Operation during transitions

We will learn about operation during transitions

Transitions involve planned transient behaviour between different initial and final conditions.

Continuous processes

- Startup and shutdown
- Regeneration
- Blocked operation
- Load following

Batch Processes

- No steady-state operation

Operation during transitions

Startup and shutdown

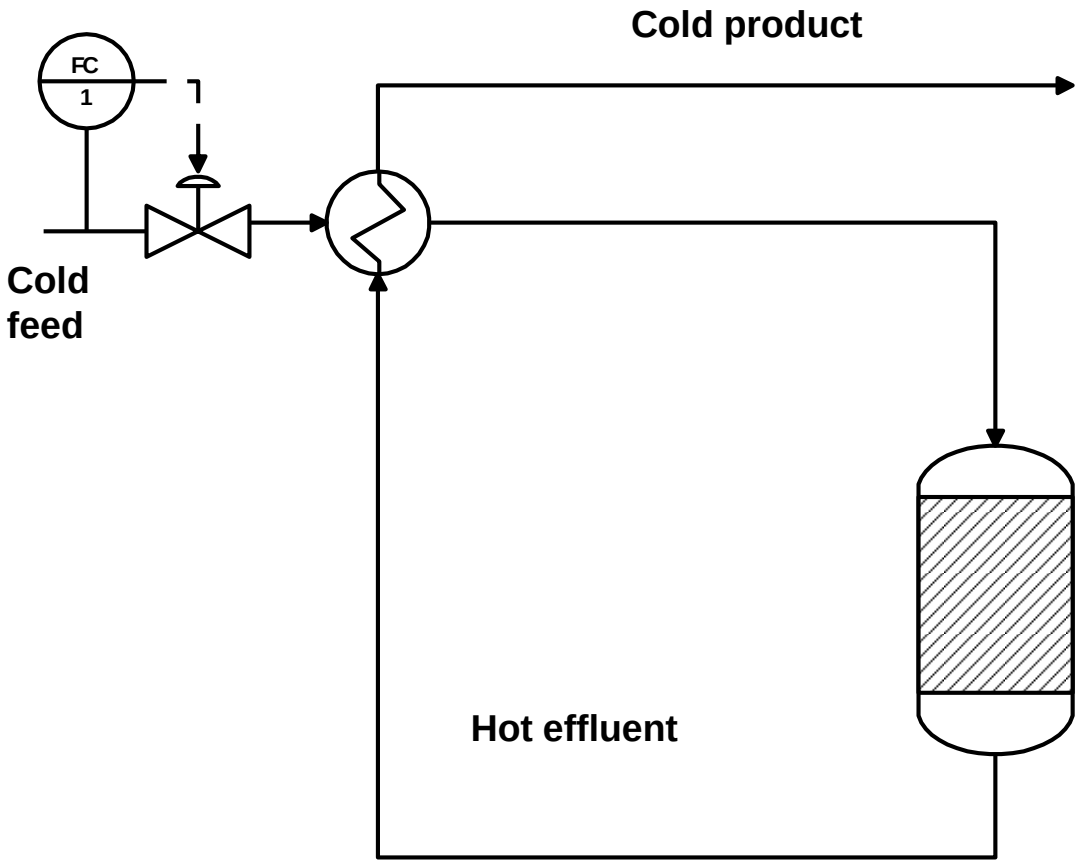
Special equipment and procedures are required for starting and stopping process operations.

- These are ***when most accidents and serious hazards occur*** - be very thorough in planning and training
- Need to load material during startup and drain material for shutdown.
- Need to heat and/or cool to approach normal process conditions or return to ambient.

Operation during transitions

Startup and shutdown

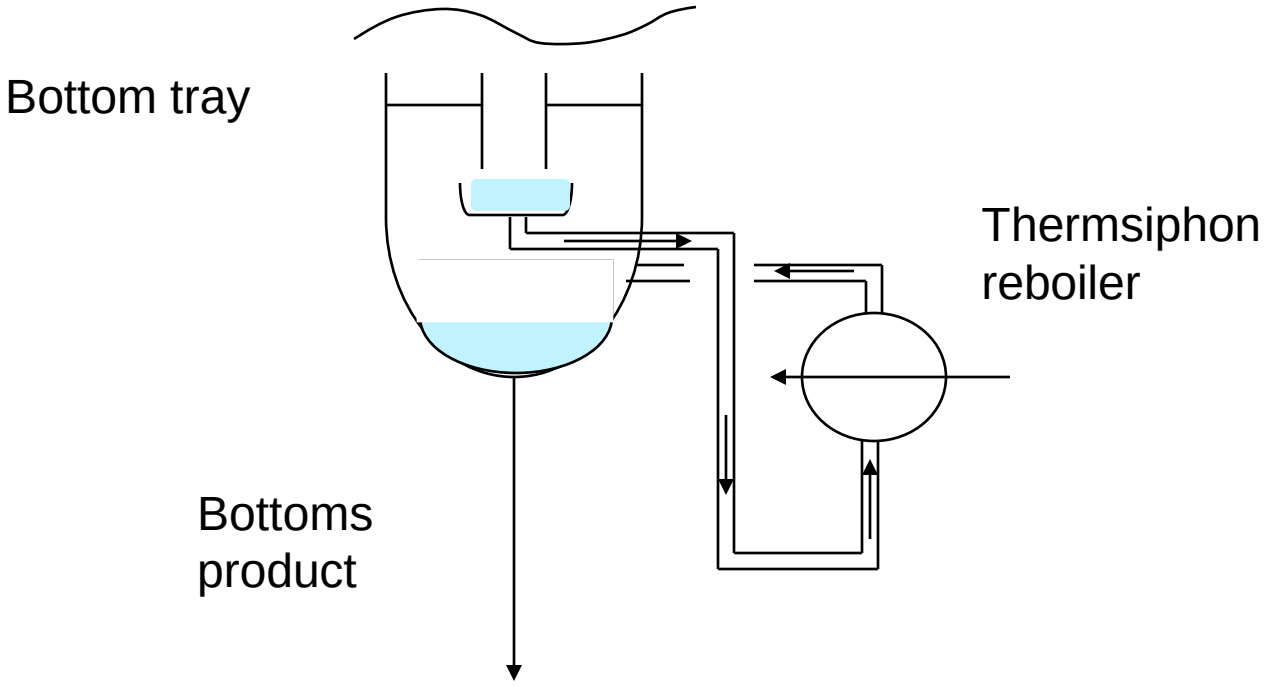
Equipment and process structure: Identify extra equipment needed for startup of the exothermic reactor.



Operation during transitions

Startup and shutdown

Equipment: Identify extra equipment needed for startup of the distillation column reboiler.

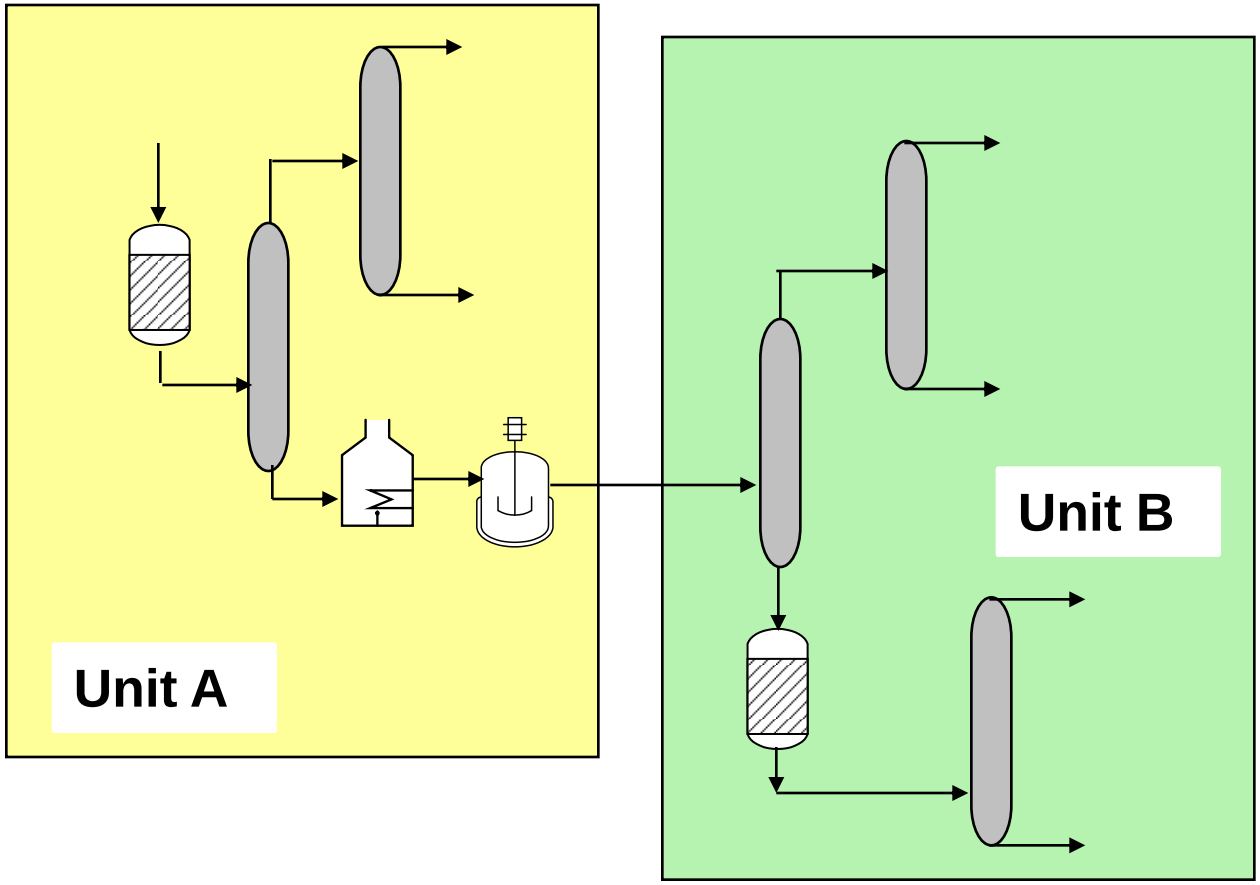


This is what the column operation looks like at full operation. But what about startup, when there is no vapour flow back up the column?

Operation during transitions

Startup and shutdown

Occasionally, equipment must be shutdown for maintenance and modifications. What is required?



Operation during transitions

Startup and shutdown

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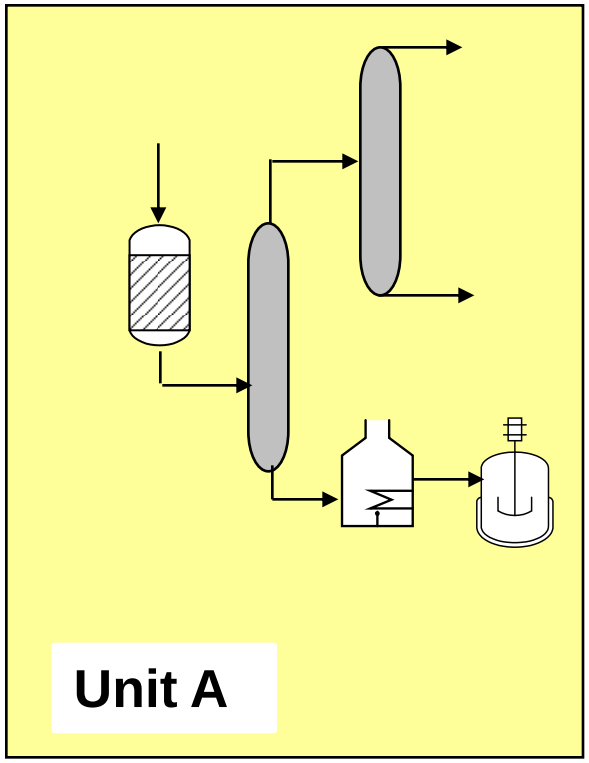
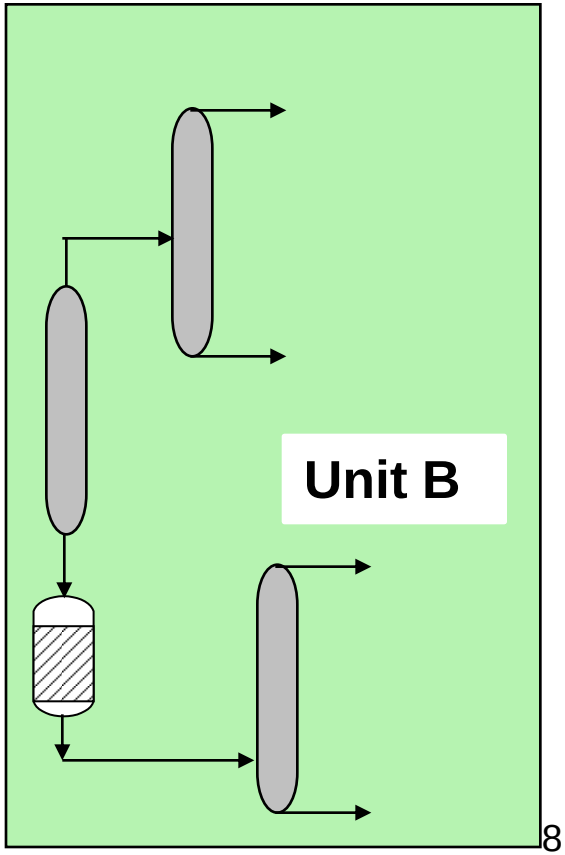




Operation during transitions

Startup and shutdown

Industrial practice

- The first step is to prepare a detailed startup (shutdown) procedure.
- Then, we check the availability of the appropriate equipment to perform the procedure
- This is very detailed work and requires considerable experience in plant operation and plant equipment

(Talk with operators and shift supervisors.)

Operation during transitions

Regeneration

Catalyst, adsorbents, fouled surfaces and some other equipment require periodic regeneration. This can involve different materials flowing through the process and even in opposite directions. The switching period varies from hours to months.

Example of regeneration include the following.

- Catalyst that loses activity
- Adsorbent that has active sites filled
- Equipment that has surface coated due to coke (reactor) or polymer (e.g. reboiler)
- Filter medium that must be backflushed (e.g. membrane)

Operation during transitions

Regeneration

Regeneration involves different operating conditions that can challenge equipment or be hazardous.

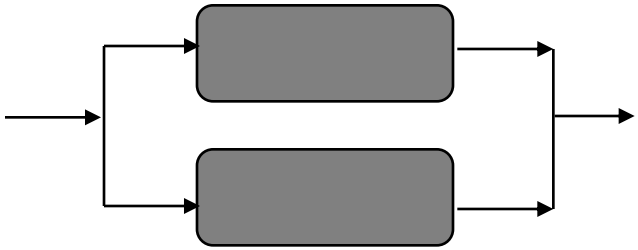
- Different feeds are required. Must have extra valves/ports.
- Hazards, such as introducing oxygen into an environment that normally contains hydrocarbons.
- Different operating conditions (e.g. high temperature steam is used)
- Special transition issues can involve corrosion, contamination, hygiene, toxicology, etc.

Operation during transitions

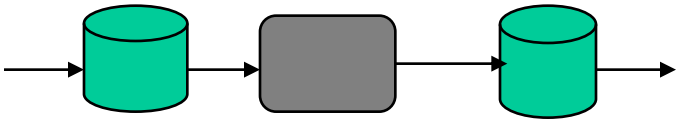
Regeneration

We don't want to shut down the entire plant when regenerating an individual unit.

How can we best maintain the continuous process operation?



Parallel equipment with isolation valves



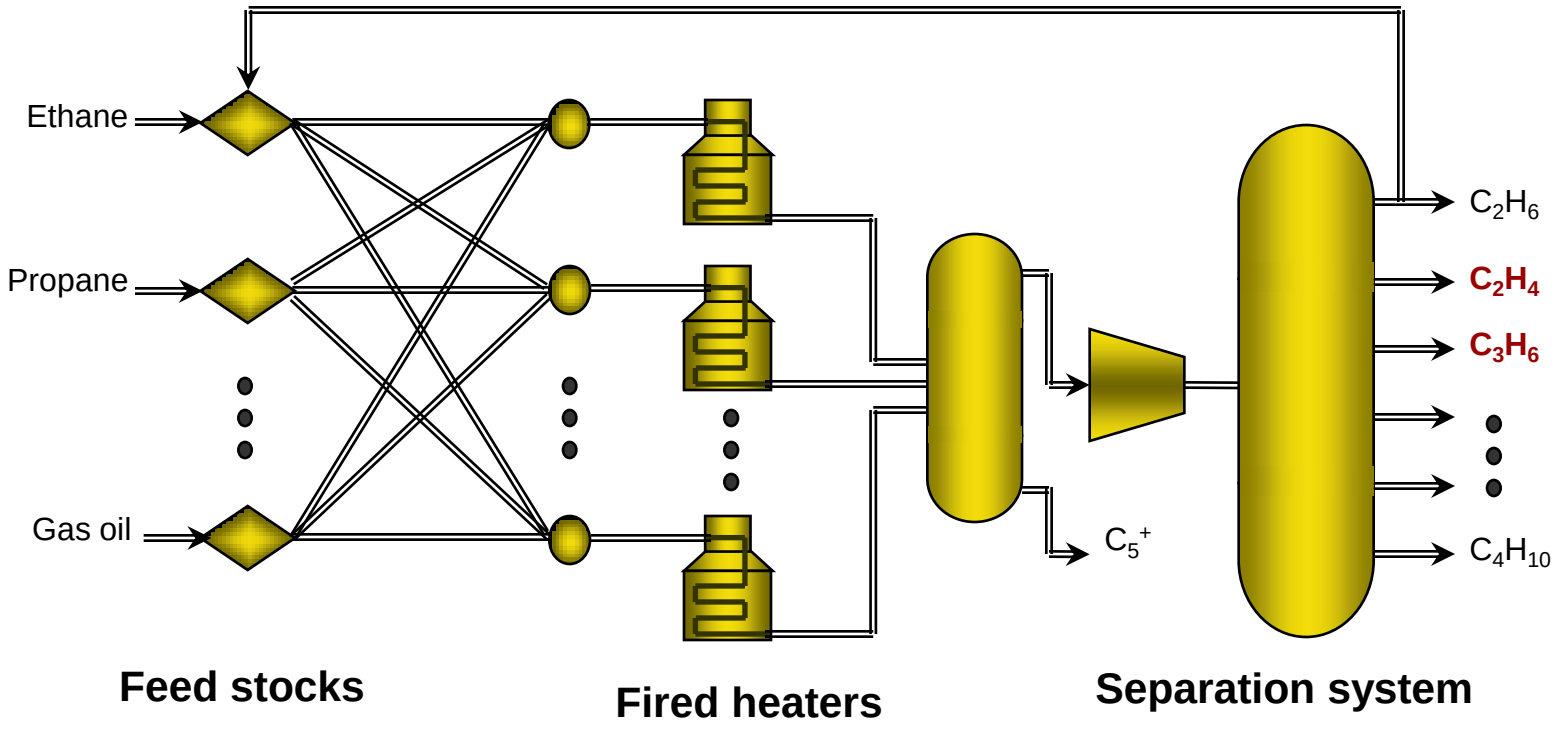
Single equipment with sufficient storage on both sides

Recall the one-way valve discussion from the prior section

Operation during transitions

Regeneration

Example of olefins plant



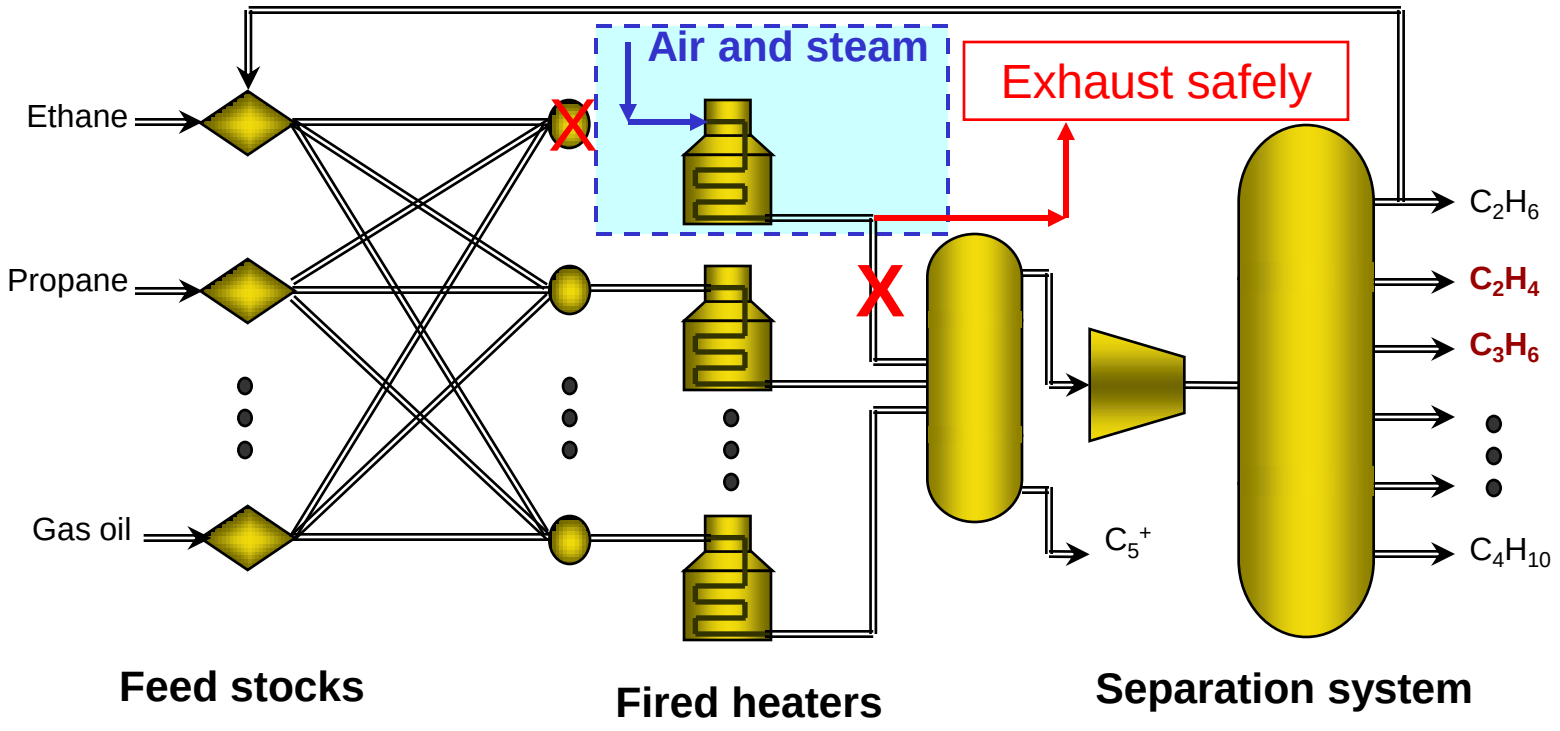
The operation of the heaters (reactor feed type, feed rate, temp, steam) influence the rate of coke and need for regeneration.

Coke buildup:
Requires periodic shutdown/decoke

Operation during transitions

Regeneration

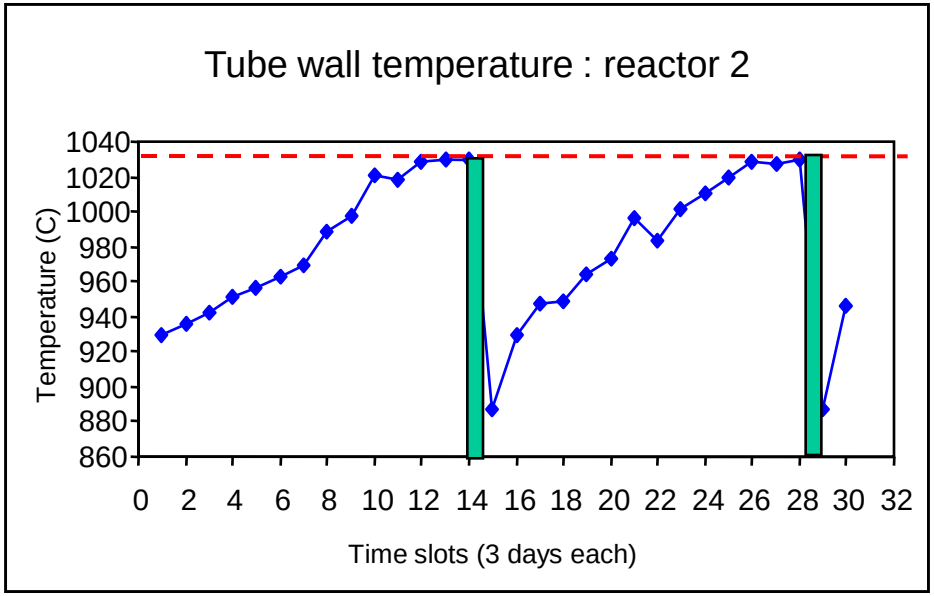
Example of olefins plant



- What happens when one furnace temporarily stops production for decoking (with air and steam)?
- Which of previous strategies is employed (parallel or storage)?
- Might significant hazards occur during decoking

Operation during transitions

Regeneration



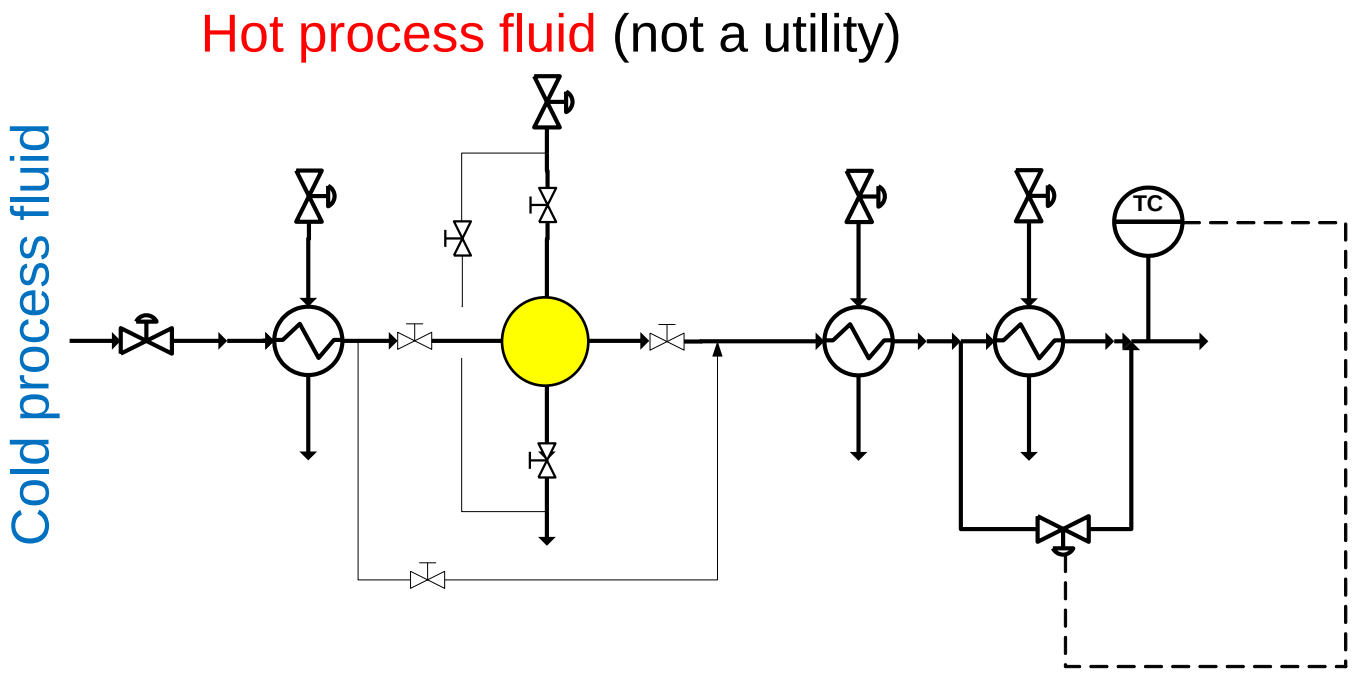
Example trend for one furnace

- The operators monitor the tube wall temperature.
- Roughly every 45 days the furnace is decoked

Operation during transitions

Regeneration

Example – heat exchanger is fouled and must be cleaned.



Since both streams are process fluids, by-passes on each are required. If one were a utility (e.g., water or steam), no by-pass on the utility stream would be required.

Operation during transitions

Batch operations

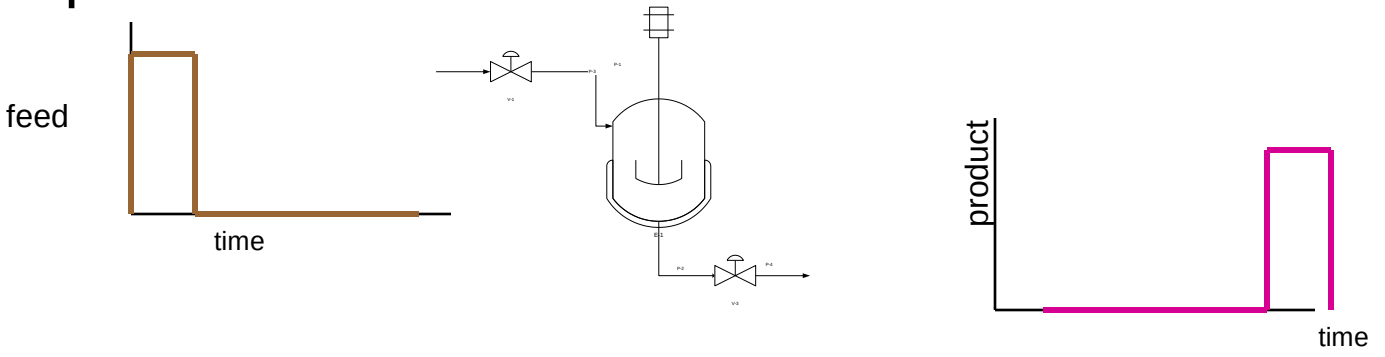
Batch operation

- Often the most economical method for manufacturing small quantities and very high purities. Is generally too expensive for producing very large quantities of material.
- A batch plant usually produces numerous products
- Each product is manufactured in a separate “campaign” involving unique feed materials and processing conditions and shared equipment.
- The process followed is called a “recipe”
- Food, pharmaceuticals, “fine chemicals”, …

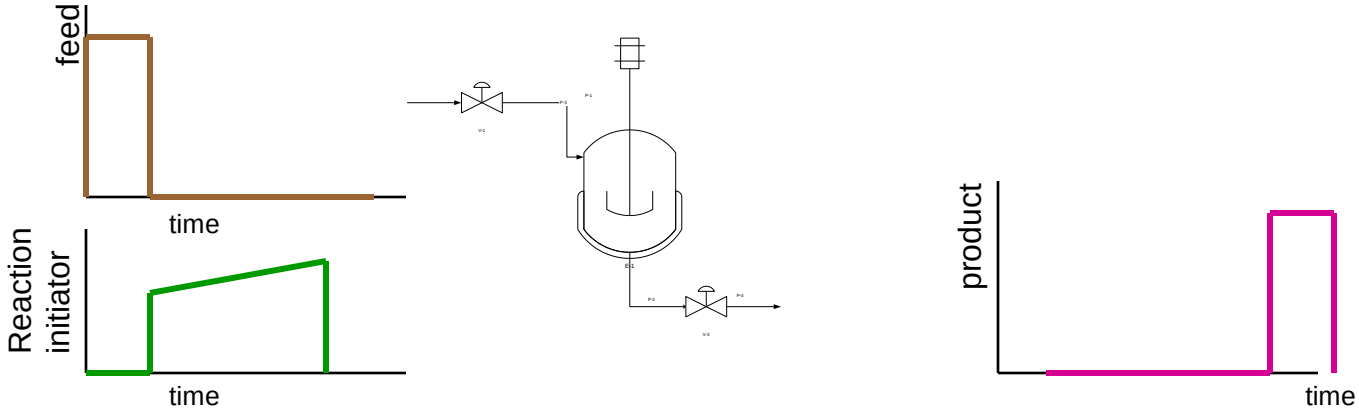
Operation during transitions

Batch operations

Batch operation: All materials provided at start of the process.



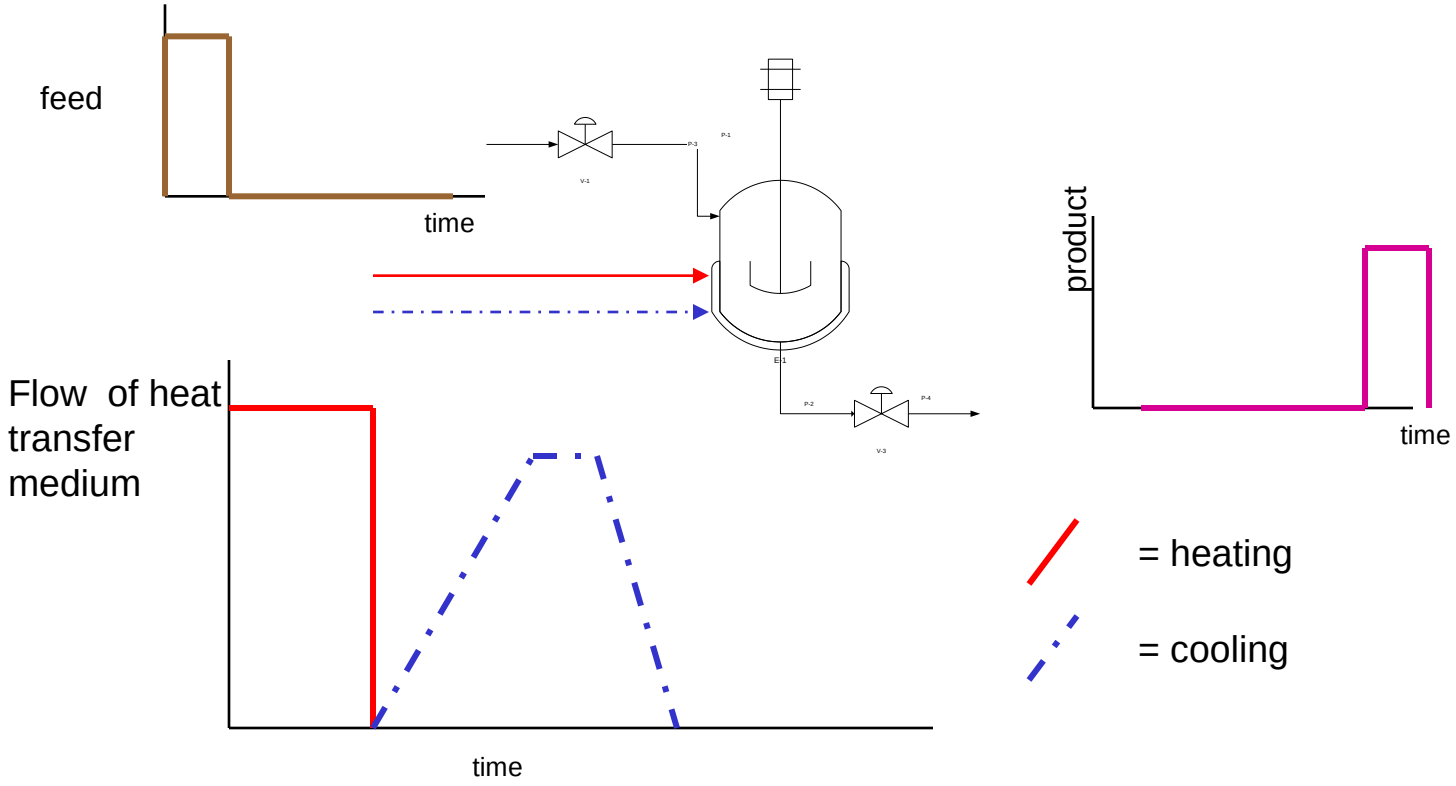
Semi-batch operation: Some materials introduced after the start of the process



Operation during transitions

Batch operations

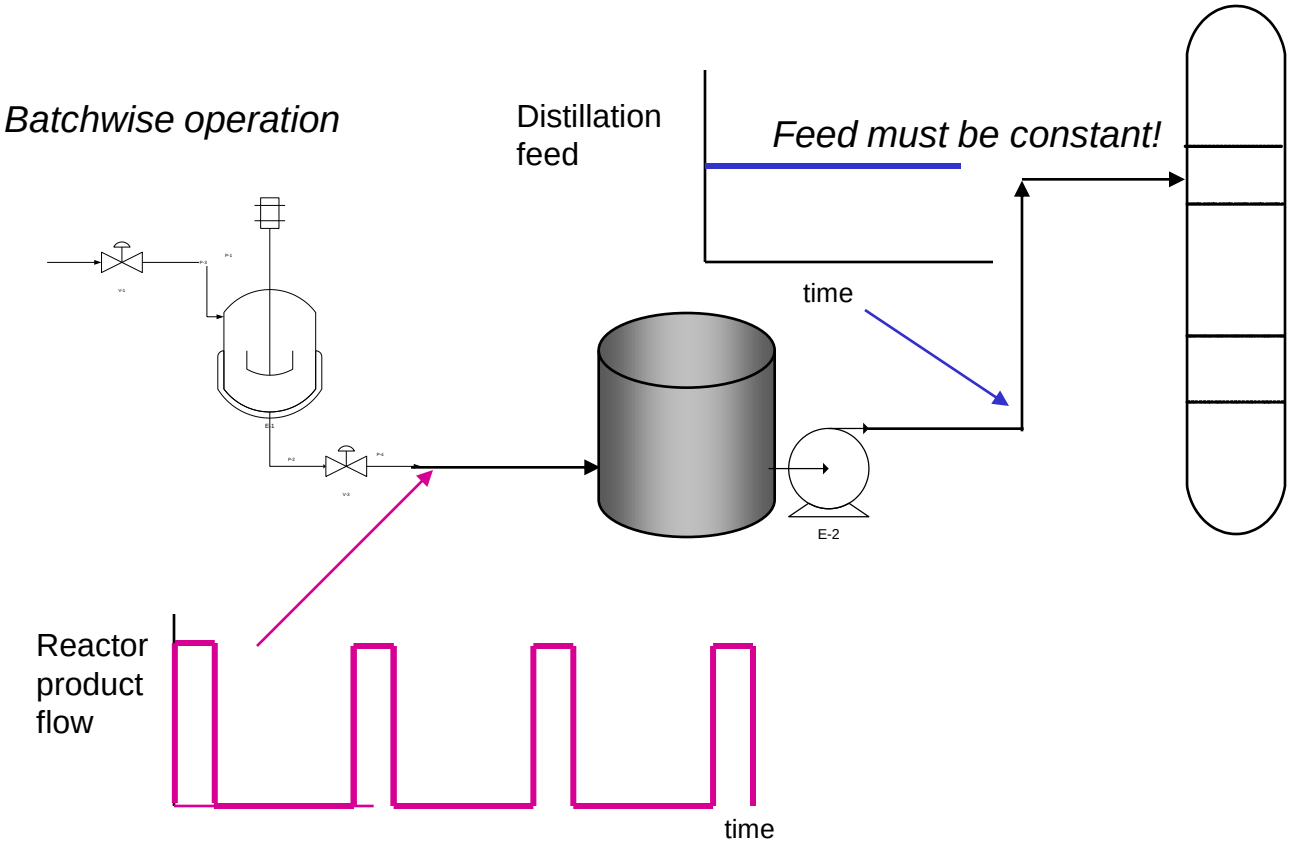
Batch can have very different operating conditions. For example, it can be necessary to heat a reactor in the beginning of the batch and cool it thereafter.



Operation during transitions

Batch operations

Some plants integrate batch and continuous units. The plant must contain storage capacity to allow the continuous parts to operate without frequent shutdowns.



Operation during transitions

All situations considered

Industrial Practice

The operating conditions change during transients. For what operation do we "size" the equipment?

We must size equipment for the most demanding condition of all operations experienced by the process.

Never use the average operation, especially for these extreme transient operations.

It may be required to have parallel equipment with different capacities when the normal and maximum operations are very different.