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Design and Development of Conveyor Belt System for Handling of Soaps in Detergents Industry

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Abstract

Darshan Detergents is soap & detergents making industry. Soap cakes & detergents are manufactured & are sold mainly in rural areas. Daily production of Darshan Detergents varies from 5 to 7 tonnes of soap cakes which depends on customer demand also. Process flow of soap making is firstly raw material is fed to extruder from where long soap cakes are extruder which is then cut into soap cakes by soap cutter. After cutting machine soaps are fed to packing machine manually with the help of labours. Main purpose of study is that this manual labour can be reduced by considerable amount if we implement automatic material handling system.

Idea is to design & develop a conveyor belt system that can convey soap cakes from cutting machine to packing machine. This project deals with synchronisation, design & development of conveyor belt system for soap handling in detergent industry.

Introduction

2.1.Darshan Detergents

'Darshan detergents' is plant which produces soap cakes & detergents for washing purpose only. Darshan detergents is situated in M.I.D.C. Bidkin, Aurangabad nearly 20 kms from Aurangabad City. Other branch of the same industry is at Railway Station M.I.D.C, Aurangabad. One at bidkin is automatic production plant & the other at railway station MIDC is manual production plant. The project which we are working on is related to bidkin plant.

Literature Survey

3.1. Process Flow Chart: The soap making processes are shown in fig. 1,

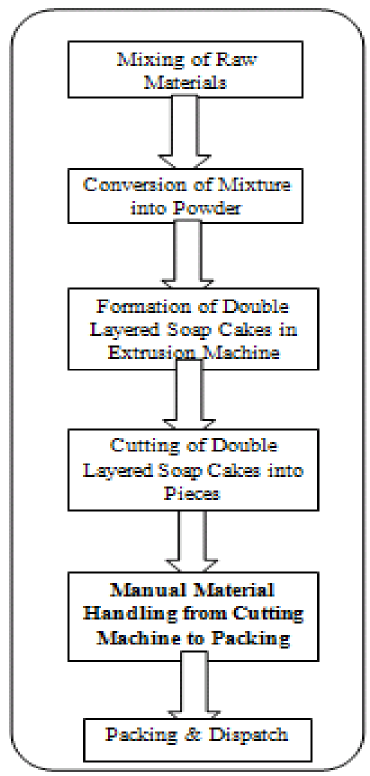

Fig 1: Process Flow Chart

3.2. Soap Making Process

3.2.1. Mixing of Raw Materials

Raw material is imported from vendors into inventory. This raw material consists of sodium carbonate, ash, clay, wax, flavors, citric acid and colour etc.

These raw materials are then mixed into furnace in proper proportion. Mixing furnace after mixing the raw material gives soft rocks of mixture.

3.2.2. Conversion of Mixture into Powder

Output from mixing furnace is fed to inclined conveyor (Crusher). This inclined conveyor consists of sharp blades located equidistantly. These blades help in conversion of soft rocks of mixture into powder.

3.2.3. Formation of Double Layered Soap Cakes

The powder obtained from crusher is fed into mixer & extruder machine. This machine heats the powder, converts into form of desired mixture (maintaining proper viscosity & density). This machine is provided with detachable die at the output which extrudes double layered soap cakes from the machine.

This double layered soap coming out from die is slightly at elevated temperature & there are chances that two layers of soap may stick to each other. These soap cakes are in the form of long strips of particular length. A rolling cutter is used to cut these strips. These strips are then conveyed to cutting machine

3.2.4. Cutting of Double Layered Soap Cakes

Cutting machine consists of a plunger which is controlled through a servomotor. This plunger has quick return motion mechanism which is used to push long strips of soap cakes towards the cutters. This pushing force cuts the soap cakes into 'n' number of pieces which depends on number of cutters fitted on cutting machine. The length of soap is controlled by distance between cutters. Unequal lengths of soaps & scrap can also be reused as an input to crusher.

3.2.5. Manual Material Handling from Cutting Machine to Packing Machine

Cut pieces of soap cakes are double layered. These pieces need to be separated & then carried to packing machine. This job includes collection of soap pieces, separation of soap pieces, unloading of soap pieces into tray & loading them on packing machine.

This involves around 8-10 workers which manually performs all these operations. Around 300 soaps per minute are cut by cutting machine & maximum capacity of packing machine is 150 soaps per minute.

3.2.6.Packing& Dispatch

Industry uses automatic packing machine for packing of soaps which only have to be loaded manually into machine. Packing machine completely covers the soap & no manual interference is needed.

Packed soaps are then filled into cartons & then dispatched manually.

3.2.7 Problem Statement As discussed above, While Production of Soap, when raw material is fed to mixer & extruder machine, it produces a double layered soap of certain length. It is then cut by cutter into soaps. After Production, these soaps are then sent to packing machine; firstly double layered soaps unloaded from cutting machine, separated and then loaded manually on conveyor which takes them to packing machine.

Total manpower required for unloading soaps, separating soaps and loading soaps on conveyor is 8-10 labors.

This is the main problem which industry face. If we design material handling system which unloads, separates and loads soaps on conveyor and carry them to the packing machine, then it will be extremely helpful for industry.

3.3. Problem of the Double Layered Soap.

As we have seen in the process flowchart the soap layer coming out from the mixing and the extruder machine is a doubled layered soap. The die of the extruder machine is so designed that the output of it comes as a double layered soap. These doubled layer soaps are first passed through a rolling cutter which cuts them into long strips and these soaps are then carried through two conveyor systems to the cutting machine, where cutting of these soaps take place in the form of double layers only, still there is no separation of the soaps to single layer. But the packing machine needs an input of a single soap, so there must be some solution out from this.

One of the possible solutions of this problem is changing the die (double layered die to a single layered die which will give or extrude a single layer of soap) at the extruder machine, but by doing so there would be the need to change the entire mechanism in the mixing and the extruder machine. The cost involved in changing this mechanism and the die is also very high, so it is not advisable to change the die and the entire mechanism involved in the extrusion process. This will also considerably affect the production rate which can be reduced to half as that takes place with a double layered soap.

3.4. Process Parameters under Study

Design needs detailed & thorough study of all process parameters involved in the soap making process. These parameters have great influence on final design & working of final output product. These parameters involve feed rates to cutting & packing machine, speeds of motors used for conveyors, cutting movement & cutting stroke time.

As we discussed earlier, raw material is fed to extruder from which long double layered soap cake is extruded which is then cut by cutters at cutting machine. This layer is cut by help of a piston stroke which pushes these layers towards the cutters which finally cuts these layers into small soap cakes. The time required to cut soap layer is 2 seconds i.e. after every 2 seconds a layer of soap is cut into small soap cakes. After this cutting process, labors separate these soap cakes and fill those soap cakes into trays & then these trays are then passed to the packing machine.

These soap cakes are packed into packing machine. Feed rates are 300 soaps/min for cutting machine &150 so aps/min for packing machine. We need to make delay so that these soaps can be managed in between. Motors are other components which are needed to study. Motor rotations per minute (rpm) should be as optimum as possible so as to consume minimum power but at the same time it should be able to convey all soaps further on conveyor belt. In short these motors should have capacity to bear loads.

Sr.No.	Process Parameters	Specifications
1	Production rate of cutting machine	300 soaps per minute
2	Production rate of packing machine	150 soaps per minute
3	Cutting Piston Stroke rate	After every 2 secs.
4	No. of Labours required	8-10 labours
5	Material of Conventional Conveyor	PU material

Table No. 1: Process Parameters under Study

Design & Calculations

Until now we have studied the production process of the soap right from the raw materials to the packing of soaps to its dispatch. We have also studied the various problems and defects involved in the production process as enlisted above.

One of the solution and the calculations related to it are as given below,

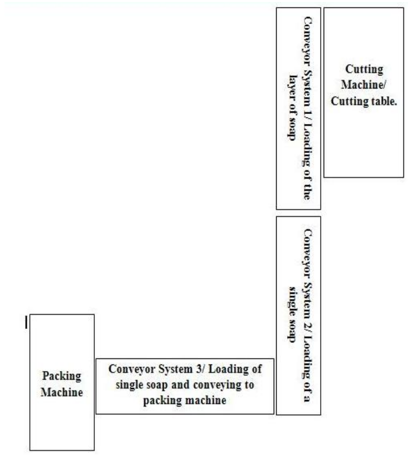

Fig 2: Layout of Initial Basic Feasible Solution

After Initial Basic Feasible Solution, It was necessary to check whether that solution is optimum in all aspects or not. On construction basis it was quite satisfactory except the fact that we will need stepper motors which is a costly affair. Hence, we emphasized our focus on reducing number of stepper motors. In initial basic feasible solution we have total three conveyors of approximately same length so we need three stepper motors to achieve step rotation of conveyors.

But if we optimize the solution, we can have one long conveyor carrying soaps from cutting machine instead of having two high capacity conveyors & we add couple of small conveyors which will carry soaps to packing machine. This will also reduce capacity of stepper motor. This revised solution is as shown below

6. Sample Calculations

Consider a Soap of Dimensions (100 x 70 x 30) mm

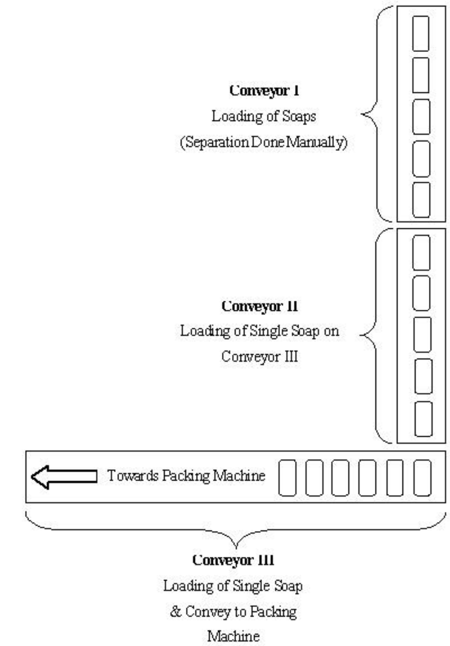

Fig 3: Revised Layout of Project Methodology

4.1. CAD Drawing of Basic Solution

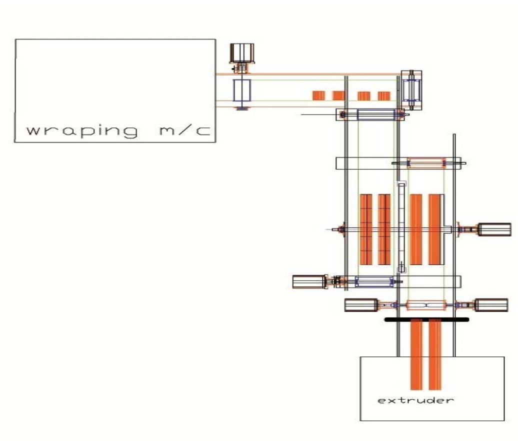

Fig 4: CAD Drawing of Basic Solution.

In this CAD drawing, Red Colour signifies Soaps, Green signifies Belts while Blue signifies Motors.

4.2. Design of Conveyors

The soap on which we are working is of dimensions (95 x 50 x 20) mm.

The flow of soaps will be as shown in figure,

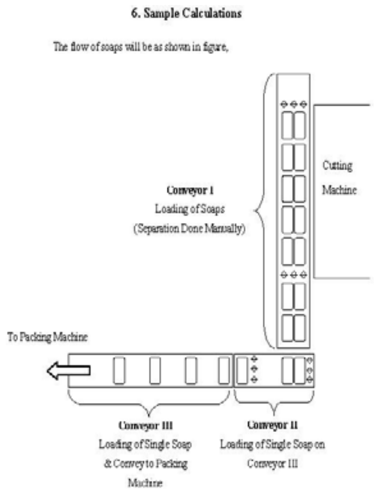

Fig 5: Flow of Soaps during Actual Working

4.2.1. Conveyor I

As shown in fig 3, Conveyor I will load soaps coming from cutting machine. Piston stokes which cuts soaps are at every 2 seconds. So, every 2 seconds soap layer of 10 soaps is being loaded on conveyor I. Hence, conveyor I must be emptied for next incoming layer in less than 2 seconds. In calculation, Conveyor I rotate for 1 second & remain idle for 1 second. As stated above, length of each soap is 100mm; hence total length of layer is,

Total Length of Soap Layer= 100 x 5 = 500mm= 50cm.

Total Rotating Time= 1 sec………………… (Rotating time/ Soap=0.2 sec)

Total Idle Time= 1 sec………………………….. (Idling time/ Soap=0.2sec)

For avoiding congestion, allowance length of 10cm on each side of soap layer.

Hence now, if we design conveyor which can carry three lots of soap layers, then its length will be,Total Length of Conveyor Belt I= (3x50) + (6x10) = 210cm.

For width of conveyor I,Width of soaps= 50 mm.Width of soaps on conveyor= 100 mm.Taking Clearance of 5cm & 1cm for each stopper.Width of Conveyor I= 10+5+2= 17 cm.

Conveyor deals with three lots of soap cakes, hence maximum of 30 soaps are loaded on conveyor I. Weight of each soap is 150gms. Total maximum load on conveyor I is 4.5 kgs.

Force on Conveyor I= (4.5 x 9.8) = 44.1 N.

Also width of conveyor I is 17 cm.

Area of Conveyor= (210 x 17) =3570 cm^2=0.357 m^2

Max. Load on conveyor I= 44.1 = 123.5 $N/m^2$0.357

Strength of Conveyor I= 2 x 123.5= 247 N/m^2 (Factor of Safety=2)

Therefore, strength of conveyor I should be more than 247 N/m^2.

Strength of PU material is 300 N/m^2.

4.2.2. Conveyor II

Conveyor II will be used for single soap loading on conveyor III. As conveyor I is forwarding soap layer in 1.5 sec hence conveyor II must be emptied in less than 1.5 sec. The soap layer contains 10 soaps hence, we need to manage loading of soaps on conveyor III including idle time in only 1.5 sec. Which can be done by,

Total Idle Time= 1 sec(Say Idle Time/Soap=0.2 sec)

Total Rotating Time= 1 sec……………… (Say Rotating Time/Soap=0.2 sec)

Hence, Conveyor II will rotate for 0.2 sec to load one soap on conveyor III & will remain idle till that soap is conveyed forward on conveyor III. Total Idle time for Conveyor II is 1 sec.

Now for length of conveyor II,

We need to adjust & carry two soaps on conveyor II at a time. These soaps are in condition of moving towards packing i.e. their length is facing towards packing so now, considering 5 mm allowance on each side,

Width of two soaps = (2 x 50) + (2 x 5) = 110 mm = 11 cm.

If we design conveyor which also carries three lots of 2 soaps then including allowance of approx 9 cm for each lot, we get total length of conveyor II,

Total Length of Conveyor Belt II= (11 x 3) + (9 x 3) = 60 cm.

Design for conveyor belt strength is already done in conveyor I.

4.2.3. Conveyor III

As conveyor II is rotating for 0.2 sec for loading soap on conveyor III, Conveyor III need to remain idle for 0.2 sec & when conveyor II remains idle for 0.2 sec, conveyor III need to carry loaded soap further towards packing machine hence it will rotate for 0.2 sec. idle time for Conveyor III is 0.2 sec per soap.

For length of conveyor III, we can have flexibility in designing third conveyor as it conveys soaps to packing machine. Its length depends on how far packing machine is & thus according to working conditions we have designed conveyor belt III of 200 cm.

Design for conveyor belt strength is already done in conveyor I.

Comparative study of Conventional System & Modified System

Factors	**Conventional System**	**Modified System**
Material handling	Manually	Automatically
Handling Equipment	Trays	Conveyor Belts
Labours	8-10 Labours	2-3 Labours
Initial Cost	Low	High
Maintenance	Low	High
Cost Effectiveness	Low	High
Factors	**Conventional System**	**Modified System**
Production Rate	Low	High
Favourability	Favourable for Double Layer	Favourable for Single Layer
Time Delay	High	Low
Cooling of Soaps	By time delay	By cooling fans
Loss by handling	More loss due to manual handling	Less loss due to automatic handling
Sensors	Not Needed	Needed for Actuation
Skill of Labour	Skilled labour required	Skilled labour is not necessary.

Table 3: Comparative Study of Conventional System & Modified System

Conclusion

In this project, we have studied detailed literature & process study of soap production. We have found certain defects & problems in conventional system. We worked on it & tried to find out possible solution that will eradicate problems during production. We designed & developed conveyor belt system for soap handling which automated material handling process. While doing that we needed to study synchronization of conveyors, various process parameters & various components design. The implementation of final developed design firstly & very importantly reduced working manpower from 8-10 workers to 2-3 workers, which is a significant achievement at the outset.

Further, this automation in soap handling increased production & thus productivity of industry. This automation can work 24 hrs giving use maximum outputs. This automation reduced material loss due to manual handling of soaps & also reduced time losses. These were major achievements of the project.

In the context, we were working on single layer or manual separation of double layered soap. This separation if made automatic with the help of stoppers or any other effective mechanism then this can completely make this process automatic.

We hope we have achieved maximum benefit for Industry & ourselves.

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