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

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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.
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.
Hydraulic unit description

- HPCU: Block Diagram
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
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
Available Features:

- 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
PLC vs analog controller

PLC System key features (vs analog controller)

- Performance
- Easy reprogramming and updating of software to provide system upgrade or optimization
- Interchangeability (simple spares procurement) and scalability
- Easy Maintenance and Troubleshooting
- Low Power Consumption
- Small physical size
- Several Communication Options
- Human Machine Interface
- Communication module to remotely monitor HPCU status!

**PLC has become a MUST for HPCU control system**
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:
Increase the system pressure

In the past normal hydraulic pressure was 100-120 barg.
E.g. Some licensors still require system pressure <125 barg 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)

• HPCU are smaller and more standardized
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
## Servovalve vs Proportional Valve

<table>
<thead>
<tr>
<th>Servovalve</th>
<th>Proportional Valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>The spool is hydraulically piloted by a jet pipe or similar</td>
<td>Solenoid is used to provide infinite positioning of the spool</td>
</tr>
<tr>
<td>Existing from 1940s</td>
<td>It is required dedicated electronics to drive the solenoid</td>
</tr>
<tr>
<td>Zero overlap</td>
<td>Positive overlap</td>
</tr>
<tr>
<td>Response time &lt; 18ms</td>
<td>Response time &lt; 60ms</td>
</tr>
<tr>
<td>Max current 300mA</td>
<td>Max current 2.5 A</td>
</tr>
<tr>
<td>Hysteresis 0.5-3%</td>
<td>Hysteresis &lt; 5%</td>
</tr>
<tr>
<td>High sensibility to oil contamination</td>
<td>Less sensibility to oil contamination</td>
</tr>
</tbody>
</table>

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

Are you asking if proportional valves are suitable for FCC control valve application? The answer is yes!
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.
Actuator – Current Technology

LINEAR ACTUATOR

- Position switch
- Redundant Position transmitters
- Hydraulic piston
- Emergency handwheel
- Position indicator
- Handwheel engagement lever
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.
Control Systems - Common Issues

Defective / Worn Out of HPCU Equipment & Hoses/Pipes

Hydraulic Leakages

No Spare Parts on Stock in Refinery

Flexibility through Reliability
Defective / Worn Out Equipment

Before

After
5) Erosions & Corrosions

«Cilinder Bellow», a Special Solution for Severe Service

Before

After

Flexibility through Reliability
## Typical maintenance schedule

<table>
<thead>
<tr>
<th>Periodic Check Description</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual inspection for major leaks</td>
<td>Every month</td>
</tr>
<tr>
<td>Start for 1 minute the back-up main pump to verify functionality</td>
<td>Every month</td>
</tr>
<tr>
<td>Start for 1-minute back-up recirculation pump to verify functionality</td>
<td>Every month</td>
</tr>
<tr>
<td>Start for 1-minute back-up heater to verify functionality</td>
<td>Every month</td>
</tr>
<tr>
<td>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)</td>
<td>Every 3 months or every TA (whichever occurs before)</td>
</tr>
<tr>
<td>Replace oil tank breather</td>
<td>When silica gel become “pink”</td>
</tr>
<tr>
<td>Replace filter (high pressure, return line, recirculation line)</td>
<td>Every TA or with “High” alarm for filter differential pressure (whichever occurs before)</td>
</tr>
<tr>
<td>Hydraulic oil analysis</td>
<td>Every 2 months or when new oil is introduced in the system (whichever occurs before)</td>
</tr>
<tr>
<td>Replace all Flexible hoses</td>
<td>Every TA or 4 years (whichever occurs before)</td>
</tr>
<tr>
<td>Replace hydraulic system O-rings</td>
<td>When leakage occurs</td>
</tr>
<tr>
<td></td>
<td>Or every TA</td>
</tr>
<tr>
<td></td>
<td>Or every 4 years</td>
</tr>
<tr>
<td></td>
<td>(whichever occurs before)</td>
</tr>
<tr>
<td>Replace solenoids, control valve</td>
<td>Every 2 TA or 10 years (whichever occurs before)</td>
</tr>
</tbody>
</table>
Thank You!