Investigating cheese yield problems

Cheese yield is a critical determinant of profitability and economic success in the dairy industry. Even a slight difference of 0.1% in cheese yield can significantly impact the economic success of a cheese manufacturing plant.
A drop in expected yield therefore necessitates a timely investigation, and this article briefly summarises two different perspectives on how this might be done:

i. Traditional dairy technology approach
ii. Chemical engineering approach

Dairy Technology approach to investigating yield problems

This approach examines each major step in the cheesemaking process against known effects of raw material and processing parameters on cheese yield. This involves going through the following 5 steps:

i. Milk quality assessment
ii. Optimising milk processing
iii. Rennet coagulation management
iv. Vat curd handling
v. Post vat curd handling

For example, we know that high somatic cell counts in milk can impact casein integrity and high counts of psychrotrophic bacteria can produce enzymes which degrade the protein in milk. Both effects will impair protein recovery into cheese.

Milk processing involves pasteurisation and usually standardisation. Overheating milk can hinder proper curd formation while failure to standardise milk composition to an optimal protein fat ratio means lost opportunity in moisture retention and fat recovery.

Coagulant selection is also key to ensure a high ratio of clotting to proteolytic activity, consistent with optimal protein retention. Firmness at cutting is critical to minimise curd shattering and losses of fat and protein fines. The increasing use of curd firmness monitoring instrumentation emphasises this.

The vat operations of cutting, stirring and scalding are where the bulk of fat losses occur (50-70%). A healing period after cutting is important to allow the curd to develop a protective surface layer which reduces losses during stirring.
The stirring programme is made up of times for different speeds of knife rotation, rest periods and overall number of rotations. The programme needs to be optimised by recipe to minimise losses. Over working the curds and excessive heating can lead to excessive moisture loss.

While the bulk of fat losses occur in the vat, significant damage to the curd can occur in transfer to and from drainage belts, cheddaring, salting and pressing. Losses are exacerbated through overworking of curd during transfer operations and subjecting the curd to undue pressure and temperature during cheddaring and pressing.

This systematic assessment of raw material and processing from a dairy technology perspective can often help identify a yield problem, but what do you do when the obvious solutions don't seem to work?

Chemical Engineering approach to investigating yield problems

A powerful approach to uncovering the root causes of yield problems involves a four-pronged strategy based on chemical engineering principles:

i. Process mapping involves modelling the entire cheesemaking process through a detailed flow chart. Each step, from milk reception and standardization to curd cutting, stirring, pressing, and ripening, should be mapped out. This allows for a systematic review and benchmarking of each stage to pinpoint where deviations from optimal conditions or procedures may be occurring.

ii. Mass Balance Analysis involves meticulously accounting for all inputs (milk, starter, salt) and outputs (cheese, whey streams) throughout the cheesemaking process. By tracking the fat, protein, and moisture content at each stage, potential losses can be quantified and located. For example, excessive fat or casein losses into the whey will indicate inefficiencies in the curd formation or handling steps. Mass balance calculations also help highlight any deficiencies in measurement process (see below).

iii. Yield Prediction & Comparison. The predicted cheese yield can be estimated using established formulas that consider milk fat and casein content. A reliable cheese yield prediction formula for individual cheese plants can be established by utilising the Van Slyke formula as a foundation, incorporating plant-specific fat and protein recovery factors, as well as a constant accounting for minerals, lactose, and salt.

    Comparing these predicted yields with actual yields obtained from production runs provides a valuable efficiency index. Discrepancies between predicted and actual yields indicate areas where the process might not be optimized or where hidden losses are occurring.

iv. Measurement Audit: The accuracy of measurements throughout the cheesemaking process is critical. A thorough audit should be conducted on all weighing and analytical equipment, ensuring their calibration and proper functioning. Inaccurate measurements of milk intake, milk composition, cheese composition or whey stream losses are not uncommon and can distort the true picture of yield and lead to incorrect conclusions about process efficiency.

By implementing this four-pronged approach, cheese manufacturers can supplement dairy technology knowledge to comprehensively investigate and address the underlying causes of cheese yield problems. This systematic strategy allows for a clearer understanding of the cheesemaking process and identifies where losses occur, supporting data-driven decision-making.

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