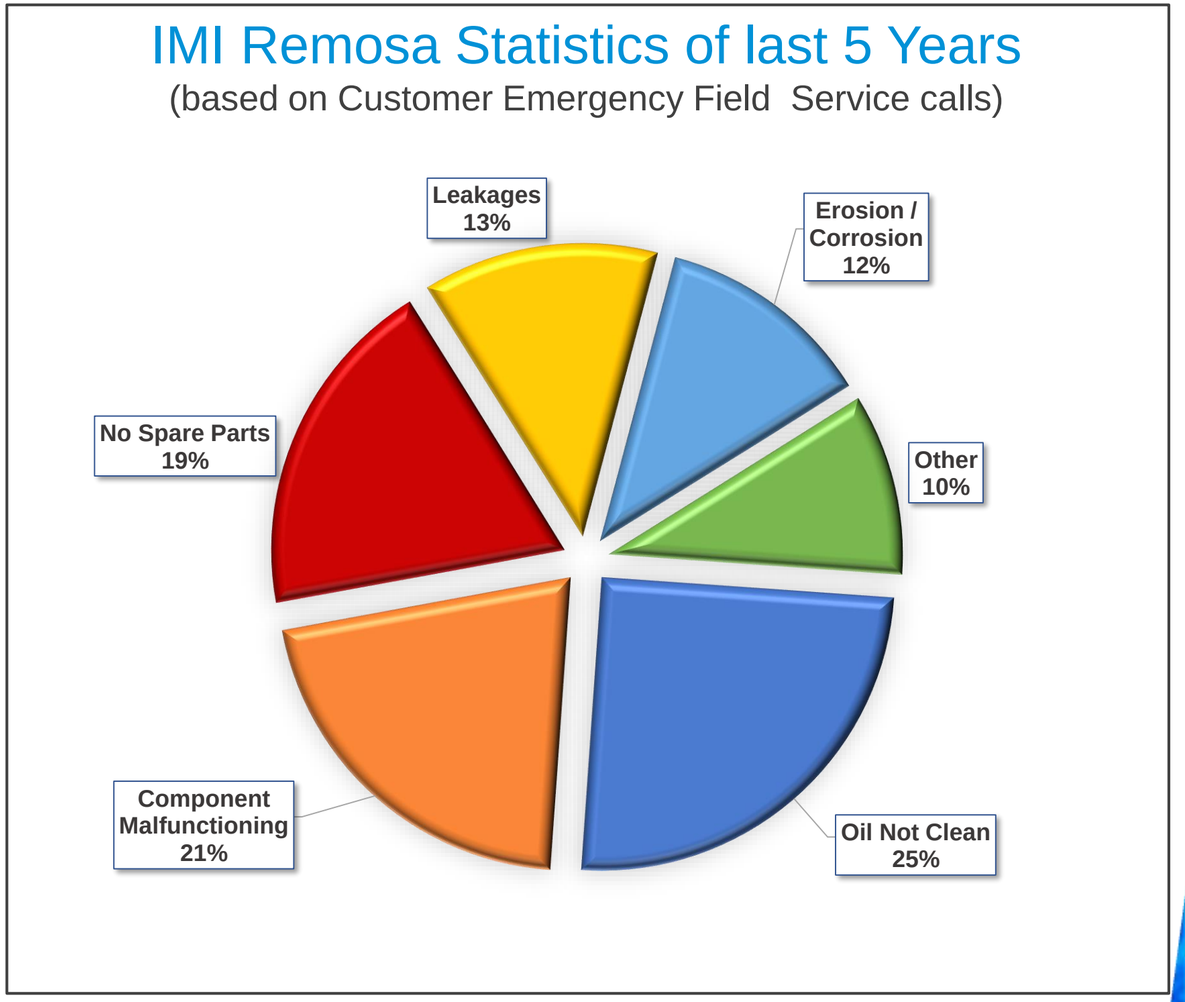


Main concerns remain:

- Force vs speed
- Accumulation method for emergency function (big batteries needed!)
- High current to be provided very close to the FCC valve

Actuation & Control Systems - Common Issues

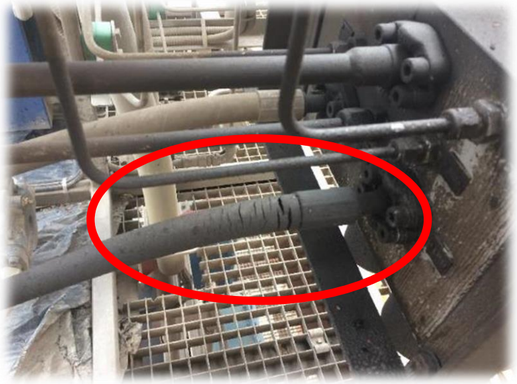
1) Fluid Cleanliness **
   - ✓ *HPCU Malfunctioning*
   - ✓ *Limited functionality of the HPCU*
   - ✓ *Shortened lifetime of Equipment*
2) Component Malfunctioning
   - ✓ *HPCU Malfunctioning*
3) No OEM Spare Parts on Stock
4) Hydraulic Leakage
   - ✓ *HPCU Malfunctioning*
   - ✓ *Fire Risk*
5) Erosion Corrosion
   - ✓ *HPCU Malfunctioning*
   - ✓ *Fire Risk*
6) Other



** **fluid cleanliness level of ISO 17/14/11, 85% of all types of hydraulic system failures are a direct consequence of fluid contamination.**

Flexibility through Reliability

Control Systems - Common Issues



Defective / Worn Out of HPCU Equipment & Hoses/Pipes

Hydraulic Leakages

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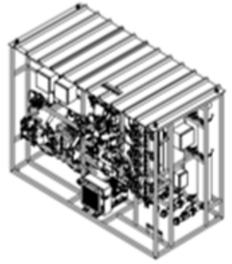
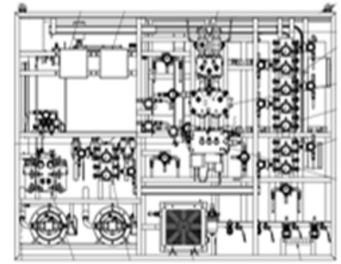
Remosa Project		HPCU	Regenerated Slide Valve	Document Ref.	HPCU Hydraulic Spare Part List
Refinery	RFCC, LTH, PRE UNITS PETRONAS	Tag No.	1311-TCV-2481	Page	1
Country				Rev.	0
Hydraulic Scheme	32363 Rev. 0	RS*: Refinery spare parts on stock		Document No.	618-226 HPCU Spare Parts





Hydraulic Schematic Tags	Description	Qty Inst.	UM	DWG Ref.	Remosa Code	Commissioning Spares	Qty Req.	Capital Spares	Qty	Turnaround Spares Parts	Qty Req.	RS*	Unit Price	Total Price
TCV2481-SR2A TCV2481-SR2B	FILTER CARTRIGE	2	No.	-	CRT2400000001	1	2	1	1	1	1			
TCV2481-SR1	COOLER FILTER CARTRIGE	1	No.	-	CRT1500000001			1	2	1	2			
N.A.	FLUSHING KIT	1	No.	-	FLUSHKITSL080			1	1	1	1			
1311-PSV-2468; 1311-PSV-2461	RELIEF VALVE	2	No.	-	VMAXPED-12R400			1	2	1	2			
1311-PSV-2463; 1311-PSV-2458	PRESSURE RELIEF VALVE	2	No.	-	VMAX00001000			1	2					
PSV-2468	PRESSURE RELIEF VALVE	1	No.	-	VDR0000002000			1	1	1	1			
FHH1C1-1; FHH1C2-1	FLEXIBLE HOSE	2	No.	-	TUF4SH0001538			1	2	1	2			
FHA1C1-1; FHA1C2-1;	FLEXIBLE HOSE	2	No.	-	TUF4SH0002000			1	2	1	2			
FHH1DR-1; FHA1DR-1;	FLEXIBLE HOSE	2	No.	-	TUFR2000000054			1	2	1	2			
FHPAOUT-1;	FLEXIBLE HOSE	1	No.	-	TUFR2000000127			1	1	1	1			
FHPDOUT-1;	FLEXIBLE HOSE	1	No.	-	TUFR2000000128			1	1	1	1			
FHPDDR-1;	FLEXIBLE HOSE	1	No.	-	TUFR2000042045			1	1	1	1			
FHCOUT-1;	FLEXIBLE HOSE	1	No.	-	TUFR2000042052			1	1	1	1			
FHPAIN-1;	FLEXIBLE HOSE	1	No.	-	TUFR2000022023			1	1	1	1			
FHPDIN-1;	FLEXIBLE HOSE	1	No.	-	TUFR2000022030			1	1	1	1			
FHCIN-1;	FLEXIBLE HOSE	1	No.	-	TUFR2000022051			1	1	1	1			

No Spare Parts on Stock in Refinery

Flexibility through Reliability

Defective / Worn Out Equipment

Before

After

Flexibility
through
Reliability

5) Erosions & Corrosions

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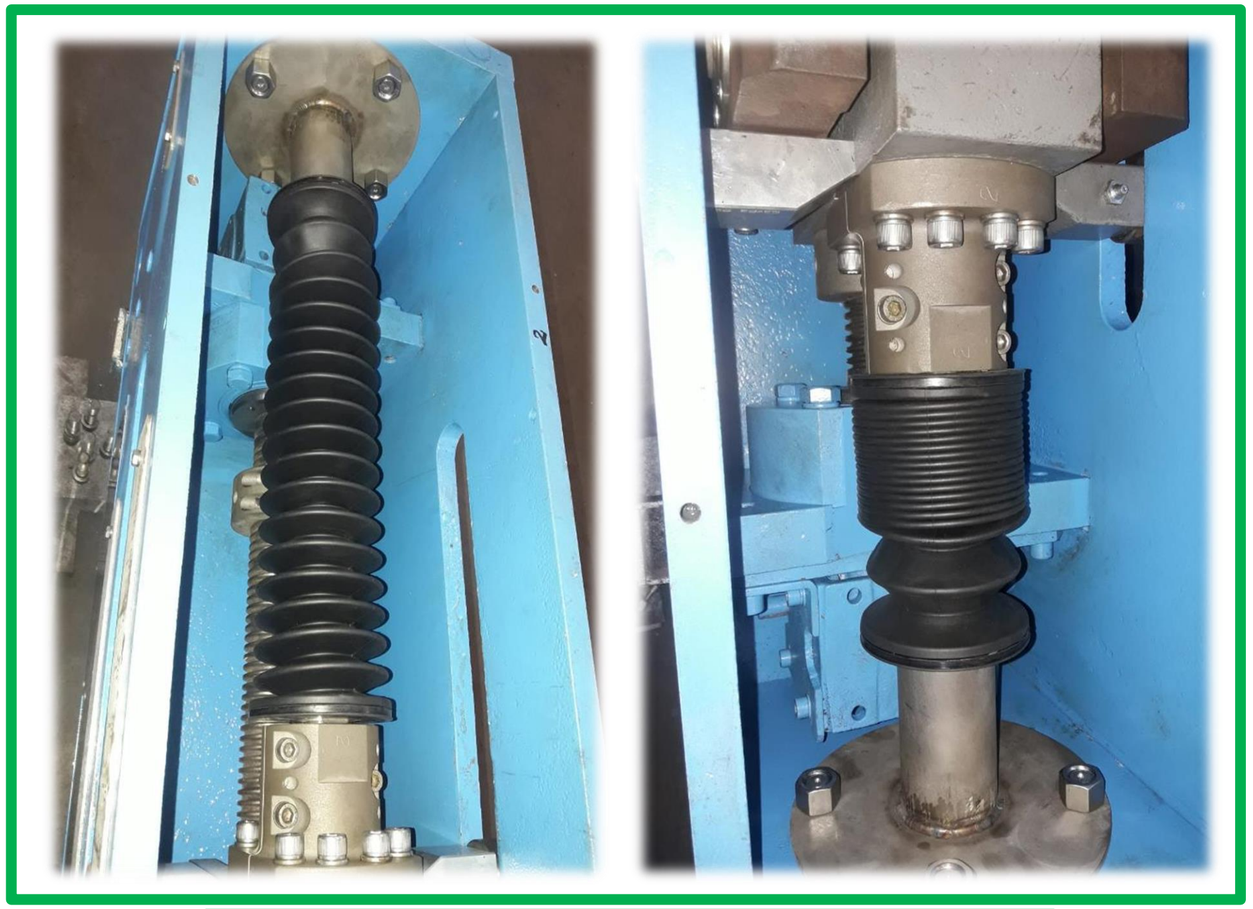
«Cilinder Bellow», a Special Solution for Severe Service

Before



After

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Typical maintenance schedule

PERIODIC CHECK DESCRIPTION	FREQUENCY
Visual inspection for major leaks	Every month
Start for 1 minute the back-up main pump to verify functionality	Every month
Start for 1-minute back-up recirculation pump to verify functionality	Every month
Start for 1-minute back-up heater to verify functionality	Every month
Verify accumulator nitrogen pre-charge pressure. (This check shall be performed isolating one accumulator from the other in order to maintain the system in operation)	Every 3 months or every TA (whatever occurs before)
Replace oil tank breather	When silica gel become “pink”
Replace filter (high pressure, return line, recirculation line)	Every TA or with “High” alarm for filter differential pressure (whatever occurs before)
Hydraulic oil analysis	Every 2 months or when new oil is introduced in the system (whatever occurs before)
Replace all Flexible hoses	Every TA or 4 years (whatever occurs before)
Replace hydraulic system O-rings	When leakage occurs Or every TA Or every 4 years (whatever occurs before)
Replace solenoids, control valve	Every 2 TA or 10 years (whatever occurs before)

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Thank You!

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