SMART POWER SAVING CONVEYOR SYSTEM

[1]Deepanshu Prasad,[2]Lokesh kumarSahu,[3]Vanshdeep Ratrey, [4]Akshay Agrawal
[1]B.E Mechanical,[2]B.E Mechanical,[3]B.E Mechanical, [4]B.E Mechanical

[1]Mechinical Engineering Department ,
[1]Chhattisgarh Swami Vivekanand Technical University C.G-India 491001

Abstract :This paper looked at the design of a power saving conveyor system which involves sizing, selection and cost-benefit analysis of its installation. This paper concentrates on factors that produce high belt power consumption and costs which are huge starting torque and extended operating hours hence there is a design of drive control system consisting of gray inventors and variable speed drives to reduce starting torque and load detecting switching system to reduce the number of operating hours. The average power savings considering all the factors of reducing the system operating hours to the average of 12 hours a day. After doing cost-benefit analysis it was ascertained that installation, operation and maintenance costs of the designed system are less than that occur on the initial system hence the design is worthy to install since it results in cost savings and increases in system life. The are some recommendations for the designed system which are the clean ventilated environment to promote adequate cooling, belt protection against overload to dodge stops and also delicate inventors, variable speed drives and sensors protection against overvoltage and overcurrent so that the drive control system will not crash.

IndexTerms- Design, soft starter, automation, control, conveyor, variable speed drive.

I. INTRODUCTION TO CONVEYOR SYSTEM

A belt conveyor system is an identity of many types of a conveyor system. A belt conveyor system consists of two or more pulleys (sometimes pointed to as drums), with an endless loop of transmitting medium - the conveyor belt - that revolves about them. One or both of the pulleys are powered, devising the belt and the material on the belt ahead. The powered pulley is termed as drive pulley while the unpowered pulley is defined as the idler pulley. There are two principal industrial properties of belt conveyors; Those in common stock handlings such as those moving boxes accompanying inside a factory and bulk stock handlings such as those used to transport huge amounts of stocks and agricultural stocks, such as grain, salt, coal, ore, sand, overburden and innumerable. One or both of the pulleys are powered, vacating the belt stuff on the belt ahead. The powered pulley is termed as drive pulley while the unpowered pulley is named as the idler. There are two principal industrial properties of belt conveyors; In general, material handling before-mentioned as those moving receptacles along inside a plant and bulk stock handling such as those used to carry industrial and agricultural materials, such as grain, coal, ores, etc. usually in outdoor areas. Generally, corporations providing general material handling variety belt conveyors do not implement the conveyors for a bulk material approach. In all, there is a plenty of commercial utilization of belt conveyors such as those in supermarket wares. An under layer of stuff to implement linear strength and shape called a cadaver and an over layer called the cover. The cadaver is often a cloth or plastic mesh or net. The cover is often various rubber or plastic aggregates specified by use of the belt. Covers can be made from more fascinating materials for unusual applications such as silicone for heat or gum rubber when adhesion is crucial.

Material passing overhead the belt may be weighed in conveyance using a belt weighter. Belts with evenly spaced obstructions, known as elevator belts, are used for transporting loss materials up precipitous approaches. Belt Conveyors are used in self-unloading bulk tramps and in live base trucks. Conveyor technology is also adopted in conveyor transport such as moving tracks or escalators, as well as on many manufacturing arrangement lines. Stores often have conveyor belts at the check-out counter to cross-shopping items. Some sections also use conveyor belts to transport skiers up the hill. A spacious kind of related conveying machines is available, different as appreciates principle of action, means and path of conveyance, the effective floor system, which uses reciprocating buttresses to move cargo, and roller conveyor operation, which practices a series of powered rollers to convey receptacles or couches.

II. LITERATURES BELOW GIVE THE IDEA FOR THE CONVEYOR SYSTEM

The application of alterable speed induction motor drives for gantry davits. Smart solution reflects an application of cycle converters for all drives. Multi-motor drives are conventional explications in crane utilization and requirements of load distribution are present. The bestowed algorithm provides load splitting proportional to the rated motor power on the easy and practically relevant method on the basis of assessed torques by frequency converters, and controller realized in PLC.

A recommended electronic synchronization has to be assured for the quality of fabricated paper rolls. Some control policies of a multi-input-multi-output system (multivariable system) have been recommended based on hearty control or electronic emulation of mechanical line stem. In this paper, a multivariable proportional-integral-derivative (PID) controller implemented on a multi-drive paper system (MDPS). PID is more skilled in enhancing the speed loop rejoinder stability, the steady state error is reduced, the increasing time is achieved and the disorders do not affect the enforcement of driving motors with no overtaking.

III. OBJECTIVE

i. To find the method for saving the wattage loss in a conveyor system.
ii. To make a prototype of the discussed method.
iii. To perform some practical on the modified conveyor system.

IV. STEPS ARE UTILIZED TO ATTAIN THE APPROACH

i. The method we are using is prototype analysis method.
ii. We are trying to install four different wattages of motors instead of single high load motor.
iii. The system will be designed such as it will put the combinations of different wattage motors with rpm same.
iv. This combination will be selected according to the load put on the conveyor.
v. There is a need for some electronic device which can measure the load on the conveyor as accurate as possible.

5.1 Possibilities of prototype

i. In the prototype system, there will be a conveyor.
ii. This conveyor will have attachments of four different low wattage motors with the same rpm.
iii. The system will also have a weight measuring device which can make some division on the load measure such as no of divisions = no of motor load combinations possible.
iv. If we are using four motors of load 10, 20, 30, 40, it gives these combinations:
v. We have total 10 combinations of multiple of 10.
vi. So we can choose the load combination which is nearest greater to the load required.
vii. This can prevent wattage loss better.

5.2 Multi motor drive system

There are numerous methods for comparing multiple motor drives and all have intrinsic benefits and drawbacks. A primitive definitive factor for election concerns whether we are bartering with a continuous web or length of the product as exposed to individual or “parallel” methods befalling at the corresponding time.

Our discussion will address several methods of coordinated control for multiple motor drives:

i. Basic Follower
ii. Cascaded Follower
iii. Frequency Follower
iv. Follower Mode Negatives
v. PID Control
vi. Process Control Interface
vii. Transmitter/Receiver
viii. Master Reference (Parallel) Control
ix. Inverted Logic Follower

The description of the above keywords are given below:

i. **Basic Follower:** A Follower design remains one of the most cost-effective and docile ways for coordinated control of two or more motor drives in an endless web operation. Carotron’s System Interface Configuration function outputs include input skill for Frequency, Voltage and Process Current signals and all present external TRIM pot reciprocities and TRIM RANGE setting modifications. A two drive Leader/Follower system is the simplistic form of follower implementation.

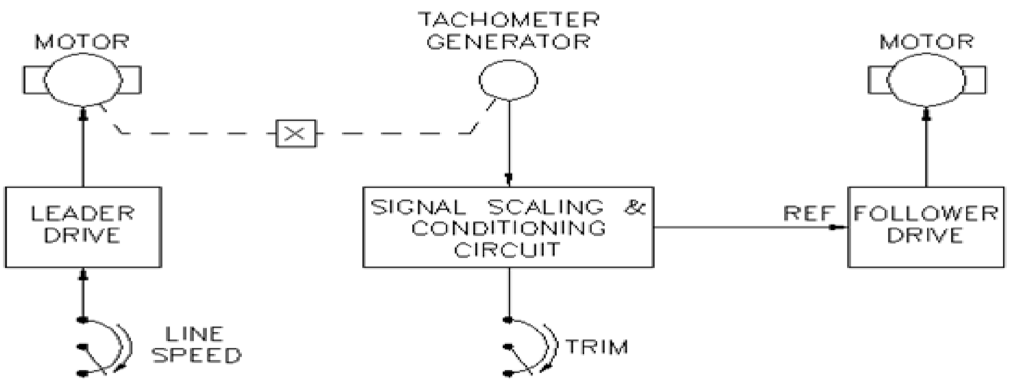

Fig.5.1-Basic Follower system

ii. **Cascaded Follower:** The Basic Follower described above can be expanded with a cascade or "daisy chain" connection to a third drive following the second and so on to allow speed changes to be reflected throughout a process.

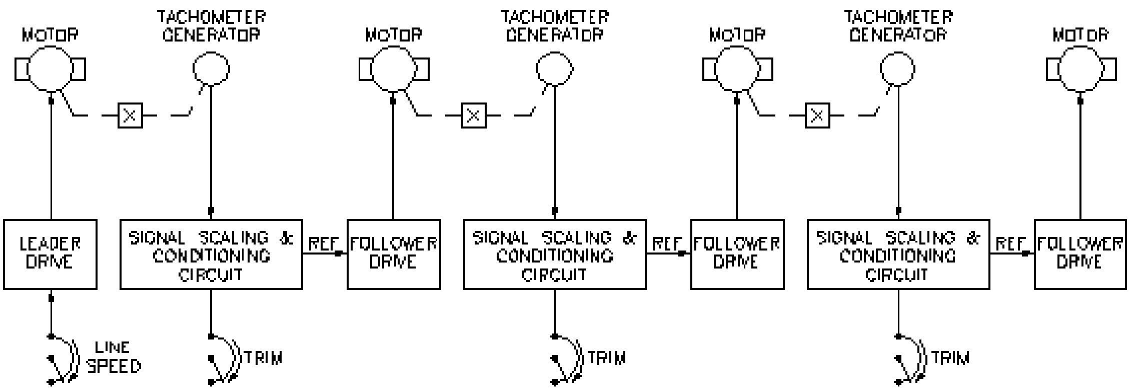

Fig. 5.2 – Cascaded Follower

Cascaded followers need the careful set-up. For genuine results, define the range of the TRIM functions for both dancer or operator control to the merest adequate percentage impact. This is easily rectified by a TRIM RANGE frame on many CAROTRON interface products and will assist setup and add to system confidence.
A methodical risk is the only sovereign variable for the CAPM and buildup, interest rate, oil prices, and exchange rate are the independent variables for an APT model.

iii. **Frequency Follower:** for any motor drives, encoders or pulse tachometers can be practiced in place of DC tachometers. With some tachometer feedback only drive models, one of Carotron's Frequency to Voltage converter cards can change frequency signals to analog voltages fit for tachometer feedback control and/or speed source in motor control systems.

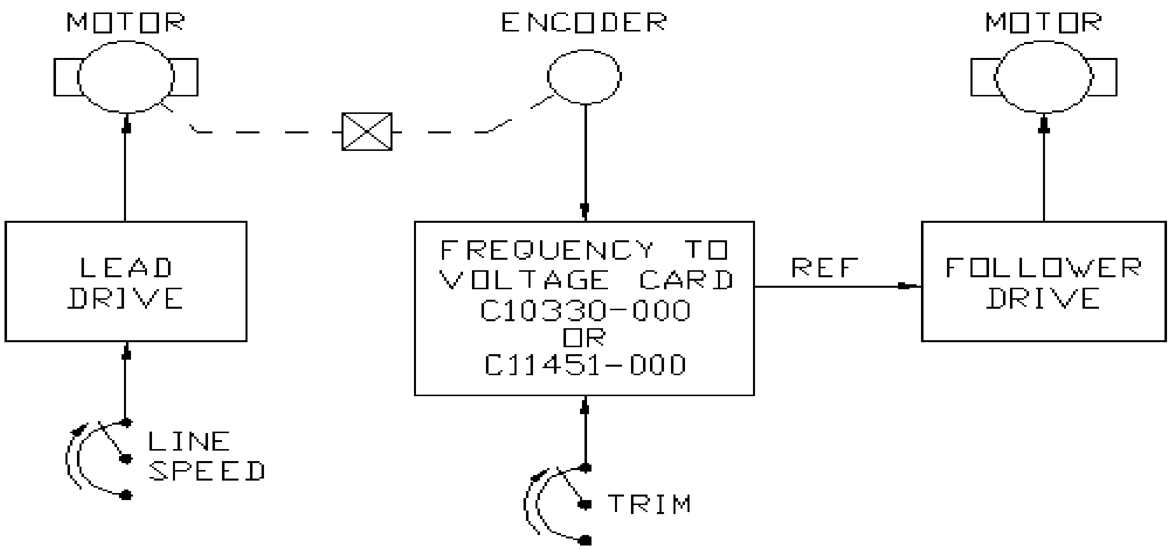

Fig. 5.3 – Encoded Follower

iv. **Follower Mode Negatives:** There are a couple of "negatives" linked to follower pertinence. First, because any handling errors by individual drives would be gathered, various steps of cascading may generate more concentrated error than the process can endure. For example; in the three drive system explained above, assume 0.5% handling error in the two follower drives for a 1% total custom error. Secondly, all follower drives will encounter a restricted start-up delay. This pause can be lessened with careful set-up but never entirely defeated. Another intensification would couple the TRIM pots to dancer tools.

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v.

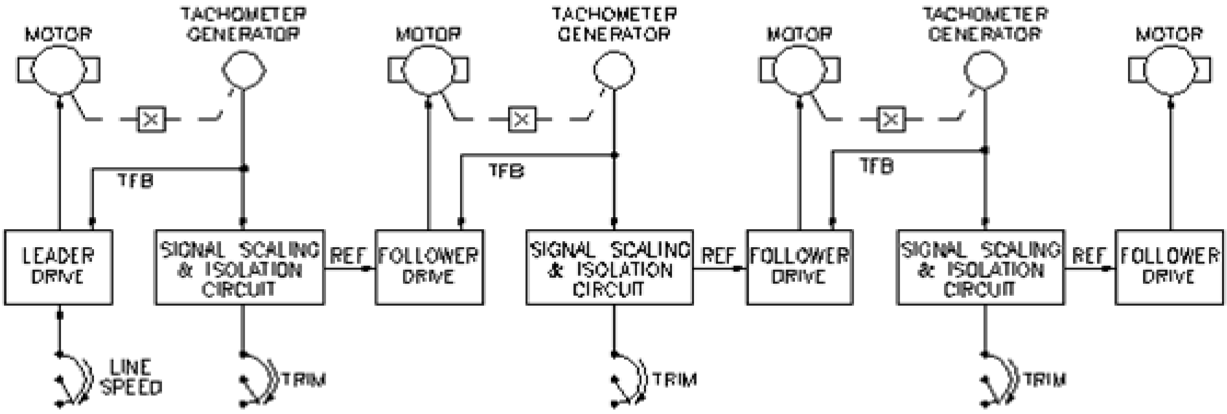


Fig. 5.4 – Cascade Follower Utilizing Tach Feedback & Reference Isolation

switch is a closed loop control method that practices a signal or condition of SETPOINT that establishes a fancied producing level and associates it to a signal or value of FEEDBACK that symbolizes the actual operating level. The setpoint can realize a fancied dancer operating circumstances, a tension level, a load level or a myriad of method contingencies that must be precisely controlled.

The PID control's principal function is to afford a yield adjusting signal or condition that reduces the error or deviation between the SETPOINT and FEEDBACK. The expression PID is derived from Proportional, Integral and Derivative processing of the error signal. The propinquity, contradiction, amplitude, and percentage of change of the error signal initiate and direct the processing methods. The polarity is determined by the greater of the set point or feedback marks and settles whether the improvements are increasing or decreasing or adding or subtracting signals.

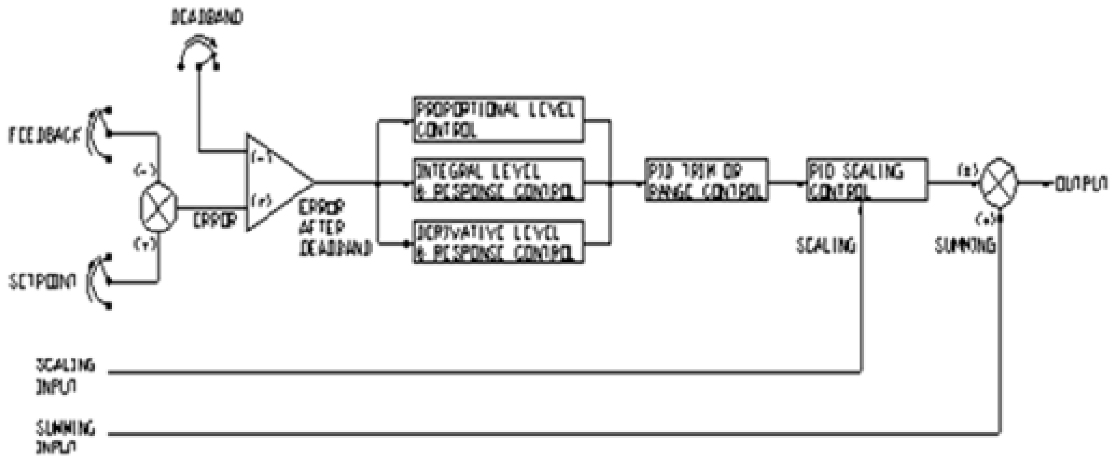


Fig. 5.5 – PID Block Diagram

Integral Processing : The Whole correction sign is also based on the presence and polarity of the error signal. Depending on the product, it uses an adjustable rate or time of acknowledgment to produce a signal that will continually enhance or decrease (based on the polarity) until the error passes to the smallest level. The integral signal will then "hold" at this level as long as the error prevails at the minimum. It is the only of the three signals already when there is no longer any error.

Derivative Processing : The majority of Ancestral correction is based on the rate of variation of the error signal. A flashing rate of change will produce a prominent correction. It is performed only while the error is shifting. Caution should be used in fulfilling Ancestral correction because its effect can change with large changes in the dynamics of an application such as with a large broadness and mass change on a capital is encouraged roll.

Certain inputs present breeze in consolidating an optimized PID correction signal with a primitive reference signal and even varying the effect of the correction by the primitive reference. For example, a dancer position correction may be calibrated to provide 10% speed trim when a line is achieved at 100% speed but, when the line runs at 10% speed, the same dancer trim likens to 100% trim In another word, the dancer trim range % (and sensitivity) doubles as line speed limits. This can mean inconsistent dancer acknowledgment and confidence at different line speeds. Use of the SEALING SET speed is affirmed.

Process Control Interface : Greatest applications concerning "process control" utilize sensing and monitoring of explicit aspects of the processor end product. In many cases the sensors used to provide output in the form of low-level millivolt or milliampere signals which will normally want conversion, amplification, scaling and isolation to a level that is feasible for use by a drive or control circuit.

Devices such as current shunts typically supply only +50 or +100 millivolts full-scale output but maybe at hundreds of volts dormant to the ground or to un-isolated circuit inputs.

A principal determining factor for choosing concerns whether we're bargaining with a consecutive web or length of a product as opposed to somebody or "parallel" manners happening at the same instant.

Transmitter / Receiver : This plan can be practiced to develop or allow control by a low-level voltage signal whose source is too remote to allow the use of a conventional voltage follower. Typically, voltage signals are crammed into high input impedance circuits to prevent unreasonable loading and contortion of the signal. When lengthy wire runs are used to carry these signals, some problems can occur.

i. The long lead wire can operate as an antenna which accumulates up or catches radiated RF or transient energy.
ii. The resistance of the lead wire can cause voltage falls in the transmitted signal that distorts or reconstruct its true quality.
iii. The capacitance of the lead wire can affect signal delays or filtering procedure that distorts or alter signal character.

By transforming the voltage signal to a manner signal of 4 to 20 mA, the reference can be transmitted over much longer gaps through wrapped pair cable and be converted back to an isolated voltage at the receiving end. By transmitting the signal as a higher power "process current" level, the conclusions mentioned above can be decreased or repealed.

vi. **Master Reference (Parallel) Control:** A primitive control signal such as a master bowl., Tachometer, method signal or rate signal is used to compare the speed of two or more motors. The start-up obstructions associated with the cascade follower orderliness are effectively excreted since the individual motor drives sustain start-up units and reference signals at the same time while settling electrically isolated from each other and the source of evidence.

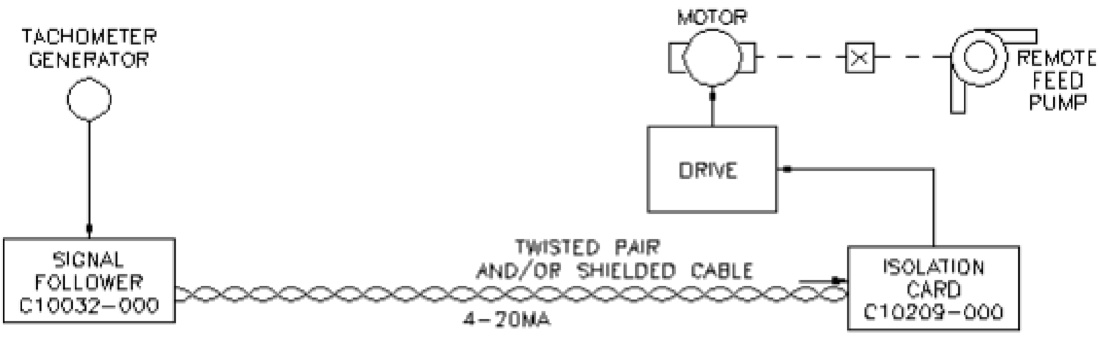


Fig. 5.6 – Typical Transmitter / Receiver Control

vii. **Inverted Logic Follower:** A several applications request for inverted logic. Maximum signal conditioning circuits will proffer an expanding output with an increasing input. Inverted logic will provide a decreasing output with increasing input. This capability is convenient in several conventional Carotron outcomes as an optional calibration set-up. It is generally used as a very simple "equivalent" control classification for non-critical applications.

viii. For Example, A drive used for a pump control or feeder control can be set to work at a maximum speed of light loads or amount. An rising signal from a load sensor or pressure transducer, etc. can produce a proportional reduction in motor speed until a insight is completed – within the prescribed operating range.

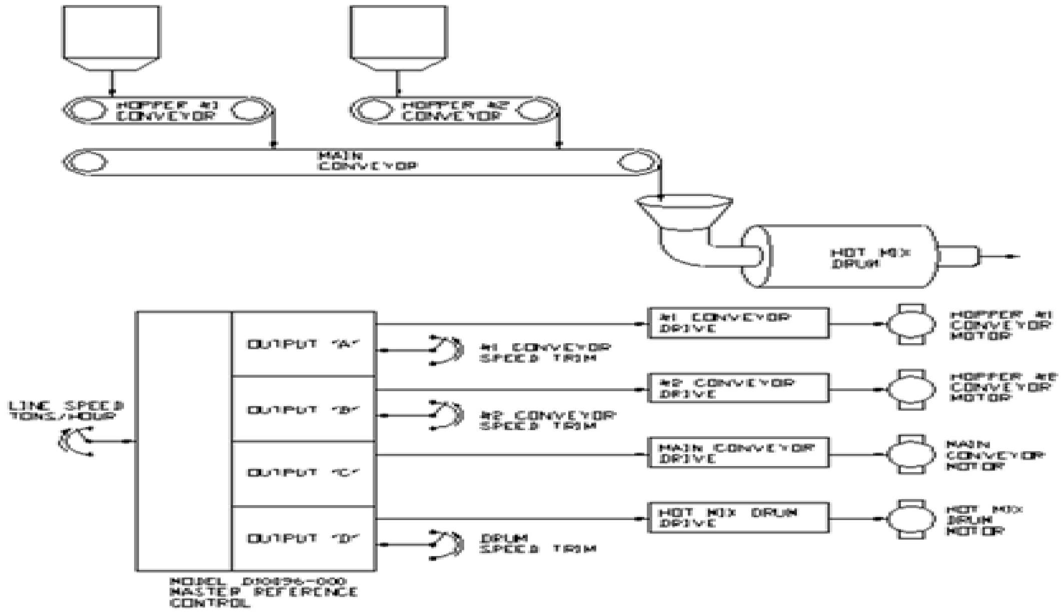


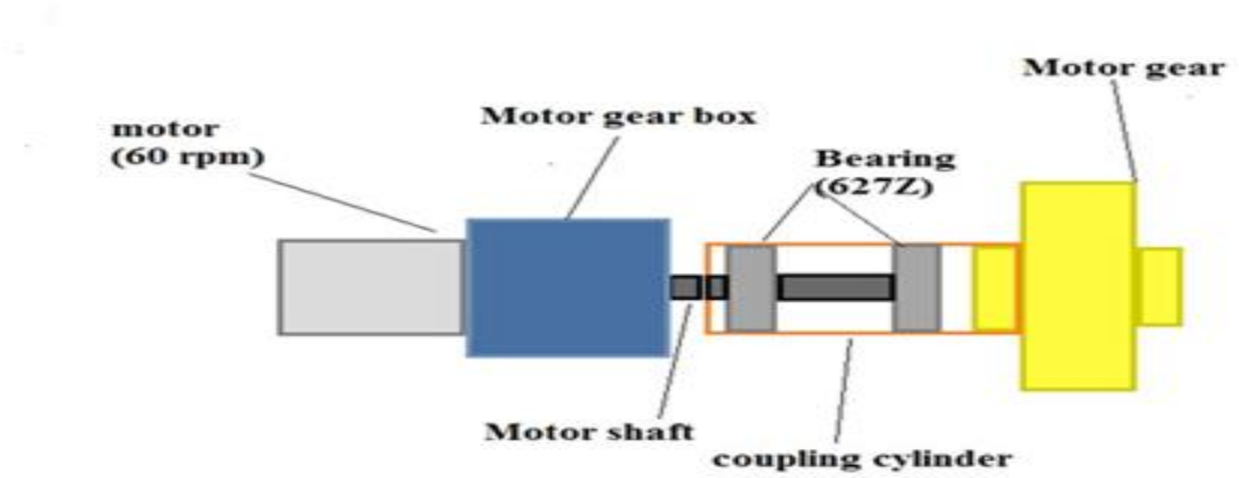
Fig. 5.7 – Master Reference Control

COUPLING OF SHAFT WITH GEAR

A coupling is a device used to attach two shafts mutually at their ends for the goal of transmitting power. Couplings do not normally allow detachment of shafts during a performance, however, there are torque limiting couplings which can slide or disconnect when some torque limit is surpassed.

All joint consists of a 1:1 gear ratio internal/external gear combination. The tooth quarters and an outer diameter of the external gear are established to allow angular displacement between the two gears. Mechanically, the gears are comparable to rotating splines with restrained contours. They are called gears because of the moderately large size of the teeth.

Fig.5.8- Functioning of motor gear



vi. Calculation and analysis

Conveyor belt calculations regards with load applications are:
Where,

Tb is in Newton.
F = Coefficient of friction.
L = Conveyor length in meters. Conveyor length is approximately half of the total belt length.
g = Acceleration due to gravity = 9.81 m/sec^2
mi = Load due to the idlers in Kg/m.
mb = Load due to belt in Kg/m.
mm = Load due to the conveyed materials in Kg/m.
δ = Inclination angle of the conveyor in Degree.
H = vertical height of the conveyor in meters.

i. **Power at drive pulley:** The power required at the drive pulley can be calculated from the belt tension value as below:

Pp = *(Tb*V)/1000*
Where, Pp is in KW. Tb = steady state belt tension in N.v = belt speed in m/sec.

Belt tension while starting the system: The belt tension while starting can be calculated as

Tbs =*Tb*Ks*
Where, Tbs is in N, Tb = the steady state belt tension in N**.** Ks = the start-up factor

ii. **Sizing of the motor:** The minimum motor power can be calculated as:

Pm = *Pp/Kd*
Where, Pm is in Kw.Pp = the power at drive pulley in Kw, Kd = Drive efficiency.

Where,

A is in m/sec2,

Tbs = the belt tension while starting in N.

Tb = the belt tension in steady state in N.

L = the length of the conveyor in meters.

mi = Load due to the idlers in Kg/m., mb = Load due to belt in Kg/m.

mm = Load due to conveyed materials in Kg/m.

iii. **Belt breaking strength:** The belt breaking strength can be calculated as:

Bs=(Cr*Pp)/ (Cv*V)

Where,

Bs is in Newton, Cr = friction factor,

Cv = Breaking strength loss factor,

Pp = Power at drive pulley in Newton.

V = belt speed in m/sec.

vii. RESULTS AND DISCUSSION

i. The first expectation from the project work is to provide a development to the human race without influencing the natural resources.
ii. The methodology is found to be useful as it can prevent the full load input to the conveyor.
iii. The method is expected to provide combinations of load at the same speed.
iv. The expected maximum wattage loss in the conveyor system is 9.

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