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Role of Electrical Drives in an Automatic Waste Segregator Plant

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***Abstract*— This paper describes about the functioning of Automatic Waste Segregator plant and the role played by the electrical drives in such plants. A prototype of this plant has been developed with a view of having the ability to expand such that not just waste from a single house gets segregated but the wastes of a locality or perhaps a city also. For such large scale industrialization of plants such as these, control of motors and drives is most important. The working of the prototype of this plant is brought about by the use of sensors such as ultrasonic sensors, moisture sensor, infrared sensor and metal sensors. It is capable of separating wastes into wet waste, dry wastes and metallic wastes. The prototype also has a conveyer belt and a motor on which a platform which has bins attached to it are mounted. The prototype uses DC motors, for a plant which should be capable of handling large quantities of waste advanced drives and motors are required. The requirements and possible drives and motors for such large scale operation are also discussed in this paper.**

Keywords—Auomatic; waste; segregation; motors;conveyor belt; wet waste;dry waste; metallic waste; electrical drives; sensors; industrialised

I. INTRODUCTION

Waste management and disposal issues are not just problem of a certain country or a continent. It is a global issue which should be addressed immediately. Poor landfills and incinerators could release cancerous carcinogen in the air and other pollutants. They could also be causes of pests, vermin, flies and other similar carriers of communicable diseases. The wastes from a household will have many things like papers, plastics, food wastes, metal pieces, wood etc. Although the separation of these wastes into their respective category is a cumbersome job, segregating them into wet, dry and metallic wastes will reduce the job to a great extent. Wet wastes are mostly food wastes and other materials which contain high level of moisture content in them[1]. Dry wastes basically mean paper, plastics, wood, rubber etc. Metallic wastes as the name itself tells consist of metals. After segregation they can be made available to their respective recycling plants for further processing and recycling [2]. A prototype is presented in this paper to segregate the different types of waste using sensors and motors .The advanced version of the model can be applied to the any site to segregate the waste.

Since this model is designed keeping in mind the scope for industrialization drives to control the motors is an important consideration due to the large amount of waste that has to be segregated [3]. The main requirements of the drives here are to maintain constant speed on varying load for one motor and for another vary the speed depending on the load. The need for these requirements can be well understood in the later part of this paper.

II. DESCRIPTION

A. Sensors Used

The sensors used here are ultrasonic sensor, moisture sensor, metal sensor/detector and infrared sensor.

I. Ultrasonic sensor

The main purpose of using an ultrasonic sensor is to detect materials. It has a large range compared to any other proximity sensors. The ultrasonic sensor used in this prototype is HC-SR04. It consists of ultrasonic transmitter and receiver. Any object in the path will reflect the ultrasonic waves back to the receiver [4]. The time taken for the signal from the time of transmission and reception will vary according to the distance the object is from the sensor. Using this time, the distance of the object from the sensor can be found out.

II. Moisture sensor

This sensor is used to detect wet wastes as they have high level of moisture content. The sensor has two metallic thongs. The moisture sensor circuit is as shown in Fig1.

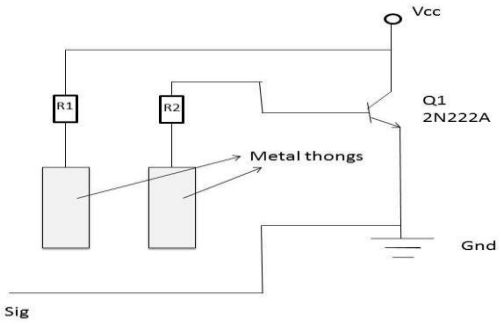

Fig : 1 moisture sensor circuit

At first the base voltage is zero hence the transistor is off and no current flows in the circuit and hence no signal. When a wet waste material comes under contact with these two thongs this will make a path for current between the two thongs and there will be a base voltage

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present and the transistor becomes on. Now a current will flow in the circuit and the waste is thus detected [5].

III. Metal detector

The metal detector is used to detect the metallic wastes. The block diagram of the metal detector is shown in Fig 2.

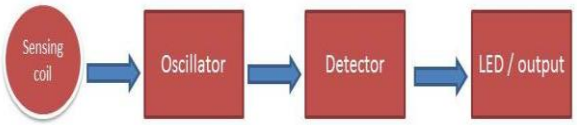

Fig: 2 Block diagram of the metal detector

It uses a sensing (inductor) coil at the input. This forms a part of an oscillator. The signal generated is fed to a detector where rectification of the signals takes place. The rectified signal is given to a transistor connected to reset pin of 555 IC. The IC is as low frequency astable multivibrator to drive an LED. When oscillator generates signals the reset pin is kept low and the LED is off. When a metal is near the coil, the effective inductance changes and the oscillator stops working, this makes the transistor go off and the reset pin is held high. This makes the LED glow indicating the presence of metal[6].

IV. Infrared sensor

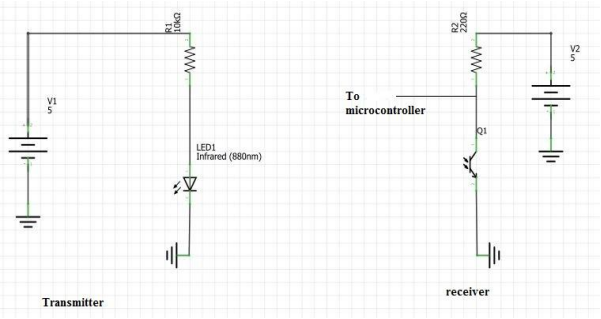

Fig: 3 IR sensor circuit

The IR LED emits IR rays whereas the receiver receives the rays and its resistance varies accordingly. This sensor is also used as proximity sensor with low range to detect the materials. The IR sensor circuit is as shown in Fig 3.

B. Construction and working of the prototype.

The prototype can be divided into three modules. The first module is a platform which has a perforated base. The perforation helps particles such as sand, dust and other fine particles which cannot be detected by the sensors to fall off the platform. This module is housed with mechanical vibrators ultrasonic sensor and moisture sensor. The platform is not horizontal but a bit slant. Garbage is when dumped on the platform will get detected by the ultrasonic sensors; this will activate the entire setup which was at low power mode. The mechanical vibrators will help the small particles which are attached to the bigger particles to fall off and also help in moving the waste materials downwards along the slant of the platform. The tip of the platform has the moisture sensor.

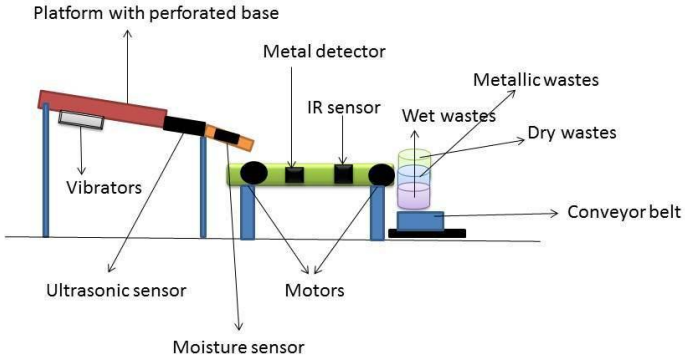

Fig: 4 Prototype for the waste segregation plant

The second module consists of a conveyer belt assembly. The particles from the first module are made to fall to this module. Along the length of this conveyor belt are the metal detector and the IR sensor.

The third module consists of another conveyor belt on which on which bins for wet waste, dry waste and metallic wastes are attached. There are two DC motor which is connected to an H bridge IC which is made used by the microcontroller to rotate the motors in either direction. This arrangement is perpendicular to the first conveyor belt. This operation can also be done by a single motor. But this might be less reliable. The Prototype developed as shown in the fig 4.

All the sensors are integrated to the microcontroller. The working of the model is initiated by the ultrasonic sensor which senses the waste materials on the platform this activates other sensors, vibrators and the motors. The third module is placed at the ending of the conveyor belt with the dry waste bin initially under it. The time required for the other 2 bins to reach the end of the second module from many positions is found by trial and error method. When a wet waste is detected by the moisture sensor, a command is sent to the H-bridge circuit to move the third module in the required direction for a stipulated time such that the wet waste bin comes directly below the conveyor belt. If the metal detector detects a metal the control signal from the microcontroller is given to the H-bridge circuit to perform the same operation as told earlier for the stipulated time so that the metallic waste bin comes directly below the conveyor belt. If none of the sensor senses the material but only the IR sensor detects something then the material is a dry waste and suitable command for required time is given to the third module such that the dry waste bin comes directly below the belt.

III. REQUIREMENT OF DRIVES

This project was done keeping in mind its expandability and the potential of it becoming industrialized. Almost all industries uses motors so is this project. To make these motors meet our requirements and perform at its fullest efficiency electrical drives are used. Hence there is need for electrical drives if this project becomes an Automatic waste segregator plant. Here the motors used are for the first conveyor belt assembly and for the motors for the second conveyor assembly which responsible for the rotation of the base mounted with bins. The conveyor belt although might not possess any problem at a low level when having constant speed[7]. In a large scale its speed has to be

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controlled. When large quantity of wastes is dumped, the conveyor belt has to reduce is speed for giving time for the sensors to detect the materials and also giving time for the suitable bin to come under the belt at its end. Hence a drive for variable speed control for this motor is required.

Next the two motors used for the second conveyor belt with the bins mounted have to be controlled by an electrical drive as well. The load on these motors is not uniform and is continuously varying. Since the control on position of the bins is done purely on timing basis, constant speed is of importance. This enables the need for constant speed drive for the motor even when the load is varying.

IV. DRIVES FOR CONVEYOR BELT

Variable speed drives (VSD) or Adjustable speed drives (ASD) can be used to achieve the requirement of controlling the speed of the conveyor belt based on the quantity on the waste. This type of drive also helps in saving energy. The conveyor belt assembly can be illustrated as shown in Fig 5.

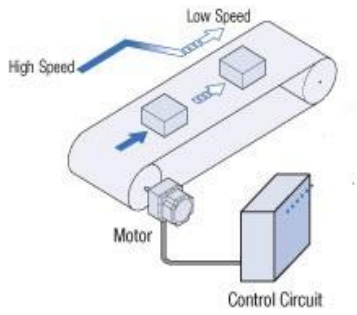

Fig: 5 conveyor belt assembly

The drive motor can be AC or DC. An AC motor speed is given by n=120f/p; where f is frequency of the supply and p is the number of poles. Since the number of poles is fixed, speed can be controlled by varying the input frequency. This can be done by a Variable frequency drive (VFD). The block diagram of a Variable frequency drive is as shown in Fig6.

The rectifier bridge converts the input AC to DC. This DC is fed to an inverter circuit via a DC link. The DC link smoothens out the ripples present. The inverter which is usually a voltage source fed inverter (VSI) is used to convert the DC to AC of required frequency.

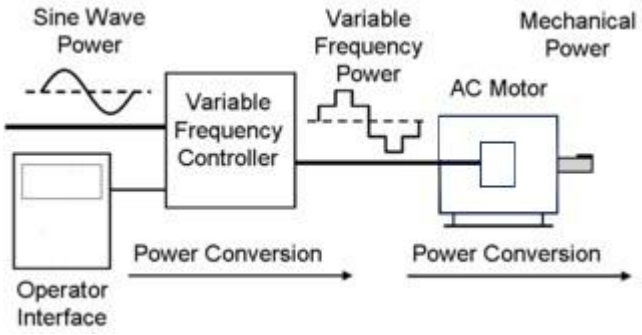

Fig: 6 Block diagram of a Variable frequency drive

Compared to current source inverter (CSI), VSI have low harmonic distortion and provide high power factor. For the inverter switching space vector pulse width modulation (SVPWM) and sinusoidal pulse width modulations are used in practice. Six-step inverter, line commutated inverter, cycloconverter are some of the topologies that are used in VFD.

In case of Dc motors the speed is directly proportional to armature voltage and inversely proportional to motor flux (field current). The AC voltage is converted to DC and is given to the motor. To control the speed the magnitude of the DC motor applied is varied.

V. DRIVES FOR MOTORS FOR THE SECOND CONVEYOR BELT

This motor has to give a constant speed for variable loads. Also there is a requirement of the drive reversing the direction of rotation of the motor accordingly.

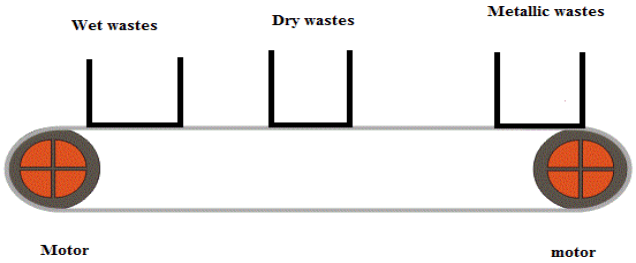

Fig: 7 Reversal of the direction of rotation

DC shunt motor can be used for this purpose. As they have high starting torque too they are optimum for this purpose. These motors can maintain almost constant speed without a drive to control them. Although a constant speed drive (CSD) can be used, there is also a need to reverse the directions of the motor. Only one motor is active at any time [8]. One becomes the drive pulley and the other becomes the driven pulley. The circuit for the reverse direction is shown Fig 7.

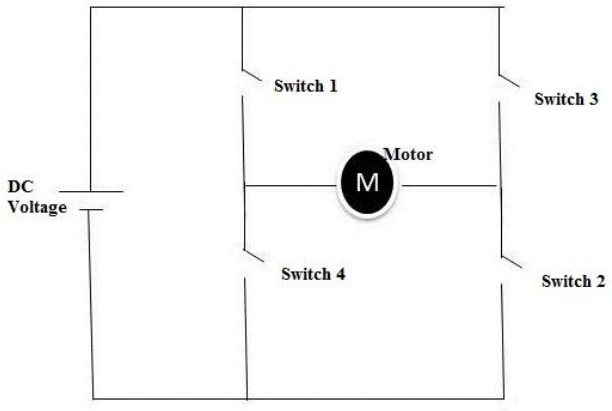

Fig: 8 Drive used for dc to ac conversion

Drive which converts DC to AC is used for this purpose as shown in fig.8. A speed sensor is also used. Any drift or change in the speed, the motor is brought back to its original speed by controlling its applied voltage. Braking (either dynamic or regenerative braking) must be provided as well. The braking is brought down almost constantly with the help of drives and also with the help of the reverse direction pull of the other motor. A single motor can also be used for this

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purpose. Since braking requires some time another motor can be used to move the belt in another direction instead of waiting for the single motor to brake and then change its direction.

Capabilities of such drives are belt slip control, load equilibration between the two driving drums, speed difference control between the two motors, maintaining optimum belt load by controlling the belt speed and safety mechanisms are some of the basic additional requirements

VI. OTHER OPERATIONS OF DRIVES

Along with providing the above requirements, electrical drives used here should also have additional capabilities as stated here. Belt slip control, load equilibration between the two driving drums, speed difference control between the two motors, maintaining optimum belt load by controlling the belt speed and safety mechanisms are some of the basic additional requirements.

VII. CONCLUSION

Realization of an automatic waste segregator plant in a large scale will help us solve the garbage crisis which we are experiencing every day. This realization can be made possible only with the help of drives which can efficiently perform their functions. The drives listed here are just possible solutions. Many other innovative steps can be taken in reducing the number of motors and in providing better control to the motors. From the available drives the most efficient drives depending on the plant capacity and load have to be selected. Thus the importance of electrical drives is clearly established in this paper.

VIII. ACKNOWLEDGEMENT

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