CH0401 Process Engineering Economics

Lecture 4b

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Process Engineering Economics

1. **Economic Analysis**
2. Economic Balance in Cyclic Operation

1 Economic Analysis

2 **Economic Balance in Cyclic Operation**

Process Engineering Economics – *Cyclic Process*

In cyclic process certain amount of materials is accumulated, and the process is then shut down either because the production rate decreases with time, such as in a filter press operation, production of synthetic rubber by co polymerization or metal smelting operations.

Process Engineering Economics – *Cyclic Process*

The nature of the cyclic process is such that it is *produced in batches*. After a shutdown period for discharging or clean out, the steps of charging, operation and shut down are repeated periodically for the number of cycles required to produce the desired quantity of product.

Process Engineering Economics – *Cyclic Process*

Cyclic processes are of two types they are:

1. Batch operation (fixed or variable cycle time)
2. Semi-continuous operations

Process Engineering Economics – *Cyclic Process*

1. Batch Operations

In a true batch operation no product is obtained during the operation period (which may be varied or fixed) until the completion of batch at the end of operation. The batch operations based on the operation period are grouped into two they are

- Batch operation with fixed cycle time (or operating time)
- Batch operation with variable cycle time (or operating time)

The simplest type of batch operation is one where the operating time is fixed and the economic balance consist of comparing fixed cost against the operating costs, start-up costs and pertinent charges for storage or any other charges that vary with the size of the batch.

1. Batch Operations contd…

In a certain batch operation, the batch time varies at operating cost i.e. the cost for different operating conditions may be computed when charging and discharging.

The operating cost varies in making a batch because the time for production of a batch varies. No product is obtained until the batch is finished which makes this different from semi-continuous operations, where the products can be withdrawn continuously.

2. Semi-continuous operations

The second type of cyclic process which will be referred to as *semi- continuous* where product is made continuously at either at constant rate or variable rate semi continuous process during the operating period.

In other words, where product is obtained continuously but because of gradually decreasing production rate the operation is stopped and initial conditions are restored to give the original high production.

This kind of operations may be considered as semi-continuous one.

2. Semi-continuous operations contd…

Scaling of evaporator is a good example. For a given annual production it is necessary that evaporator be designed to produce the required product allowing for the fact that scaling of tubes scaling of tubes gradually reduces the heat transfer and thus reduces the hourly operation.

After a certain optimum operating time the evaporator is cleaned and the cycle repeated.

Therefore, an economic balance exists between the cost of cleanout and the increased cost per unit of product because of decrease in production rate.

Process Engineering Economics – *Cyclic Process*

Production rates in batch and semi-continuous process

In both the batch and semi-continuous process two production rate are involved they are

a) Instantaneous production rate (at any instant during the cycle - this may be constant or vary from zero to infinity)

b) Average production rate is given as below

$$\text{Average production rate} = \frac{\text{Total production for the cycle}}{\text{The total cycle time}}$$

Process Engineering Economics – ***References***

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