EXCERCISE 2 IDENTIFICATION OF PARAMETERS FOR PRODUCTION EFFICIENCY

Structure

2.1 INTRODUCTION

Purpose: Various aspects of dairy plant are monitored through bench- marking system with respect to prominent production efficiencies. Hence, identification of these prominent production efficiencies becomes the basis of management control system. The efficiencies are analysed from the relevant parameters. Hence, once the production efficiency parameters are identified, studied and established, an effective planning is done to prepare a workable monitoring plan. The on-going status is compared with the set bench -marks for achieving desired improvement.

Importance: Production efficiency reflects recovery or utilization of resources and plant/machinery and in-turn indicates cost effectiveness of the individual operation and/or overall system and therefore, has direct impact on its viability. It is obvious that better efficiency means lower losses and operational cost. Therefore, proper analysis based on systematic practical approach, to find out, potential parameters of each production efficiency has a great significance over the economy of dairy plant.

Normally milk processing or production efficiency is identified with parameters like throughput, energy and resource utilization efficiencies, quality defects and product rejection status in terms of percentage, cleanliness or hygiene index, capacity utilization of equipment(s) and whole manufacturing system.

2.2 OBJECTIVES

- to provide practical guidelines for identifying various possible parameters of production efficiency in a dairy plant; and
- to analyse significant production efficiencies of dairy plants.

2.3 EXPERIMENT

i. Principle

A dairy plant involves number of processes to transform inputs into outputs under required plant conditions. The difference between inputs and outputs is termed as inefficiency or loss and the ratio of outputs with inputs is known as process efficiency. The production efficiency could vary between 0 to 1 or 0 to 100%. The extent of losses and inefficiencies adds to the operational cost and therefore, reduction of the losses improves production efficiency of the system.

Milk processing and manufacturing operations normally involve various unit operations containing number of processes, equipments, and resources including manpower, ingredients, packing materials, utilities and other infrastructures. Utilities are provided through the conversion process of resources like fuel and electrical energy into useful utilities. Therefore, overall effectiveness of the plant depends on the resultants of all these. Most of the parameters influence each other and in turn have influence on the final productivity of the plant.

ii. Requirements

i) Experimental Requirements: In a dairy plant a closed system to be earmarked as depicted below with definite boundary in which input to the system and output from the system are identified and measured for determining the production efficiency through monitoring of relevant parameters.

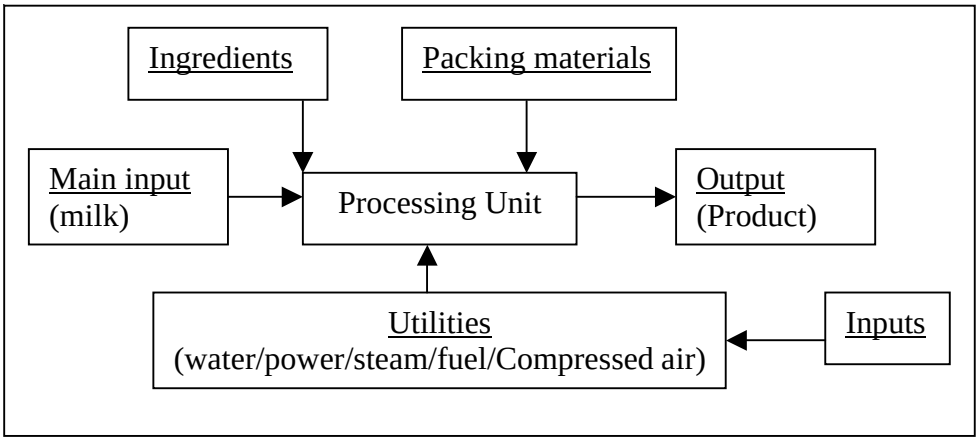

Fig. 2.1 : Experimental Processing Setup Representing Various Resources and Output

ii) Machinery / Instrument Requirements: The major category of equipments required for carrying out various unit operations are listed in Table-2.1. These belong to the operations such as: 1) Conveying /transportation 2) Heat transfer processes (heating, chilling, pasteurization, condensing and drying etc.), 3) storage, and 4) Measuring and monitoring instrument

Table-2.1 : Major Equipments Required for Productivity Efficiency Determination

S.N.	Experiment Setup	Main process equipment	Accessories	Instruments & testing devices
1	Milk Chilling	Can conveyor, Dumpvat, chiller, calibrated storage tank	Pipeline, pump, strainer, valves	Weighing balance, Fat & SNF tester, dip stick
2	Milk processing	Milk pasteurizer, cream separator, homogenizer, cream tank/pasteurizer, milk silos	-do- and compressed air / steam supply	-do-
3	Milk packing	Insulated tank, milk packing machine, cold store, crate conveyor etc.	SS pipe line, filter, clean and compressed air/ cool water supply	-do-
4	Butter making	Butter churn, cream loading pump.	Trolly, chilled water supply	Fat /SNF / moisture testing devices
5	Ghee manufacture	Butter melting vat, ghee boiler, clarifier, settling tank, packing machine	Pump, valve, pipe line	-do-, temperature & pressure gauges.
6	Milk Powder production	Condensing and drying units	Pumps, condenser, spray pond, bag filling machine	-do-

iii) Chemicals /Materials requirement: Milk, conserved commodities, packing materials, fuel oil, potable water etc.

iii. Procedure

i) Identify the production efficiencies to be monitored.

ii) Identify various parameters relevant to the above production efficiencies.

iii) Prepare the dairy operation for the experiment. It should be clean and tidy. Take initial reading and record the position of material and other resources.

iv) Start various equipments to perform dairy operations.

v) Monitor various parameters related to the production efficiency.

vi) Based on the recorded fact sheet of parameters, production efficiency is determined as detailed below:

Some Important Production Efficiencies of Dairy Processing Plants

1) Steam generation efficiency in %: (Enthalpy of steam; Kcal/Kg C Steam generation, Kgs/hour) C 100 / (Kcal Calorific value, Kcal C Mass of fuel used, Kg/hour)

2) Steam Utilization, in % = η=

$$\frac{\text{Steam requirement of all the unit operation} \times 100}{\text{Fuel quantity, Kr(lit)} \times \text{steam, kg/kg(lit)fuel}}$$

3) Refrigeration Utilization efficiency, % = $\frac{(\text{Refrigeration load / day} \times 100}{\text{Rated refrigerated capacity / day}}$

4) Milk processed per Kg steam=milk processed in litre/ daily steam production

Where, Steam Production per Kg(lit) fuel = Quantity of fuel C Conversion ratio and Conversion ratio = Calorific value of fuel / energy value of steam.

5) Milk processed per KWH = Milk processing qty, lit/ Electrical power consumed (KWH)

Note : Consider daily or periodical quantities.

6) Milk processed per TR = Milk processing qty, lit/ Refrigeration used (TR).

Note : Consider daily or periodical quantities.

7) Pasteurizer regeneration efficiency, % = percent of heat gained or recovered from the stream of returning hot milk by the forward cold milk or vise versa.

Note : Measure the relevant temperature at the inlet and outlet of each section of milk pasteurizer, being same flow rate, the ratio of temperature gradient of gaining heat medium (milk) to the loosing medium(milk) heat becomes the efficiency of heat regeneration in heating.

Similarly, efficiency of regeneration in cooling could be calculated.

8) Water to milk Ratio = Daily water used, Lit / Daily quantity of Milk processed, lit

9) Pasteurizer throughput, LPH = Daily quantity of milk processed / Pasteurizer running hours on milk.

10) Capacity utilization of:

a) Milk Pasteurizer, % = Average throughput C100 / rated capacity of pasteurizer.

b) Dairy plant, % = $\frac{\text{Qty. of milk handling lit / day} \times 100}{\text{Rated per day plant capacity, lit / day}}$

c) Resource utilization Efficiencies

i) Packing material use/Kg (lit) milk or milk product =

= Qty. of packing material consumed / (Qty. of Milk or product packed C specific use per unit packing)

ii) Raw material use/Kg(lit) milk or milk product =

= Qty. of raw material consumed/ / (Qty. of Milk or product produced C specific use per unit production)

iii) Manpower use / Kg(lit) milk or milk product =
= Number of man hours used / (Qty. of Milk or product produced C specific use per unit production)

Similarly by applying above basic concepts other aspects of production efficiencies can be analysed, through identifying the relevant parameters based on basic concepts and feasibility of measurability in the dairy plant.

iv. Observations

While conducting a particular experiment, all the observations regarding the initial and final condition are recorded. The process parameters like temperature, pressure and flow quantity is monitored and noted during the experiment. Some standard / technical information regarding heat and/or mass transfer, thermodynamic and/ or psychometric properties are noted from the standard reference tables / books / monograms.

Monitor and record the physical parameters as :

SR. No	Name of equipment/section	Observation on parameters			
		A	B	C	D

Remarks: A, B, C and D etc. are the relevant production parameters

v. Results

Based on the above observations, the production efficiency under experimental objective is calculated by using the equations mentioned in the procedures or using the technique of mass and /or energy balance within the defined experimental boundary. Accordingly, determine the production efficiencies as detailed above in para-1.3.3 in terms of i) plant or equipment capacity utilization ii) resources(human, utilities, raw materials, packing materials) utilization efficiencies.

2.4 PRECAUTIONS

1. Uses calibrated instruments or calibrate before using them.

2. Dairy operations are of process type and hence all the measuring / testing devices should be readily available. If possible, in-line measuring /testing devices / instruments should be used.

3. Before conducting the experiment, one should study the relevant production technology.

4. The study should be conducted under the guidance of experienced professional.