

Batch versus Continuous

■ Advantages of continuous

- greater capacity
- lower capital
- less operator attention (at steady state)

■ Disadvantages of continuous

- lower conversion and/or yield
- product changeovers more difficult
- loss of batch identity
- buildup of solids on walls and contaminants in liquid
- less availability for maintenance
- less availability for improvements
- instability from recycle streams

Overdrive

- Overdrive of the manipulated variable is essential to provide a fast transition to a batch set point
- Overdrive is the integral of the area of the manipulated variable above its resting value when the PV is at set point
- The overdrive integrated area divided by the total integrated area of the manipulated variable until the PV first reaches set point is the fraction reduction in batch time to reach set point
- Too much overdrive will cause overshoot and an excessive amount of time for the oscillations to die out (settling time)
- Bang Bang control and aggressive tuning maximizes overdrive
- Head starts to resting values, set point profiling without a lead (lag only), and Lambda tuning factors > 1 eliminate overdrive

Batch Reactor Control Methods

- Maximum controller gain and rate for less overshoot on startup
- Head start of control valves to make startup faster
 - use “Full Throttle Setpoint Response” for overdrive
- Set point profile to reduce set point overshoot
 - use lead-lag on controller output to induce overdrive
- Set Point feed forward to track frequent changes in set point
 - use % feed forward with opposite action of control action
- Temperature rate of change control to control reaction activity
 - use filter and calculation interval to reduce A/D noise
- Composition profile slope control (e.g. biomass profile slope)
- Heat removal model to control reaction conversion
 - use accurate coolant flow meter and RTD sensors
- Analysis such as pH, microwave spectrum, crystal wavelength, or fiber optic NIR spectrum to control reaction selectivity
- Rapid sustained change from average for shifting end point
- Vector projection for “Full Throttle Setpoint Response”
- Ramp down of driving forces to reduce excess reactant at end

Batch Cycle Time Reduction

- Reduce wait times, OARs, and manual actions by automation
- Reduce excess process hold times
- Reduce lag times by better sensor and valve design and location
- Reduce interlock interruptions by tighter control and optimization
- Minimize acquire time by improve prioritization of users and releases
- Reduce failure expression activation by better instruments, redundancy and signal selection, and more realistic expectations of instrument performance
- Improve failure expression recovery by configuration and displays methods
- Eliminate steps by simultaneous actions (e.g. heat-up and pressurization)
- Increase feed and heat transfer rate by an increase in pump impeller size
- Reduce transition time by head starts, and profile rate of change control
- Minimize processing time by constraint control (MPC and override control)
- Minimize non constrained processing time by all out run, cutoff, and coast
- Minimize processing time by pairing of loop variables to maximize rate
- Minimize processing time by better end point detection
- Minimize processing time by capture of last batch's best IVPs for next batch

Operator Attention Requests (OARs) Elimination

- If operation can make a reliable automatic correction, then it should proceed , notify the operator via a message, and give the operator a chance to change the action by changing a register or analog point.
- Instead of requesting and waiting for a manual entry of information via an OAR, the lab computer system or the operator should enter the result needed into a register or analog input point so it is ready before the operation must absolutely have it. The operation zeros out the value after reading it so an OAR is only triggered if the analog input or register is zero when the information is needed. A message can remind the operator of an impending data requirement.
- Similarly, instead of requesting and waiting for a manual action (closure or opening of a manual valve), the operation should look for a limit switch activation and only trigger an OAR if the action is not done.
- The elimination of OARs facilitates faster and more consistent batches and allows the operator to concentrate on the more important issues.