Small Batch Control Using IEC 61499

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Purpose of This Project

- Experimental study of batch control using IEC 61499
- Discuss system design and design methodologies
System Over View

- Tank #1
  - Parameters #2
  - Data #2
  - PID Parameter Data #2
  - HMI (Operation, PID tuning)
  - Batch sequence
  - Logging

- Tank #2
  - Parameters #2
  - Data #2

Computer

- PID
- Transducer

Laptop

Computer

- PID
- Transducer

Voltage
Coupled Tank
Physical Model

Process Cell

- TANK
  - SENSOR
  - PC
    - PID
    - TRANS
  - PUMP
- MASTER
  - PC
    - BATCH
    - HMI
Tank

- **Instruments**
  - Tank
  - Level sensor
  - Pump

- **Function**
  - Level control

- **PID**
  - Auto/manual
  - Remote operation

![Diagram of Tank System]

- **Level Sensor**
- **Pump**
- **AI/O**
- **PC**

- **Voltage**
- **PID Control**
- **Variables**

- **Network**
Batch Procedure

1. Charge tank #1
2. React
3. Charge tank #2
4. React
5. Discharge

Charge tank #1
React
Charge tank #2
React
Discharge

3 sec
3 sec

Charge
React
Discharge

3 sec
3 sec

Tank #1
Tank #2

mm

200

150

100

0

0

3 sec
3 sec
Application

1. Components
2. Tank Control
3. PID Tuning
4. Batch Process
5. Results
Process Interface

Analog Input

Interface

Analog Output

Interface

AI/AO  FBs
FBDK
JNI  Java VM
Driver
Windows 98
I/O Board
I0 I1 I2 I3 O0 O1
Level Sensor

<table>
<thead>
<tr>
<th>Interface</th>
<th>Body</th>
</tr>
</thead>
</table>

**AIConv:**

- Linearize **voltage** from sensor and the **actual height**
- **VIN** : (voltage)
- **HOUT** : (% of 0-300mm)
Pump

AOConv:

\[ v_P : (\%) \]
\[ v_R : \text{(voltage)} \]
Application

1. Components
2. Tank Control
3. PID Tuning
4. Batch Process
5. Results
HMI and Control

Separate

- PID tuning
- Batch Monitoring

- PID control
Sub Application of the Tank

Application in the tank unit
**FILE_RW_3R:**
Read and Write 3 data in order to memorize PID parameters.
## YC_PID

### Interface

<table>
<thead>
<tr>
<th>变量</th>
<th>类型</th>
<th>注释</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUTO</td>
<td>BOOL</td>
<td>0-manual,1-auto</td>
</tr>
<tr>
<td>PV</td>
<td>REAL</td>
<td>Process Variable</td>
</tr>
<tr>
<td>SP</td>
<td>REAL</td>
<td>Set Point</td>
</tr>
<tr>
<td>MVM</td>
<td>REAL</td>
<td>Manipulated Variable in MAN mode</td>
</tr>
<tr>
<td>PB</td>
<td>REAL</td>
<td>Proportional Band (%)</td>
</tr>
</tbody>
</table>

### ECC

<table>
<thead>
<tr>
<th>变量</th>
<th>类型</th>
<th>注释</th>
</tr>
</thead>
<tbody>
<tr>
<td>TI</td>
<td>REAL</td>
<td>Integral Time (Sec)</td>
</tr>
<tr>
<td>TD</td>
<td>REAL</td>
<td>Derivative Time (Sec)</td>
</tr>
<tr>
<td>CYCLE</td>
<td>REAL</td>
<td>Sampling Interval (Sec)</td>
</tr>
</tbody>
</table>

### Output Variables

<table>
<thead>
<tr>
<th>变量</th>
<th>类型</th>
<th>注释</th>
</tr>
</thead>
<tbody>
<tr>
<td>MV</td>
<td>REAL</td>
<td>Manipulated Variables</td>
</tr>
</tbody>
</table>
TANK_REAL
# HMI_PROXY

## Interface

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>REQ:</td>
<td>IND_V:</td>
</tr>
<tr>
<td>for monitoring</td>
<td>for batch control</td>
</tr>
</tbody>
</table>

## Events

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IND_P:</td>
</tr>
<tr>
<td></td>
<td>for PID tuning</td>
</tr>
</tbody>
</table>
Application

1. Components
2. Tank Control
3. PID Tuning
4. Batch Process
5. Results
HMI and Control

- PID control
- PID tuning
- Batch Monitoring

Separate

Network
HMI for PID Tuning
HMI for PID Tuning

Application of HMI
Application

1. Components
2. Tank Control
3. PID Tuning
4. Batch Process
5. Results
HMI for Batch Control
Batch Control and HMI

Application
Batch Procedure

Procedure:

SQ1) Set SP of Tank#1
SQ2) Set SP of Tank#2
SQ3) Discharge both tanks

Note:
If Tank#1 level have been disturbed in SQ2, step back to SQ1.
Batch Procedure

Interface

Body
BATCH_CTRL

Interface

Body
BATCH_CTRL_C_S

Interface

Event
- INIT
- REQ
- R1
- R2
- PV1
- PV2
- AUTO1
- SP1
- M Vin1
- AUTO2
- SP2
- M Vin2

Body

Process variable checking function block
Application

1. Components
2. Tank Control
3. PID Tuning
4. Batch Process
5. Results
Result of PID Tuning
Result of Batch Control (1)
Result of Batch Control (2)