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Pneumatic Teflon Type Level Measurement in Fly Ash Silo

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Abstract- This paper presents, an understanding a new method of pneumatic type fly ash level in storage silo. With the increased use of fly ash in cement production more and more fly ash is ending up in silos and storage vessels. However the use of fly ash becomes challenges when it comes measuring the level of fly ash in your storage bins and silos. In this method pneumatic type regulated air is passed through solenoid valve which is controlled by controller when inlet valve is open controller starts the timer and pressure increases Polytetrafluoroethylene (Teflon) elastic bag, where Teflon bag is directly placed inside the storage silo and it directly contact with the fly ash material. Depend upon level of fly ash material there will be proportional change in free space of Teflon bag which leads to change in back pressure. When desired back pressure is reached pressure sensor sends the signal to stop the timer, time taken is directly proportional to the level of flyash as stored.

I. INTRODUCTION

Through the years, process industries have effectively handled countless requirements of bulk materials. The handling of Fly ash is more important in many industries mainly cement industries and coal power plants. Still many of process industries they are using olden manual method of solid level measurement in storage silos because due to high cost of instruments and inefficient because of dust particles and its size. Pneumatic type fly ash level measurement technology is a problem solver and is proven reliable for measuring virtually any powder and especially the previously-difficult-to-measure fly ash. Regulated air supply is given periodically into Teflon type elastic bag. Elastic bag is placed at top centre of storage silo and it will directly contact with fly ash. Depend upon level of fly ash there will change in free space of elastic bag. Bottom of the elastic bag is contact with fly ash and top of bag is connected with inlet and outlet solenoid valves. The time taken to reach the set pressure value is directly proportional to the level of the storage silo.

A. FLY ASH:

Fly ash is a fine solid powder which is specifically derived from the combustion of burned coal mainly from coal fired thermal power plants. Manufacturing of cement requires a source of silicon raw material. In late 1940's they do some research to find some way of making usage of waste from burned coal. Then they find that fly ash consists of silicon sources, it can be often used in cement production which will reduce the cost of cement manufacturing process and also consist of other benefits. 15 to 35 percentage of fly ash can be added with concrete mixes. The benefits of adding fly ash in cement production are make better for the workability of the concrete, improves sulphate resistance, will decrease the water ratio required, will reduce permeability and it reacts with any free lime left after hydration and improves concrete strength. Mostly cements plant buy fly ash raw material from coal fired thermal power plants just because of lower sulphur and carbon content in fly ash and which leads to better concrete. Fly ash dielectric Constant will vary from 1.5 to 2.6 of its properties. Fly ash is more easily loaded into and unloaded from storage silo by pneumatic conveying system which will cause dust cloud dispersion and concentration of fly ash will also vary heavily.

B. Properties of Fly Ash

Initially properties of fly ash will not same always, because fly ash collected from coal fired thermal power plants gets differ. Due to temperature range at which coal was burned and also burning process of coal plant has an impact on the fly ash properties at coal-fired power. The burning of coal at cement plant and thermal power plant gets differ which leads change in properties. The dielectric constant of fly ash is never the same. Due to the temperature and humidity most of the fly ash changes occur commonly. Then the fly ash collected from the heavy oil or waste burning installation process also naturally will have different properties as well. Important properties of fly ash are weight of the fly ash, temperature, dielectric constant, size of the particles, and how sticky is it.

Figure 1: Cement vs Fly Ash

II. SOLID LEVEL MEASUREMENT METHODOLOGY

Solid level measurement in fly ash storage silo is critical because this storage vessel is directly feeds cement production. High accurate level measurement helps to check that the storage material will never overfill and runs out. In added, plant operators control the level of storage silo to optimize quality. Production department in cement industry uses the level measurement readings to plan future production quantity based on inventories and shutdown period maintenance schedule.

There are large number of solid level measurement technologies are available in the market for the process industries application. The difficult for large number of end users is not selecting the correct technology for that application, but selecting the correct technology will benefits low maintenance, cost of ownership and good performance for that application.

Few solid level measuring instruments works well for different multiple of applications, while other instruments are only for specific application. This will allow them to make an knowledgeable decision that will best suits to their own

application. Modern technology might changes the way of end user to address point level and continuous level application for bulk solid level storage silo.

Point Level measurement: The vital task of point level measurement is used to avoid excessive empting or overfilling of the storage tank and to protect outlet pumps from running dry condition. RF admittance, paddle switch and capacitance type sensor are some of the level sensor used for point level measurement.

Continuous level measurement: Continuous level measurement technology is used to determine current running process condition such as level of storage silo continuously. Guided wave radar, ultrasonic and strain gauge type are the some of the sensor used for continuous level measurement.

Fly ash measurement principles: In some of the process industries, mechanical system and weighing system are used for fly ash level measurement, in this method it mainly depend upon specific density of the fly ash which determines the accuracy and reliability of the measurement. A float type weight was lowered on a cable or metal tape into the storage silo. When the weight touches the storage level in the silo, the electronic sensor identify the slack in the band or cable, motor can be reversed and the length of the metal tape is counted which will indicated the amount of free space or empty in the storage silo. This method is the simple and robust way of level measurement in storage silo, but main limitations are it requires high maintenance as the mechanical moving parts, mechanical parts wear out and need frequent replacement mainly in a dust applications and it is also costly method of level measurement. Reducing maintenance cost and ownership cost for the current focus of modernization and building process plants, this technology is being neglected. Guided Wave Radar sensor is commonly used in cement silo but main drawback is high cost it will range from 6 to 7 lakhs and it is dependent on the dielectric constant of a storage media. Most of the modern industry prefers less maintenance measurement devices and this pneumatic type fly ash level method also have less maintenance work.

Figure 2: Fly Ash Storage silo

Teflon will give maximum bag life, because of its superior chemical and thermal properties. It is very non-reactive, partly because of the strength of carbon–fluorine bonds and so it is often used in containers and pipework for reactive and corrosive chemicals. PTFE is a thermoplastic polymer, which is a white solid at room temperature, with a density of about 2200 kg/m3 and its melting point is 600 K (327 °C; 620 °F). PTFE's coefficient of friction is 0.05 to 0.10 which is the third-lowest of any known solid material, so there is no coefficient of friction between fly ash and Teflon bag.

III. PROPOSED METHODOLOGY

This method consist pneumatic regulated air supply in the range of 15psi given through inlet solenoid valve, when inlet solenoid valve is open, air is passed through the Teflon elastic bag. The opening and closing of the solenoid valve is controlled by microcontroller, when inlet solenoid valve is open microcontroller send the signal to start the timer. Depend upon the level of the fly ash in the storage silo there will be change in free space of Teflon bag. In the outlet line there will be pressure sensor which is used to sense back pressure from the Teflon bag, this pressure sensor continuously send the back pressure value to the controller, there will be set valve of back pressure in the microcontroller which is 18psi. If outlet pressure signal reaches 18psi controller automatically send the signal to stop the timer, open outlet solenoid valve and close inlet solenoid valve. The time taken to reach set valve of 18psi is directly proportional to percentage of level in fly ash storage silo. Then due to opening of the outlet solenoid valve there will drop in pressure signal when back pressure signal reaches 0psi then controller send the signal to open inlet solenoid valve and close the outlet solenoid valve which leads to increase in air pressure signal to Teflon bag and the cycle keep continues. Then LCD display is used to indicate the percentage of level continuously for every cycle.

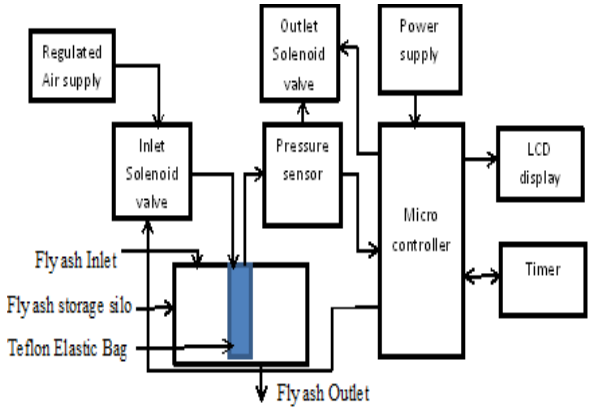

Figure3: Basic Hardware Block Diagram

IV. THE CORRELATION BETWEEN FLYASH STRESS AND FREE SPACE

The behaviour of a fly ash is completely different from fluid medium. The positive stress of a bulk solid is normally exerted in the vertical direction. Within the solid storage silo the horizontal stress, is a result of existing vertical stress, where resulting vertical stress is higher than the horizontal stress. The stress ratio is the ratio between horizontal stress to vertical stress. Due to this stress ratio the free space in the elastic bag will vary depend upon the fly ash storage level.The flow ability of a bulk solid particle it mainly depends upon the adhesive forces between individual particles. The normal stress of fly ash is given by equation

$$\sigma_\alpha = \frac{\sigma_v + \sigma_h}{2} + \frac{\sigma_v - \sigma_h}{2}\cos(2\alpha) \quad (1)$$

Angle of Repose: The surface level of the solid will not be uniformly maintained throughout the storage silo as like liquid surface level. If the solid material surface lies at an angle to the incident acoustic waves, then transmitted echo will be reflected away from the transducer towards the side walls of the storage vessel. This leads to that the returning path of echo will be in zig - zag form and it will affect the accuracy of the measurement. In common, surface granularity changes with solid surface make sure that adequate energy is reflected back in the direction of the receiver to acquire more accurate reading. For targets with sharp angle of repose, the thickness of the beam that strikes the surface target can consist of will

covering broad range of distances and it leads to tough, to consider correct one. In this case, it is major to understand the solid surface target material, and to provide maximum possible frequency range to reduce the transmitting beam width and hence spot size on the target material surface.

V. EXPERIMENTAL SETUP

To demonstrate the concept of level measurement using fly ash in storage silo, pneumatic air supply is applied through the inlet solenoid valve. The inlet and outlet solenoid valve opening and closing is controlled by the microcontroller. The pressure sensor used to continuously monitor the back pressure from the elastic bag and the set valve of back pressure is coded in the microcontroller. When the inlet solenoid valve is open controller sends the control signal to start the timer, pressure sensor sends the back pressure signal. When back pressure signal reaches the set valve controller stops the timer, close the inlet solenoid valve and open the outlet solenoid valve. Time taken to reach the set value is directly proportional to level of the fly ash silo.

V. RESULT AND ANALYSYS

Output results shows that the measured data level of the storage silo rapidly changed using pneumatic Teflon type level measurement. The time taken for the back pressure to reach the set value will be different for each percentage of the storage level. Then time taken to reach initial zero level to set value and set value to zero level is the time taken to complete one cycle which will continuously run on. Depend upon the height of the storage silo the lengths of the Teflon elastic bag will get vary and the time taken to complete one cycle will also vary. When the inlet solenoid valve is open pressure increases inside the elastic bag, depend upon the free space there will be change time taken to reach the set value gets varied for different storage levels.This method is not affected by any dust particles. The output percentage of the level will be indicated on the LCD display it can also transmitted to the control room by converting 4 to 20 mA standard signal.

CONCULSION

In this experimental studies, a fly ash storage silo level measurement method based on Pneumatic Teflon type Fly ash level methodology in storage silo is studied and validated. It incorporates Teflon elastic bag from top to bottom of storage silo. Depend upon level of storage silo there will be change in free space of the elastic bag which will change back pressure in the outlet. The time taken to reach the set value from initial zero psi helps to determine the level of the storage silo. This method is more user friendly and less maintenance. Further study is required to understand the different silo structure at different material size.

References

[1] Kwade, A.; Schulze, D; Schwedes, J.: "Determination of the stress ratio in uniaxial compression tests, Powder Handling & Processing" (1994).

[2] L.k. Crouch, Heather J Sauter, Audrey Copeland, Todd Walker, Jamey Dotson and Daniel Badoe " The Effects of Fly Ash and Portland Cement on long termExcavatability of Flowable Fill" International Ash utilization Symposium, Center for Applied Energy Research (2001).

[3] R. Ciccu, R. Peretti, L.G. Orsenigo and G. quattroni ―The Italian Approach to the Problem of Fly Ash‖ International Ash Utilization Symposium, Center for Applied Energy Research,(2001).

[4] Lindon K.A Sear, Andrew J, Weatherley "The Enviromental Impacts of Using Fly Ash" perspective International Ash Utilization Symposium, Center for Applied Energy Research,(2003).

[5] Robert Youells and Dave Spacek "Continuous Fly Ash Transfer System" World of Coal Ash(WOCA), Northern Kentucky,(2007).

[6] Schulze, D.: "Powders and Bulk Solids – Behaviour, Characterization, Storage and Flow" Springer Berlin – Heidelberg – New York – Tokyo (2008).

[7] Joe Lewis "The Problem With Measuring Levels" Blue Level Technologies Technical Exclusive.(2010).

[8] Hugo Aparicio PE and Will Mattingly and Jennifer McCosby ―Instrumentation and Monitoring Program ash storage facilities World of Coal Ash Conference.(2013).