

SOME PRE-CONSTRUCTION CONSIDERATIONS IN DESIGN OF DAIRY PLANTS

[For Medium size (150 KLpD) Dairy Plants in Processed Branded Milk & By-products]

1.1 ABSTRACT:

India's White Revolution, known as Operation Flood, was launched in 1970. It was an initiative by India's National Dairy Development Board (NDDB) and was the world's biggest dairy development program which transformed India from a milk deficient nation, into world's largest milk producers.

Milk is a highly perishable agro-product. It decays, if not chilled to less than 4 degree Celsius or other processing methods, within 4 hours of milking and the entire supply-chain cycle collapses. Today with highly automated milk processing, the construction of large dairy plants meeting international norms of food-grade hygiene, safety, quality, cold-storage, and secured supply chain upto the consumers in national or international markets, is an important aspect as the demand for milk and milk by-products increases day-by-day. From a routine collection of milk at farmer level, to processing of dairy products, 'commercial branding' and branded sale of milk or milk products is a highly organized commercial activity. It is a huge agro-based industry.

While Dairy plants are categorized as industrial buildings, the similarity between any other industrial building (shed type constructions) and a dairy building ends here. Dairy buildings are very specialized 'Food-processing units' where the ingredient processed is milk, which has self-life of just a few hours, if not treated. Thus, from raw milk reception to delivery of processed milk and its array of by-products has challenges related to maintaining food-grade hygiene within the buildings, maintaining controlled room environments, heating, cooling, washing, sterilization in the process activity and temperature controlled storage facilities, cold store ware-housing and creating a suitable supply-chain, etc.

While addressing the above primary issues in Dairy building design, machinery and equipment installations, process piping, other building services, light and ventilation aspects, creating comfortable working environments on shop-floors come in picture along with the function and aesthetics. It is thus, the performance of these buildings in addressing the above issues, which play a key role in the success of the product. Due to the manufacturing requirements the structures are normally long-span, tall or double-heighted floors and heavy industrial loading which pose a technical challenge to construct.

Dairy projects are relatively complicated and require lot of interactive inputs between the project promoters, planners, architects, process-consultants, structural consultants, electrical consultants, HVAC agencies, plumbing and sanitary engineers, fire-safety experts, dairy-equipment vendors, hygiene consultants, other specialist and thus 'construction management' is essential in order to achieve success in the project. This industry has a specialized typology of Building Construction and it is the construction practices play a major role in the success of a dairy plant apart from the product process technologies. The projects fully depend on services, machinery & much of the planning evolves around this aspect, apart from other functions related to design, aesthetics & brand imagery.

Considering that the product is a perishable liquid and the spaces have constant washing or cleaning requirements, any material prone to corrosion, deterioration or decay and any accumulation of water or dust, is not considered suitable for planning dairy plants. Thus exposed use of mild-steel or wood becomes unsuitable. RCC construction in this industry has been traditionally used, however it is observed to be very time consuming. Apart from other causes, construction delays have been observed to be one of the causes for project delay in dairy industry, upsetting the start date of commercial operations and affecting the Cost of Capital. On the overall, construction takes only about 1/4th of entire Dairy Project Cost, whereas it consumes 4 to 5 times more time than machinery installation. Hence it is obvious, that focus has to be on reduction of construction time & reduce overall timeline.

Managing better construction Time-lines for Dairy is possible if '**Pre-Construction Understanding**' is clear. After prolong work in this sector (about 17 years), this paper is a humble attempt to look at important aspects for planning considerations, which can readily help new investors in construction of new dairy-plants in a better way. It shall help clear the thought processes & help reduce construction time-line for dairy plants, thereby improving the quality of the built environment and workout dairy projects with lesser time to help achieve an early BEP (break-even point).

1.2 INTRODUCTION:

Machinery installation and construction many times happen as parallel activities, with finishing happening after installation of equipment and testing & commissioning of equipment happening after finishing. While designing Dairy plants, understanding the product demand, determines the capacity to produce and thus the size and scale of the buildings. Also the production processes, space requirements of equipments related to processes, special needs of hygienic spaces and the building services are diametrically opposite requirements, which need to be understood and considered for each department of manufacturing, at the design stage itself and its installation & maintenance, as well as building maintenance, ultimately lead

to better performance. Clean environments (essentially dust free, bacteria & insect free) are essential in these buildings and design has to cater to this aspect also.

Dairy process plants are complex structures to design and construct. They require a multitude of skills and technical inputs. Smooth co-ordination between the project stake-holders and the key-actors in the process such as the project owners, planners, process-consultants, architects, structural consultants, electrical consultants, dairy-equipment vendors, hygiene consultants, HVAC agencies, piping & instrumentation contractors, plumbing and sanitary engineers, fire-safety experts, other specialist consultants and the construction management team, is essential in order to achieve success in the project. The manufacturing processes are water intensive and huge amount of liquid alkaline effluent is generated, which has to be handled effectively, so as not to harm the product as well as the environment.

The other requirements are of statutory approvals, registrations, licenses for the manufacturing activity and products, which also affect the time-line. Thus, Dairy-plant constructions can be very interesting, if only, imaginatively worked upon.

Since the construction cost in dairy is about 1/4th or even less than the machinery & equipment cost; hence an investor is not so much concerned on construction cost, if construction is achieved well with-in time-line. If the production starts earlier, it gives better RoI. Saving construction time, is thus, very crucial for construction of dairy plants. Hence it is essential to optimize the dairy construction timeline, which would value add to success of the commercial venture. Understanding a 'pre-construction road-map' can thus help improvise and reduce 'implementation time' that is crucial to success of any Dairy plant.

1.3 NEED, RELEVANCE AND SIGNIFICANCE:

- i. It is usually seen that though Process-consultants for machinery & equipment are appointed on priority. However, construction managers have so far not been seen actively appointed or involved by the owners, for the construction, as the importance of a good infrastructure is only realized by the owners after the building is completed. At that point, it is too late, since lacunae in construction cannot be rectified when the plant becomes operational or after start of Commercial Operations.
- ii. Many-a-times, even the Civil Contractors / Constructors are generally not specialist in this typology and rely on their experiences in other industrial works, which is actually an eye-wash, unless they are not exposed to intricacies of dairy constructions.
- iii. Dairy & Milk process facilities have to be designed in a special way for creating and keeping maintained, clean 'food-grade' environments which are dust free, microbe-free and insect-proof, right from bulk milk-reception up to processing and delivery.

- iv. Lot of milk-process plants actually operate in unhygienic environments, as due care was not taken during construction. It is difficult to rectify their flaws after production starts.
- v. Site-management from mid-course till completion, is one of the toughest part of such project as multi-tasking is involved with multiple agencies.
- vi. Various norms are expected to be implemented in a 'Food-Grade Industry' for construction also.
- vii. There are many types of consultants involved at various stages and each of their requirements has to be coordinated during construction. Next in line are the vendors whose 'Design Freeze' and 'Go' decisions are crucial.
- viii. In most cases the structures are of Long-spans, Extra-heavy Industrial loading, double or Triple heighted slabs. Working at height is difficult, reduces work speed & is risky due to windy conditions.
- ix. Thus, proper awareness of managing such constructions is the way forward to reduce the greater risks involved and such constructions getting delayed.

1.4 SCOPE & LIMITATIONS:

Milk processing is a prominent Agro-based industry in Western Maharashtra. This study is based on practices seen more in Western Maharashtra. The study is limited to PROCESSED BRANDED MILK plants of 'medium to large scale' with 'Normal By-products'. The study is limited to private dairy businesses only. Here we shall not consider the co-operative sector, as the outcome from co-operative dairies is not clear, with conflict of interest amongst different pressure groups and lobbies.

2. GENERAL INFORMATION

The processing of milk is with the objective of extending its shelf life & saleability. This objective is typically achieved by (a) heat treatment to ensure that milk is safe for human consumption and has an extended life with quality, and (b) preparing a variety of dairy products in a semi-dehydrated or dehydrated form (butter, ghee, hard cheese and milk powders), which can be stored. Even pasteurized pouched milk has a shelf life of about 4 days, but only under refrigeration. Since the ingredient is processed milk, hence there is a lot of stress on not allowing any stagnation of milk anywhere within and outside the 'process system'. Even splashing of a drop of milk anywhere on any surfaces, due to system-leakages is a risk as it leads to bacterial growths which then quickly infects the whole plant. Hence there is constant washing the floors, cleaning of machinery, etc. is necessary, which requires huge amount of water. Even air-bourne bacteria can affect the product. Clean environments (essentially dust free, bacteria free, insect free) are essential and building design must cater to this aspect.

2.1.1 MAIN ASPECTS FOR PLANNING DAIRY PLANTS:

- i. **Availability of milk & milk collection** – Milk being the raw material, before finalizing the site it is necessary to do study and research on its easy availability. The extent of milk procurement area, percentage of milch animal population, average milk yield, marketed surplus, etc. will determine the size of the plant. The biggest challenge in dairy industry is the ‘quality of raw milk’, as it is something which cannot be improved further from the point of its reception, but only be maintained.
- ii. **Consumer profile** – Though processed milk can be sold far away from the point of its processing, it is very essential to do market research for knowing the target consumer.
- iii. **Marketing Potential & current requirements** – The manufacturing strategy and processing capacities shall be decided based on market potential and current trends, to meet the immediate demands of achieving early BEP.
- iv. **Location of the Plant site / Site selection** – This is a very important aspect and involves many aspects. It is a primary need to locate site close to potable water source. Also, the other important factors to bear in mind while finalizing the site are – availability of uninterrupted electricity, proper road upto site since milk tankers upto 40 tons weight commute to and fro the site, ease of access to a main road and proximity to an urban area. Proximity to potential ‘market’ and the type of ‘Business model’ a dairy proposes is important to create its niche in the market.
- v. **Site requirements** – From a constructional point of view the site shall ideally be an almost levelled ground (gradient between 0 – 2 degrees). It shall be generally hard murum with good founding strata available at about 1.5m to 2.5m. Most importantly, an important part of expenditure on work upto plinth happens, but it is not seen.
- vi. **Product mix** – Any business process requires a good product mix to survive in the market in all seasons. Thus a study of market potential is essential for deriving the product mix.
- vii. **Potable Water supply** - Availability of large quantities of potable water is required - Since milk processing requires huge volumes of potable water.
- viii. **Availability of funds** – This aspect starts with seed capital and ends with availability of sufficient working capital. An early completion of building and commissioning of plant generally helps owners in getting better working capital from financial institutions.
- ix. **Seasonal fluctuations in the availability of milk** – As a commercial venture, the dairy plant has to take care of seasonal fluctuations in availability of milk & provide for adequate storage of raw milk.
- x. **Competitors** – The owners / project proponents have to study the competition for their proposed product before entering the market.

- xi. **A plan for future growth** – “Post-Establishment Plan” must be in place, say 5 years or 10 years hence. Thus the site identified must have sufficient additional space for well-planned future expansion needs.

2.1.2 KEY ACTORS IN SUCCESS OF ANY DAIRY PROJECT:

For making such a project operational the primary involvement is of the following:-

- i. Owners
- ii. Process Consultant
- iii. Architect & his sub-consultants
- iv. Equipment Vendors
- v. HACCP Consultant
- vi. ETP Agency & Water treatment plant agency
- vii. Civil Contractors with know how of dairy constructions.
- viii. Piping Contractors
- ix. Government + local population - the support of local villagers and surrounding population has a positive impact on plant operations.

2.2 The organized dairy sector (both cooperatives and private) presently handles about 15 per cent of total milk production in the country. Thus it indicates, there is a wide scope for organized processing of milk and systematic manufacture of milk products for domestic consumption as well as export and creating a value added supply chain. We are world’s largest producer of milk, but still we are not an exporting nation for milk products. Thus, there is a huge scope in organized processing and branded milk products.

- **Land and Location:** Atleast about 2 – 2.5 acres of land is required for a milk processing plant handling about 1,50,000 litres of milk per day. The location of site should have proximity to road/rail facilities, services, such as water, electricity and effluent mains, social infrastructure, etc.
- **Site Development** includes proper roads for circulation of tankers, proper drainage arrangements should be made to ensure cleanliness. Stagnation of storm water in gutters or effluent water in effluent drains must be avoided.
- **Layout and Buildings:** The civil works comprise of main processing building, which includes Raw Milk Reception Dock, Main processing halls, provision for manufacture of other products, cold storage, CIP, Laboratory, quarters, office, garages, security office, etc. The factory building for the milk reception, quality control, processing, packing and storage of milk products should be as per BIS. The total covered area / built-area depends on the processes involved, products

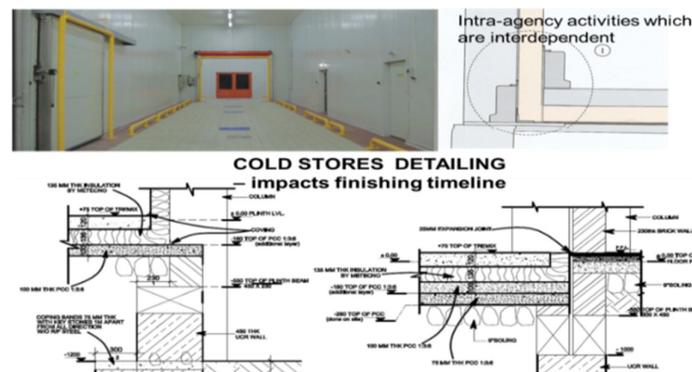
manufactured, the quantity of milk handled and the equipment chosen for product manufacturing. About 25,000 s.ft. area of built area is required for handling 1,50,000 ltrs of milk / day. The essential sections of a milk processing plant are as under:

2.2.1 FLOOR DRAININGS SYSTEM:— is a very intricate system and success of any dairy depends on efficient floor draining system, every part of which is again cleanable periodically to eliminate any bacterial formations. The drains can be preferably open or closed drain systems with necessary SS grating. Drains end in ‘Water-seal Traps’ which are cleanable ‘goose-neck water seals’.



Diag. No. 1 – Typical ‘Cleanable Goose-neck trap’ in floor drains

There are many inter-dependent activities in and during construction, such as piping, equipment installation, insulation below floor in cold stores, etc. which need proper planning.



Diag. no. 2 – interdependent activities in construction & cold stores detailing

2.3 UTILITIES & SERVICES -

- i. Power: Normally a three phase electricity supply is required for milk processing plants.
- ii. Water: A typical milk processing plant requires the water in the ratio of min. 3.5:1 (3.5 litres of water for 1 litre of milk processed) for processing, cleaning of equipments; cold storage and drinking purposes.

- iii. Steam: The steam requirement depends upon the processes involved and the source of steam may be met by coal / oil / gas fired / electric boiler plants as required.
- iv. Fuel: The fuel is need for various processing operations. The type of fuel will depend upon the type of boiler used for steam generation and needs a space for fuel yard.
- v. Compressed Air: It is required for various pneumatic, flow control operations & for cleaning purposes.
- vi. Vehicles: The vehicles required for procurement and distribution of milk depends on the quantity of milk to be handled.
- vii. Other Services: A maintenance workshop is an integral part of milk processing for carrying out repairs and maintenance of equipment.
- viii. Environmental Aspects and Pollution Control: The effluent will be in the form of washed water and milk solids apart from the detergents and sanitizers used in the plant. Construction of suitable effluent treatment plant is necessary.

2.4 Licenses, Statutory Permissions and regulations -

- A. Dairy & Equipment related
- B. Land & Building Permission

Generally the project proponents start realizing the need for commercial sales model as soon as the milk collection reaches to about 10,000 ltrs. per day. The 'Branding' need comes into picture and at around 25,000 ltrs. of collection, the need for processing pouching and branding may start after that.

For manufacturing 'Processed Branded Milk' the following factors are considered in defining the size and scale of plant:-

- The ease of availability of milk and the plant location with respect to availability of market within about 6 hours' drive i.e. an overnight journey are considered important, for morning sale is the maximum. – Later-on day sales of milk are not that high. Today, people going to super market to buy weekly stock of milk are not even 1% in India. Rest of all 99% is a daily delivery at doorstep – and for this the plant has to be nearer to markets / urban areas.
- Secondly, size and scale is 'Profit Driven' – Maximum Profit is in liquid milk. In by-products the scale of market is very less, unless marketing scale is very large like Amul & Nestle, spread over a wider geographical area & large market spread. Or have a diversified setup of many plants nearer to large cities.
- Thus normally, 'closer to market' is a necessity for size and scale. Additional milk if not consumed then goes to powder plant for making milk powder which has longer shelf

life, but this requires special processing needs. Some Dairies are closer to market, but their processed milk is less in retail and they are more focused on the by-products. Thus different business models are also seen in market.

Time consumed in project conceptualization, infrastructure planning, statutory approvals to “Project go-ahead” decision and finalization of contractors:

For a well managed project this period is very important and stake-holders generally neglect this part. It is observed that this takes almost about 1/3rd of the entire project life cycle, if not more. Construction techniques and methodology of construction also play an important role in the time consumed.

Probable reasons for delays in construction of dairy plants: There are various causes of delays in constructions and these may vary from place to place. The common reasons seen are: unsuitable contractors being appointed for such projects, delay in timely disbursement of payments to equipment suppliers, vendors and contractors, Government permissions, government restrictions on use of certain construction raw-materials on some sites, Site location (remoteness from a major town) and site-conditions.

CONCLUSION

Clarity and knowledge of the pre-construction process intricacies of this sector would help in suitable, hygienic and better design of dairy plant. It shall help in reducing the construction time for dairies there by help in achieving early ‘commercial operations date’ which is the main focus of financial institutions and creditors.

With regards,

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