



INFOTROL Batch Reactor Controller

What is HPCB?

HPCB(Hierarchical Predictive Controller For Batch) is a INFOTROL's own Batch reactor APC(Advanced Process Control) solution designed to handle Model Predictive Control Technology and Nonlinear heat-reaction.

This solution, which can manage reaction recipe and control conditions for each grade, can be applied to both full batch and semi-batch process.

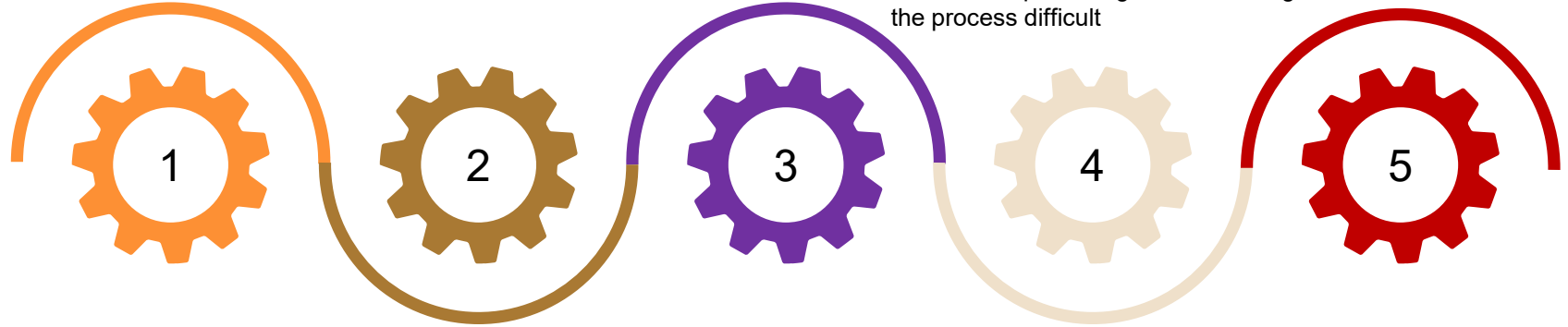
Challenges in Batch Process Control

Nonlinear Dynamics

- Batch reactions are nonlinear
- Nonlinearity complicates control design

Variability in Biological Systems

- Variability exists due to differences in starting materials, environmental conditions and random biological events
- This makes predicting and controlling the process difficult



Time-Dependent Changes

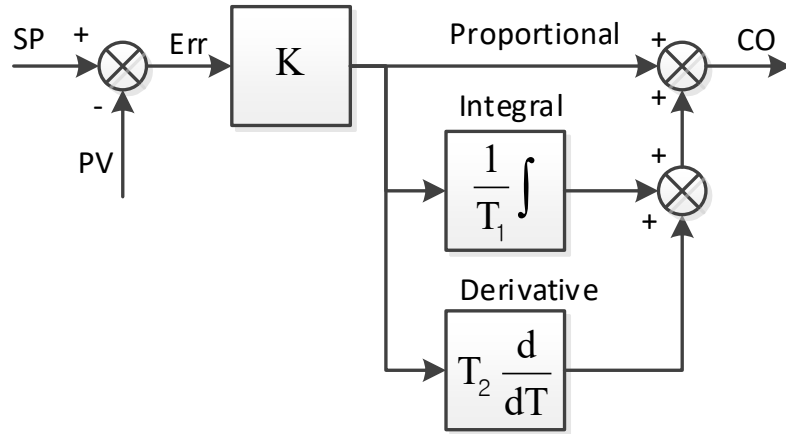
- Batch processes are time-dependent
- Conditions and reactions continuously change
- Real-time dynamic control strategies are needed

Optimization of Multiple parameters

- Balancing multiple parameters to optimize productivity is complex
- Parameters are interdependent, requiring a holistic approach

Scale-Up Challenges

- Scale-up presents difference in mixing and heat transfer
- New control issues may arise during the scale-up process



PID Controller

• Feedback Control

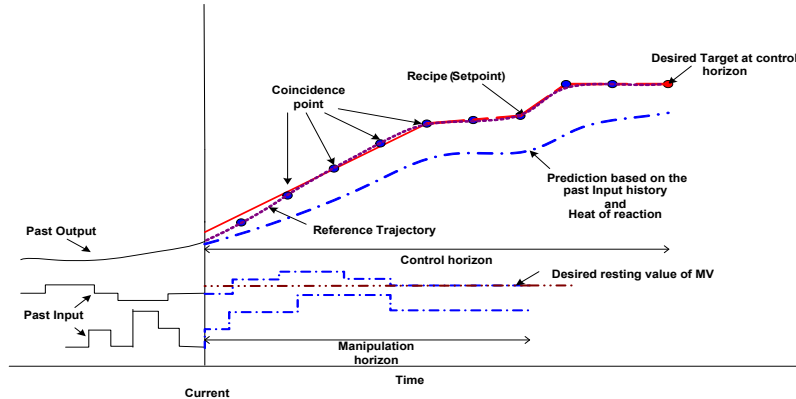
- To control the process value according to the desired setpoint, the error between these two values must be calculated. This error is then used to determine the control value (Controller Output, CO) needed for the adjustment

• Disadvantage

- **SISO (Single Input Single Output) structure**
- Temperature recipe (future desired trend) cannot be given as a target
- Difficult to disturbance rejection even though it is known in advance
- Inferior control performance on the process which has slow response or long dead time
- Controller tuning should be adjusted manually to the operational change

HPCB

(Hierarchical Predictive Control for Batch)



I. The world's best batch reactor model predictive controller

II. Conducts multi-stage optimization, allowing users to easily create and modify recipes for each grade according to control objectives

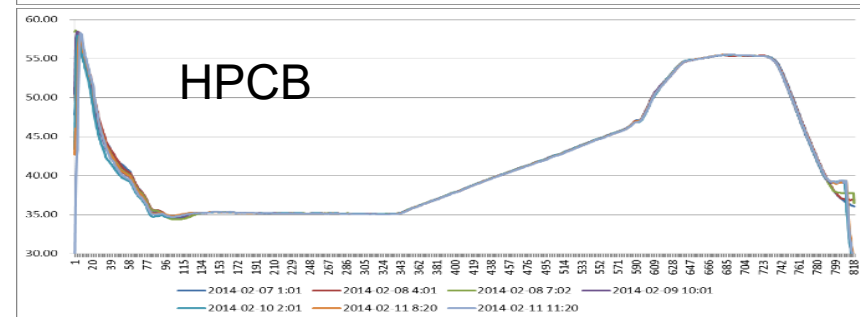
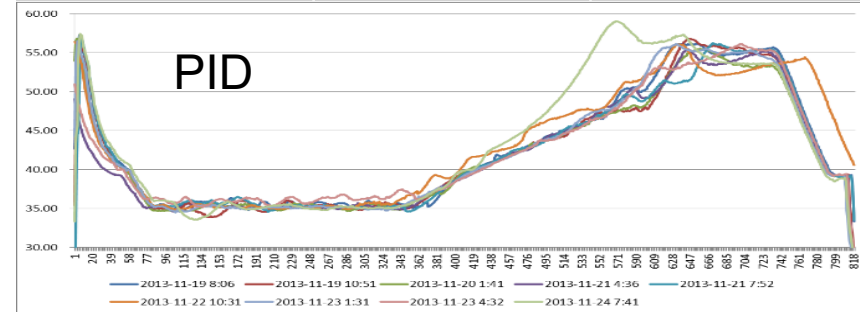
III. HPCB can quickly respond to processes with non-linear characteristics (Heat of reaction)

IV. Trajectory Target Control: Conducts feedforward control considering predetermined setpoints like the reaction temperature recipe

V. Optimization: Real-time optimization considering the direction for economic benefit

PID vs HPCB

	PID	HPCB
Feedback Control	O	O
Consider Future Setpoint	X	O
Consider Disturbance	X	O
Multi-Variable Control	X	O
Optimization	X	O
Control Structure	Tuning	Model Accuracy



PCA: Batch Reactor Quality Analysis Solution

- Extract history data of the batch
- Analyze the interrelationship between batch trajectory and quality using a PLS model
- Display PCA analysis results of each batch in real-time online
- Enable quality control and abnormal operation analysis through online application of PCA
- Establish control and automation strategies for quality improvement through PCA application

sizeD50	LESS3UM	MORE10UM	MORE16UM	GSDP	GSDV	D16N	D50N	D84V	D50 - 3um	D50 - 16um
6.4079	2.8296	1.4047	0.249	1.2995	1.2631	4.0475	5.3127	7.9774	3.5783	6.1589
6.4484	2.6801	1.1281	0.077	1.287	1.2493	4.176	5.4165	7.9228	3.7683	6.3714
6.4282	2.6469	0.766	0	1.2886	1.2464	4.154	5.4127	7.863	3.7813	6.4282
6.4103	2.2231	1.2017	0.122	1.2765	1.2518	4.2226	5.4008	7.9143	4.1872	6.2883
6.4266	2.8714	0.7847	0	1.2826	1.2497	4.1876	5.4088	7.904	3.5552	6.4266
6.4207	2.788	0.9132	0	1.2762	1.2415	4.2373	5.4611	7.8774	3.6327	6.4207
6.5364	3.2862	1.2524	0.055	1.2876	1.2461	4.2244	5.5197	8.0438	3.2502	6.4814
6.4908	2.5076	0.9737	0	1.283	1.2478	4.2268	5.4714	7.9763	3.9832	6.4908
6.5011	2.8935	1.2383	0	1.2808	1.2481	4.2469	5.4854	8.0112	3.6076	6.5011
6.5419	2.6773	0.9877	0	1.2819	1.2469	4.267	5.5134	8.0235	3.8646	6.5419
6.5061	2.1552	1.0334	0	1.2731	1.2404	4.3125	5.5377	7.9553	4.3509	6.5061
6.4333	2.3347	1.3475	0.1216	1.2787	1.2534	4.2193	5.4166	7.963	4.0986	6.3117
6.4473	2.3887	1.1935	0.0753	1.2802	1.2466	4.2261	5.4536	7.9301	4.0586	6.372
6.5265	2.0837									
6.4481	2.6601									
6.4561	2.5292									
6.5668	2.5993									
6.3971	2.3451									
6.4475	2.3576									
6.5801	2.8384									
6.5464	2.8176									
6.481	2.2579									
6.5378	2.4364									
6.4472	2.5719									

