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Temperature Regulation in Milk Processing

Milk and its derivatives are highly perishable products and require the monitoring of the temperature from the collection at the farm, during the processing and the delivery to the consumer. Controlled processes are central to the consistency and quality in each of the batches of the products that are processed.

Among the many factors that need to be managed in the production of Milk and its derivatives, Temperature control - during the heating and cooling processes, that are illustrated in Figure 1, is a critical parameter to be monitored and regulated.

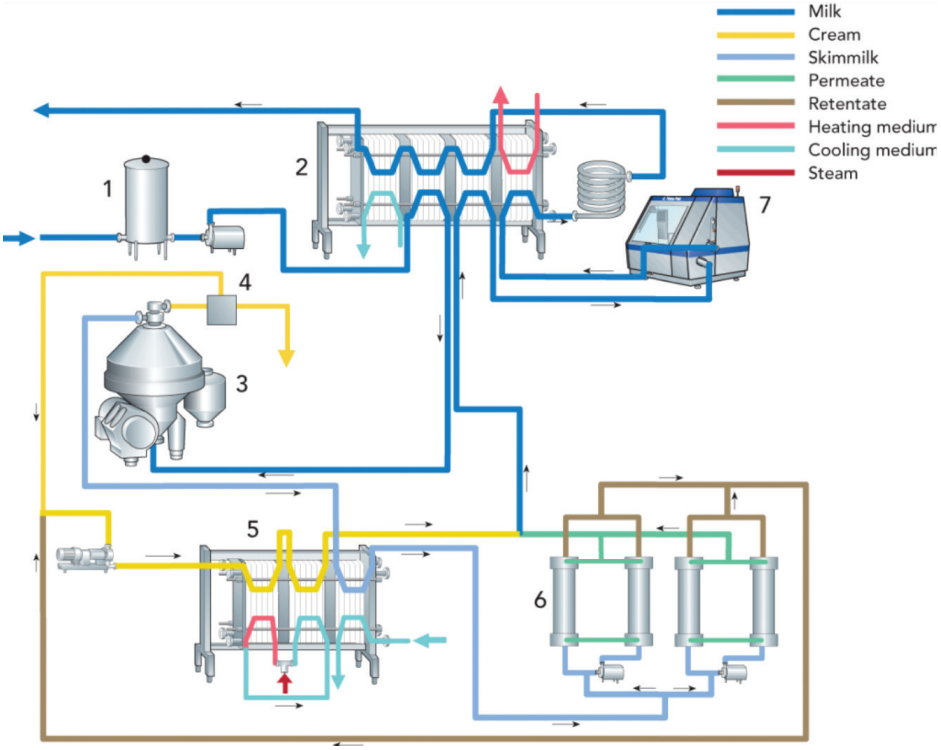


Fig 1: Typical workflow in Milk Processing, focused on required temperature control.

In the processing of Milk and its by-products, Temperature is the greatest single factor to be controlled for quality and consistency.

The monitoring of the temperature of Milk as soon as it leaves the Udder to storage, transportation and processing is vital in ensuring the safety of the consumer and the quality of the product. With the advent of pasteurization, one had to monitor the temperature using a simple thermometer. In today's large-scale production operations, one can use advanced electronics to monitor temperature using thermocouples. In most countries, it is a legal requirement that the monitored temperature be recorded and made available for audits.

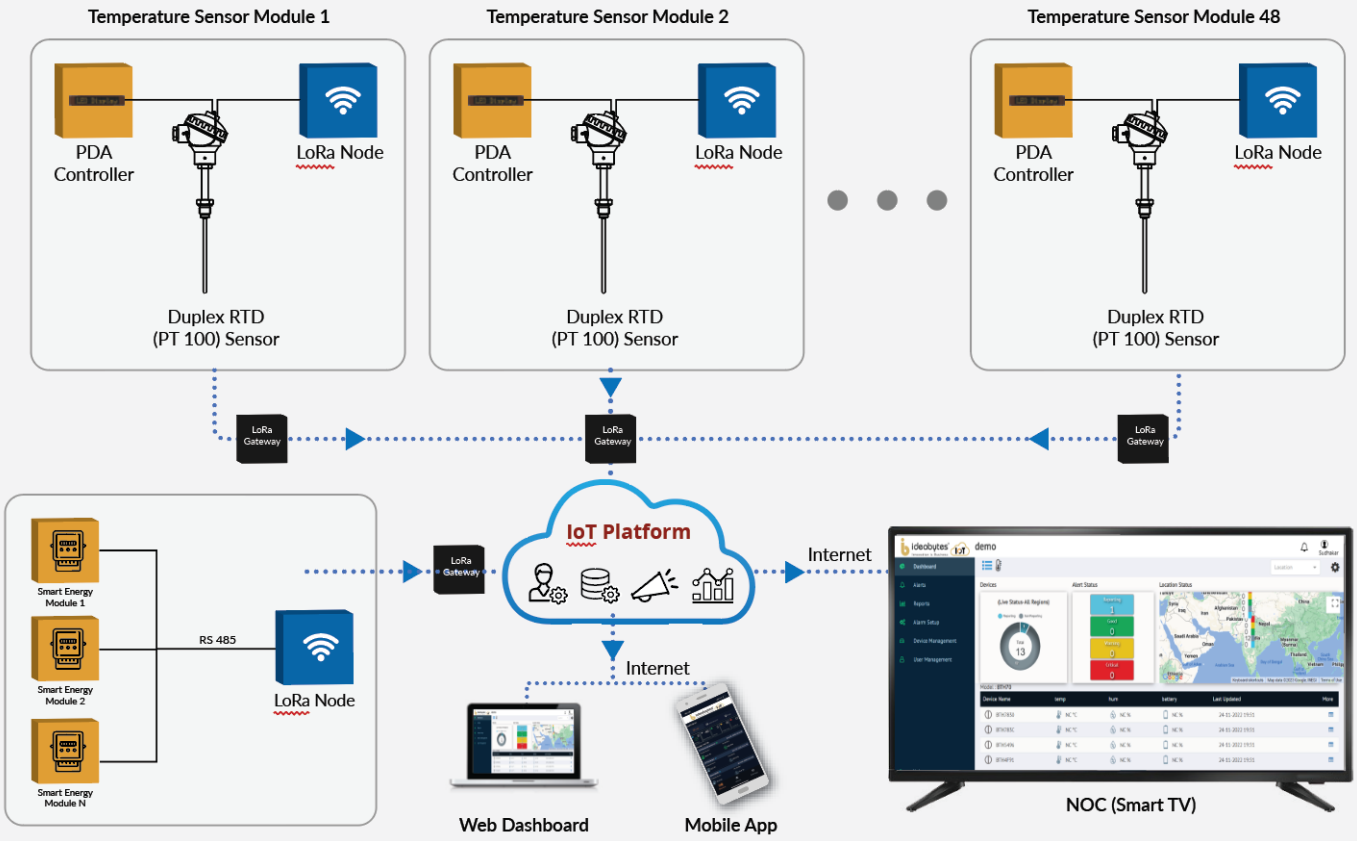
While measuring, monitoring, controlling and recording of temperatures has been facilitated with the advancement of IoT (Internet of Things) technology, pre-emptive actions to manage and control the cooling and heating equipment using AI/ML (Artificial Intelligence/Machine Learning) can contribute to significantly lowering OPEX and eliminating waste.

Fig 2: Temperature is critical for all dairies in the production and distribution of quality products

Temperature measurement is achieved using Thermocouples which measure temperature to within ± 0.25°C. The digital value monitored by these sensors are sampled periodically by controllers and then transferred over a network to a central controller. There are three methods of transferring the data, 1) Sneaker Net, 2) Ethernet/Wifi 3) LoRA (Long Range).

In medium to large production facilities, LoRA provides the most efficient cost effective method to transfer data from sensors to collection hubs that can aggregate data from multiple sensors and transfer it to a central HUB many 100's of Kilometers away using 4G/5G or internet technology.

Lowering OPEX in the Modern Dairy with LoRa and IoT



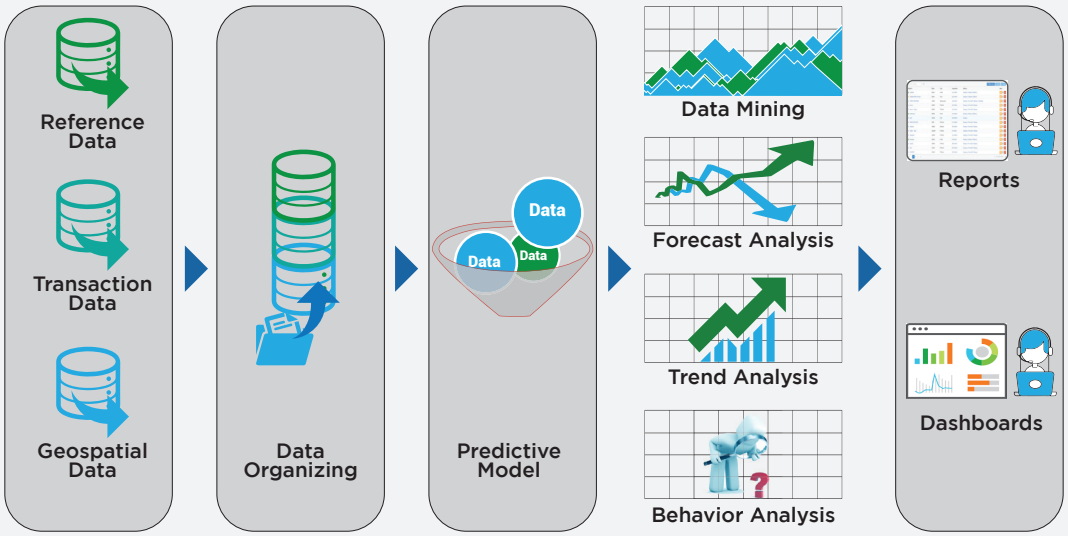
While most Dairies have temperature monitoring methods, this solution will help retrofit existing machines with a cost-efficient solution - reducing OPEX and takes the first step to consolidating the monitoring of all the existing sensors at a central NOC (Network Operation Centre) on a cloud-based platform. The traditional NOC augments mobile devices (tabs and smart phones) to physically monitored locations. IoT enables the processing of Alerts and Faults from a cafeteria, washroom or while travelling in an automobile.

Additional OPEX efficiencies can include the monitoring of the power to the heating and cooling units with Hall effect sensors to determine that the units are running to specifications. Efficiencies in the cooling and heating are determined using AI/ML techniques, and if anomalies are detected, maintenance can be scheduled to avoid failures, improve performance and reduce power consumption.

While the focus has been on the cooling and heating systems, the inclusion of the monitoring and control of the agitators and centrifuges in a Dairy are equally important to achieve optimum efficiency. When the agitators don't function correctly, milk can get separated by gravitational forces that makes temperature control inefficient. Over aeration can cause the fat to separate making the molecules susceptible to degradation and milk to clump forcing the centrifuges in the clarification process to work harder - prior to the pasteurization process.

The purpose of the paper is not to advocate a big bang adoption of IoT for every system in a Dairy, rather it advocates a layer by layer approach, with temperature monitoring and control being the first step. This methodology is very much in line with the Kaizen approach, where progressive evolution rather than disruptive methodology is important.

When the temperature monitoring infrastructure is in place, data is continuously being gathered to be fed into the AI/ML algorithms to determine performance patterns. The next phase would be the monitoring of the power consumed by each of the devices, which when over-laid on the tempera-ture data, begins to give performance patterns of each of the devices.



The data captured in the first two steps can then be used to determine a baseline which can be used to control the efficiencies of the agitators and centrifuges.

The next layer from a flow perspective is to introduce viscosity-meters to measure the flow efficiency of the milk through the vast pipe lines in the Dairy. Inefficient flow in the pipes caused by temperature, flow-impeding build ups affect the quality of the products.

IoT offers the Dairy industry the ability to harness the latest technologies to gather data to make determinations to better control the processes and drive the bottom line. After all consistent quality in every glass of milk is what end users seek and Dairies strive to out-perform their compe-tition.

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