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AUTOMATED PROCESS CONTROL SYSTEM MILK PASTEURIZATION

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General Concepts and research motivation methods of pasteurization

Milk can be defined as the lacteal secretion practically free of colostrum. However, the contamination of milk from the udder and teat surface, as well as soil bedding, manure, feed, milking equipment, milk handlers invariably lead to the introduction of psychotropic and mesophilic bacteria at reasonably high numbers. To ensure the increase in shelf life of the bovine milk, thermal treatment with three generic techniques have been evolved in dairy industries.

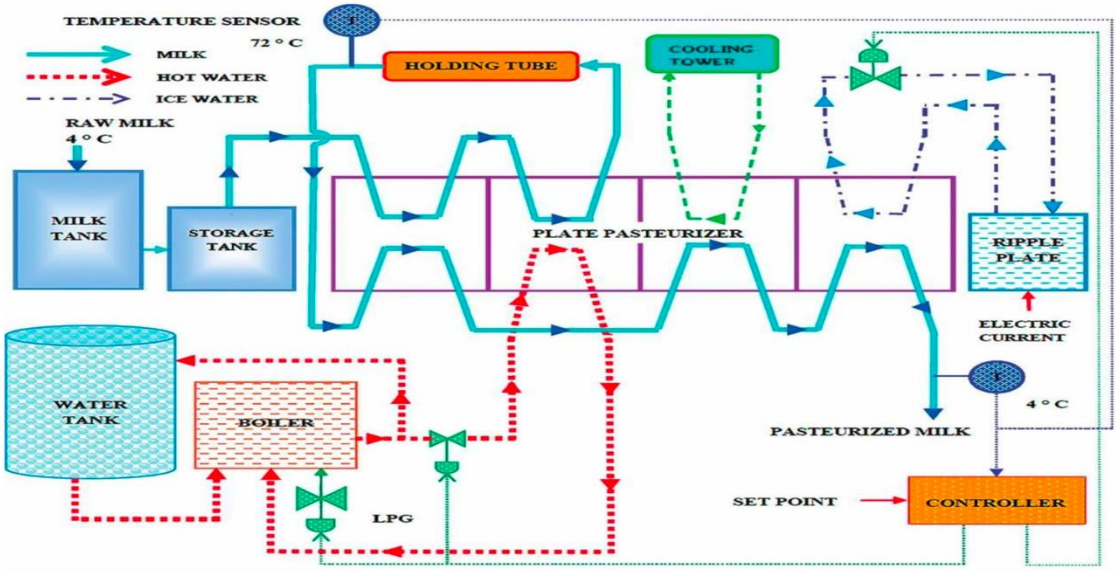

Figure 1 The schematic diagram of the HTST milk pasteurization process

Pasteurization is a nonlinear and multivariable interacting process of heating the raw milk from 6°C to 70°C, holding it for a period of 15 seconds in the holding tube and cooling it down for upto 2-4°C depending upon the setpoint in the controller. It is difficult to control this system by the conventional on–off controllers

$$G_C(s) = K_P + \left(\frac{K_I}{S}\right) + K_D S^{\mu}$$

The biggest challenge for controller design in front of dairy producers and plant builders is to ensure that the process parameters are under steady state conditions followed every time and as closely as possible. Any deviation can lead to changed features or contamination, in overall to product recall and loss.

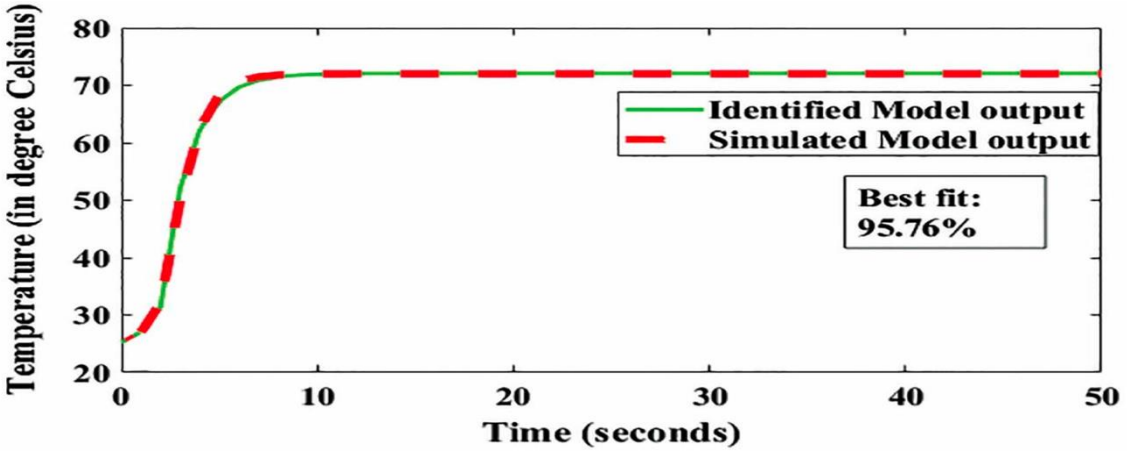

Figure 2 Identified and Simulated model output of the Heating Stage

The process was conducted for the time of 30 min. In which 15 min was taken to maintain the steady state with the aid of classical PID controller. In order to minimize the time taken for steady state response, the proposed controllers were used. This controller was operated based on the response outputs obtained from the classical controller as process with time delay. The process model was obtained based on the equations provided on the section with time delay function using the Deep reinforcement learning based on RL (reinforcement learning) agents.

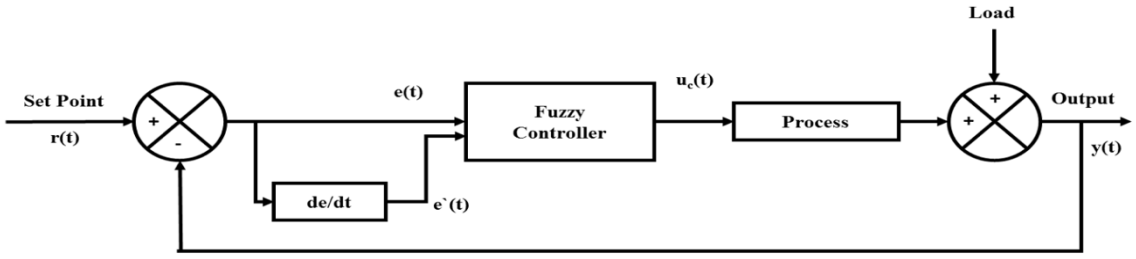

Figure 3 The closed loop fuzzy logic control

Literature

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