
EXPERIMENT 13 STEAM LOAD ESTIMATION OF A DAIRY PLANT

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13.1 INTRODUCTION

Steam is an essential utility required in a dairy plant for performing cleaning and various heating operations. Cleaning of floor, tanks/vessels/silos/equipment/pipe lines etc. requires hot water for removing sticky oil/fat from the surfaces. The main cleaning operations that need steam or hot water include cleaning/sterilization of milk cans, cleaning in place of milk chiller/ pasteurizer/ homogenizer/ tank/vessel/silos and other processing equipments. Heating is mainly required in dairy plants for destroying microbes, achieving temperatures for improving process efficiency (e.g. homogenization at 66°C, cream separation at 40°C) and/or concentration / drying of milk/milk products.

Steam is generated in steam generator/boiler by heating water with the help of fuel (coal/furnace oil/ LDO/ Diesel/ Natural gas/ electricity etc.) The prices of these fuel source are very high and therefore could be kept under control by optimizing the use of steam in dairy processing operation.

The extent of requirement of steam is dependent upon process schedule and load of plant operations. During some period, the requirement is higher compared to other period. Proper estimation of the steam requirement ensures its timely and enough supply of steam for smooth plant operations. The information about the requirement of steam is helpful in proper selection of the related equipment and would be significant in optimizing cost of utilities.

13.2 OBJECTIVES

- 1 identification of steam consuming and generating centres /processes; and
- 1 load estimation of steam for various processes & dairy plant.

13.3 EXPERIMENT

i. Principle

Steam is generated in steam boiler and utilized in cleaning and heating operations. Generally, steam of dry and saturated condition at 2 to 3 kg/sq.cm is used for most of the dairy operations. However, drying of milk requires high pressure steam above 10.5 kg /sq.cm to get hot air of more than 185° C temperature. Steam is utilized either directly at suitable pressure or in the form of hot water in the dairy operations.

Heat content of Steam:

$Q = (\text{sensible heat of steam} + \text{latent heat of condensation} + \text{sensible heat of condensed steam}) \text{ quantity of steam.}$

The latent heat of steam is a function of pressure and temperature and hence to be noted down from steam table.

Heat given by steam = $Q - \text{heat content of unutilized steam and /or condensed water from equipment.}$

Heat gained by product, KCal = quantity of product, Kgs {specific heat, Kcal/ (Kg deg.C) temp. gained (deg.C).

Heat loss in the process = heat given by steam – heat gained by product

ii. Requirements

i) Plant Equipment: A dairy plant in operational condition having provision for generation/supply of steam.

ii) Instrument requirement

a) Stopwatch, pressure and temperature gauges.

b) Other accessories like graph paper, scale, pencil, eraser, steam table.

iii. Procedure

i) Prepare a process diagram for each of products being manufactured in dairy and identify the various unit operation involved.

ii) Observe the operation period of each unit operation

iii) Plot these hours on “X” axis for each unit operation.

iv) Find out the steam requirement of each operation on hourly basis that consumes steam /heat energy.

v) Sum up requirement of each operation on hourly basis.

vi) Plot the requirement of each process and overall requirement on “Y”axis.

vii) The graph will show requirement of steam on hourly basis for the whole day. Mark the average, peak and lowest consumption rate/hour.

- viii) Similarly, observe and record the generation/supply ratings of steam boiler and running period.
- ix) Plot the rating on “Y” axis and running hours on the “X” axis.
- x) Compare the requirement and supply status.
- xi) Arrive at conclusion to optimize the generation/supply of utility.

iv. Observations

Observe the followings and record:

| Name of Process | Steam Requirement | Operation Period |
|--|--------------------------|-------------------------|
| 1. Milk reception | | |
| a. Milk procured | | |
| b. Nos. of Cans | | |
| c. Nos. of tanker trips | | |
| 2. Milk pasteurization | | |
| a. Processing qty., lit | | |
| b. Pasteurization periods | | |
| c. Cleaning period | | |
| 3. Cleaning operations | | |
| a. Manual cleaning items | | |
| b. Manual cleaning periods | | |
| c. CIP cleaning items | | |
| d. CIP cleaning periods | | |
| e. Cleaning of other production equipments | | |
| f. Cleaning periods. | | |
| 4. Milk Product manufacturing & packing | | |
| a. Milk products manufactured | | |
| b. Product quantities | | |
| c. Manufacturing periods | | |
| 5. Steam Generation | | |
| a. Capacity of steam boiler | | |
| b. Water consumption on hourly basis | | |
| c. Fuel consumption on hourly basis | | |
| 6. Steam losses | | |
| a. Steam leakage points | | |
| b. How water leakage points | | |
| c. Milk losses requiring cleaning | | |

- v. **Results:** Requirement of steam in the dairy is as follows:
- a. Average hourly consumption of steam in dairy :
 - b. Peak steam requirement /hour: Period:
 - c. Lowest steam use /hour: Period:
 - d. Processing consume highest steam: Period:
 - e. Steam generation/hour Total run hours:
 - f. Plot the steam load on hourly basis as depicted in Fig-13.1.

Fig-13.1 : Steam Load Diagram

Use Hours → 6-7-8-9-10-11-12-13-14-15-16-17-18-19-20-21-22-23-24-1-2-3-4-5

- Steam use: ↓
- 1 Can cleaning/ sterilization
 - 1 Floor cleaning
 - 1 Tankers cleaning
 - 1 Pipe line cleaning
 - 1 Manual cleaning of
 - 1 Other dairy equipment
 - 1 CIP cleaning
 - 1 Milk processing
 - 1 Products manufacturing
 - 1 Total steam use

13.4 PRECAUTIONS

1. Steam is used for many products/processes and dairy plant does not have separate measuring device. In such cases it becomes very difficult to apportion them. Proper care in separating steam use for each product is required.
2. Cost of steam must be based on actual consumption, hence, always update posting of issued items in the record.
3. Reschedule operations if present use is very high on some period without compromising dairy's objectives.

Steam Load Estimation
of a Dairy Plant

