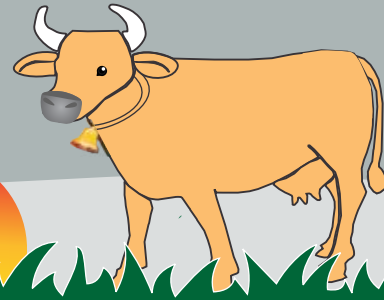


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Automatic Milk Sampling System - A Step Towards More Transparency



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Unit Profile-The Anand Pattern

UKaira Union is popularly known as “Amul Dairy”, is the first Milk Co-operative in India, established in the year 1946. The Co-operative began with 250 liters of milk collection per day and is collecting and processing 33 lakh liters of milk per day in peak season from nearly 1247 villages of Anand, Kaira, and Mahisagar Districts of Gujarat. The milk producers’ owned and managed Co-operative has been provided to be the tool for empowering 7,14,623 milk producers to adopt modern science and technology, acquire professional expertise to produce, process, and market milk and milk products and be the market leader in India.

“Anand Pattern” - a successful model has been replicated not only in India but abroad by the NDDDB and FAO to bring about the socio-economic change in the rural area.

Village Dairy Co-Operative Societies (Vdcs)

In “Anand Pattern” Village societies are the foundation where the Milk procurement activities are carried out. Each Village consists of a milk collection center (VDCS, Village Dairy Co-operative Society) where any one of the family members from the society members’ house takes the milk produced in the morning and evening at the specified time. At the center, milk is promptly measured and a portion of the sample for testing purposes is taken, to test fat for payment. The staff appointed by society and trained by the union works out the amount to be paid based on milk quantity received and the quality. This everyday checking on quality discourages adulteration. The processing plant managed by the Union receives the milk, where it is graded. From each society, the milk is pooled and weighed, and the sample is tested for FAT and SNF. The society receives its payment for milk once in ten days based on fat and also on the quality of milk.

Morsel Of Milk At Vdcs- A Base For Payment System

India is endowed with a large milk production base comprising of a large no. of milch animals. Maintaining the quality of milk from udder to consumer is a major challenge.

The first step for meeting this challenge and ensuring the cold chain there was a need for installation of Bulk Milk cooling units in the milk-shed areas (Village Chilling Units). Hence Amul Dairy in the nineties took initiative to conduct a detailed investigation on the quality status of milk starting from milking point to collection centers, transportation up to the dairy dock.

Based on the results, Amul introduced the concept of chilling the milk at the collection point i.e. at Society level to less than 4 degree Celsius within 1-2 hours of milking by installing



Bulk Milk Chillers (BMC) and Kaira Union (Anand, Kheda and Mahisagar Dist.) was the first in India to have 100% installation of BMC in all VDCS (1202 no., Yr. 2016-17). VCU Monitoring Cell completes the link between milk producer's and dairy by transporting raw milk in milk tankers from VCU/DCS to processing facilities.

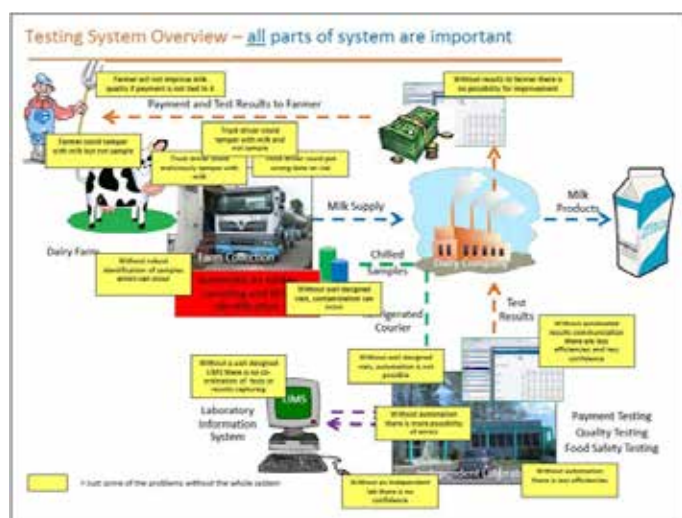
Milk haulers (name as BMC sahayak/ Conductors) play a crucial role in the measurement of milk as payment to the VDCS is done based on milk measurement through Dipstick and the BMC milk sample of VDCS collected by them.

Earlier Milk Sampling Scenario And Challenges

In the existing scenario, the Conductor goes to the village with a tanker and measures the milk quantity collected from BMC through dipstick but unable to detect quantity transfer in a tanker of respective VDCS. Also, the measurement through a dipstick is never accurate and depends on its calibration and positioning.

Milk sampling is done manually by agitating milk in BMC tank for 5 to 7 minutes and taking the sample in a bottle manually. We have a major concern regarding the accuracy of milk sampling and quantity of Milk measured through the dipstick considering human error & mischief.

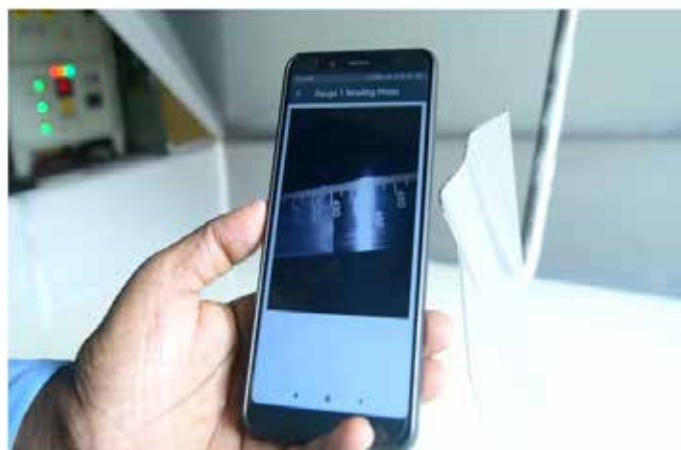
Over the period, we have adopted technologies like Automatic Milk Collection System (AMCS), Bulk Milk Coolers (BMC), Solar-based system, CIP units, and so on to preserve the quality of Milk. To date, Milk measurement & sampling through automation is the untouched area at the Village level because of this Dairy Industries are facing problems of Milk Pilferages, Adulteration, Sample tempering & so on. Such kind of problems makes society members skeptical attitude towards the transparency of the system.



Problems in current Milk Sampling System

Inception Of Automatic Milk Sampling At Amul:

The original concept of the automatic milk sampling system is derived from New Zealand where big cooperatives like Fonterra and Tatua use to have automatic sample collection with limited features. They only use the technology of Auto milk sampling to draw milk samples from BMC automatically. The system is not GPS-based and also, they have not required the digitally locked box. So, it was a big challenge to incorporate this system into



Raw Milk Quantity & Temperature measurement at VDCS

our scenario. To take charge, we analyze the system of route management, identify the threats, loopholes, and errors in the system.

Based on that, Amul Dairy worked out requirements and designed a robust, full proof system and introduced new features along with imported automatic milk sampling system like GPS coordinates, mechanical lock/ temper proof system, magnetic flow meter (Bidirectional) with temperature sensor, air eliminator and glycol filled vials rack.

Meantime, we installed a magnetic flow meter on the tanker for the prototype to ensure sustainability and working of flow meter on Indian road condition and other aspects. After examining the data & results, we felt confident to move on next level "Automatic Milk Sampling System" technology and increased access to data is enabling the dairy business to make smarter decisions day to day and stabilize milk procurement. Therefore, getting the advantage of technology, we introduce RFID & GPS based Automatic milk sampler system installed on milk tankers that enable automatic sampling & measurement of raw milk quantity from various VDCS.



Automatic Milk Sampling System

The auto sampling device is a closed, containerized, and digitally Password-protected system which consists of 7 sampling pumps, RFID tagged temper proof sample vials, and rack with glycol gel, inline filter & Flow meter as primary components. Glycol gel in sample rack preserves milk samples at low temperature.

The device is also fitted with an inline filter, air eliminator & non-return valve. It also has an inbuilt tablet device with a digital display to record & display the real-time data of milk collected from a single VDCS/BMC, all VDCS pertaining to route & total milk collected from a particular route. Data of milk temperatures & milk collected on the previous day are also recorded & displayed. All data collected using tablet devices are fetched to the central server.



Imported Automatic Milk Sampling Unit (Initial stage)

In a single unit, a total of 6 VDCS/BMCs samples & 1 composite sample can be collected using this device. The identity of samples can be secured by a GPS device & RFID tag present beneath to sample vials. Identification of sample can be revealed only at the Quality laboratory at the time of analysis using RFID tag reader.

A total of 40 ml sample of milk shall be collected from a single VDCS/BMC in sample vial through a sampling pump. A representative sample of BMC/VDCS milk shall be collected based on the previous day's milk collection at the same BMC/VDCS and the system only controls and decides the stroke of a pump. A composite sample of all VDCS/BMC shall be collected based on fractional sampling.

Flowmeter present in device captures data of milk collected from each BMC/VDCS as well as total milk collected in a particular tanker. The device is having an inbuilt system of auto CIP. Once the tanker returns from route to dairy, it can be switched to CIP mode. Sample pump starts CIP once the flow rate of water achieves 3000 LPH.

With the help of the Automatic Milk Sampling system, we eliminated the conductor and sample box with the tanker. At the dairy plant, an officer of the VCU cell and laboratory chemist will jointly load the vials rack with their individual password (both need to enter the password) and initiate the system. Now the tanker is ready to go. Driver goes to the BMC and connects the hose to the BMC outlet and just to switch on the BMC pump. The system will start sampling once detect the flow automatically and also identify the location of collection through GPS and hence no need to enter the source details. The system will decide the sampling interval and quantity based on the last day pick up. One can see the online flow as well as the temperature of the milk on the tablet along with the sample vials quantity but cannot see in which vial the sample is getting collected. It will be revealed only by employing an RFID

reader at the time of analysis. Once the BMC tank is empty, the fixed quantity of water purge will be applied, and the tanker will move to another BMC.

In between the route, if anyone tries to unlock the door, a system-generated message will be sent to the authority on their mobile. The system also logs all the data related to start/stop, filling time, temperature, location, halt of the tanker, average speed, and many more. The heart of the system is the PLC installed in this black box which is energized through the power of truck battery only and hence no need for other sources of power and it also withstands with the power jerks at the time of truck start-stop.

Once the milk collection is completed from all the routes/BMCs, the tanker will come back to the dairy plant and the laboratory officer will unlock the box and take out the sample rack. The identification sample vial will only possible through an RFID reader and it will give all the data related to sampling i.e. BMC/VCU name, start time, stop time, quantity, and temperature. Fat and SNF with other quality parameters will come through the Milk testing machine which is connected with the system and hence no manual intervention of the quality parameters too. Quality-related data will directly go to the system and a report will be generated.

Accuracy of the system is very high and matches with the weighbridge quantity as well as the control samples.

Major Highlights are:

- Automatic sampler unit installed on VCU tanker which functions as a collection of BMC milk samples automatically as well as to measure temperature & weight of milk collected from BMCs with the help of a magnetic flow meter having inbuilt temperature sensor.
- The RFID tag on each sample so that sample data secured from human intervention.
- GPS technology enables the machine to start/ stop operations at a targeted location only.
- Unit is guarded with password-protected doors which give alerts when open during transit. (Location as well as a time of door open).



Upgraded Automatic Milk Sampling Unit (Second stage)

Initial Problems

Initially Amul Dairy implemented this system with 4 tankers having 6 DCS in each route. We faced a lot of challenges that were expected.

- **Road conditions at village level:** Due to poor road conditions, there was a lot of vibration in the system and mechanical parts get loosen very often which resulted in damage in small parts of Autosampler units i.e. we need a rugged solution that can sustain in the Indian village context.
- **Software modifications:** As Autosampler was the first-time approach, there are lots of software modifications are required for each of the issues. We suffered from issues like sample quantity, route information, latitude and longitudes accuracy, tanker capacity etc.
- Acceptance of new measurement/sampling system by farmers.
- **Cleaning:** Cleaning is the process (CIP) of Autosampler unit parts like sample capillaries, pumps, pipes, valves, and so on.
- The temperature of samples: After sample collection by Autosampler system, it is a prime requirement to preserve the samples at a low temperature until the analysis.

Amul dairy resolved all challenges that faced during the trials, one by one and run the system smoothly without any hurdles by taking the remote help from New Zealand and another 8 Nos. of the imported system developed with the suggested modifications.



A Step Ahead – Towards Atmanirbhaya Bharat

This system was effective and useful, but the only constraint was its high cost. Considering this Amul Dairy thought of having an indigenous system which is cost effective. Amul started working on this day and night and came up with an Indigenous automatic milk sampling system with the help of local technology partners with an improved version as below.

- 1. Peristaltic Pump Design:** - We developed closed housing Peristaltic Pump to prevent the tube from coming out from SS rotating rollers.
- 2. PharMed® BPT Tubing:** -PharMed® BPT Tubing for peristaltic pump reducing production downtime due to pump tubing failure.



- 3. Milk Temperature:-** We also taken the precaution to maintain the temperature of the milk sample by considering ICE-Substitute tray and ICE-substitute Bottle holder.
- 4. Rugged HMI:-** In place of Tablet on machine use of Rugged HMI to prevent against damage from water during CIP and Screen heating issues in summer.

Indigenous Automatic Milk Sampling System CONCLUSION

With the help of an Automatic milk measuring system, we achieved the following–

- 1. Transparency in the system:** As this system shows the milk quantity transfer in tanker and temperature of milk at the VDCS location now farmers are more confident about the transparency of the system.
- 2. Digitalization:** This system is a great example of automation and digitalization.
- 3. Elimination of manual entries:** No need to enter data manually in the Autosampler system. Due to this, the chance of error is also reduced.
- 4. Sampling error reduced:** As sampling done automatically, thereby chances of sampling errors are eliminated.
- 5. Farmer satisfaction:** Due to Auto sampling, the accuracy of milk samples is high, so farmers are much satisfied as they are able to know that they are getting paid what they expected.

