Remote Monitoring Cement Silo Stock Data

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Abstract: The study considers the hardware and software solutions implemented in the automated control system for remote monitoring cement Silo stock data. System can be used in Silos where bulk trucks load the Silos by pneumatic conveying system. They check the level of product in the Silo, inner pressure of Silo, they control the jet filter, inlet and discharge valves for safety and reliability. The system, supplied in component form, prevents overfilling or excess pressurisation, thus, avoiding damage to the Silo to the venting filter or any other accessory at the same time reducing the risk of dust emission. The system is using wireless communication technologies and data exchange between sensors and data acquisition devices. This makes it possible to combine separate Silo (groups of Silo) into a single cement warehouse, control them and monitor cement stocks remotely via the internet.

Key words: Cement Silo, Silo stock data, wireless radio, Automated Control System (ACS), sensors, Programming Logical Controller (PLC), Cement Silo Safety System (CSSS), inventory management system, Industrial Internet of Things (IIoT)

INRODUCTION

In order to turn a cement warehouse into a modern automated complex it is necessary to equip it with a system of sensors and industrial controllers integrated into an automated control and monitoring system (Ostroukh and Yuan, 2013a-c, Ostroukh and Tian, 2014) filling cement Silos. Typically, such a system is included in a comprehensive system for automation of warehouses and cement terminals, ready mixes concrete plants or precast mixes concrete plants for the manufacture of concrete block and constructions (Ostroukh *et al.*, 2006a-c, 2015c). The developed automated system should correspond to the modern concept Industrial Internet of Things (IIoT) (Maksimychev *et al.*, 2016a, b; Ostroukh *et al.*, 2015b) which implies the use of wireless subsystems and controllers with the ability to remotely access, exchange and manage data over the internet as well as the application of cloud and fog computing and services for storing, processing and exchanging data.

Automated Control System (ACS) for remote monitoring cement Silo stock data was designed with sensors and Programming Logical Controllers (PLC) Kistler-Morse (Fig. 1). Let us consider in more detail the elements of automated control system for the remote monitoring cement Silo stock data.
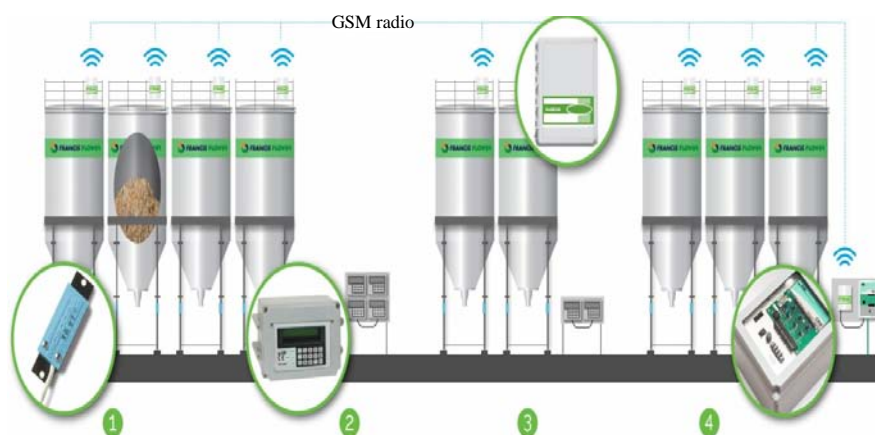

Fig. 1: Automated control system for remote monitoring cement Silo stock data: 1) Microcell bolt-on sensor; 2) SVS2000 controller; 3) Invisilink wireless radio and 4) ORB inventory management system

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MATERIALS AND METHODS

Cement Silo safety system: Cement Silo Safety System (CSSS) for the safeguarding of Silos consists of a central electronic monitoring and control panel which manages a series of Silos and a component kit including in the basic version, one power panel for each Silo a Silo pipe connection a pinch valve a tanker coupling to the filling pipe a maximum level indicator a differential pressure switch or electronic pressure meter a pressure gauge for the venting filter a pressure relief valve and an audible alarm (Fig. 2).

CSSS features:
- Monitoring up to 32 Silos simultaneously
- System events list
- Starts and stops filter cleaning automatically
- Electronic pressure meter gives indication of when filter may need attention
- Internal pressure monitoring of each Silo
- Maximum level indication

Reveals presence of compressed air to venting filter (if air jet filter is used) and pinch valve. CSSS can be used for Silos which are filled with powders or granular materials by tanker. Damage to the Silo or its accessories is most likely during filling operation from the tanker. This is due to the risk of overfilling or excess pressurisation.

CSSS, supplied in component form, prevents both overfilling and excess pressurisation, thus, avoiding damage to the Silo to the venting filter or other accessories and reducing the risk of dust emission into the atmosphere.

RESULTS AND DISCUSSION

Hardware components: The automated control system for remote monitoring cement Silo stock data is equipped with a microcell bolt-on sensor (Fig. 3) which is screwed to the racks carrying a weighing container-in this case a Silo.

When the weight (level) of material inside the container changes, the corresponding part of the capacitance design decreases or increases as a result of which the microcell bolt-on sensor is compressed or stretched (changes the length).

Reacting to the variation in the extension of the load-bearing part of the structure, the sensor generates an electrical signal proportional to the density of the material to be weighed.

Sensors are most often mounted on each rack or console. They can be installed at any time while during the installation you do not need to empty the tank or stop production.

Electrical signals from microcell bolt-on sensor are transmitted to SVS2000 controller (Fig. 4). The

Fig. 3: Microcell bolt-on sensor

Fig. 4: SVS2000 controller

Fig. 2: Cement Silo safety system

user-friendly and easy-to-configure SVS2000 controller displays on a small display a mass of cement in the Silo in the form of a digital indication or a histogram, depending on the user's preferences.

The data exchange is carried out by InvisiLink wireless radio (Fig. 5) which eliminates the need for cables and cable connections between sensors and data acquisition devices. InvisiLink wireless radio interacts using radio frequencies using RS-422 or 485 protocols and can be configured as single-point or multi-point.

The ORB inventory management system (Fig. 6) is made in an industrial enclosure that withstands the harshest operating conditions. ORB inventory management system interacts with the digital level and load sensors to monitor and log performance and system performance. Large amounts of the data can be safely monitored, retrieved and the structured by various users including in the remote access mode via the internet.

ORB inventory management system maintains constant monitoring of technical condition and warns

Fig. 5: InvisiLink wireless radio
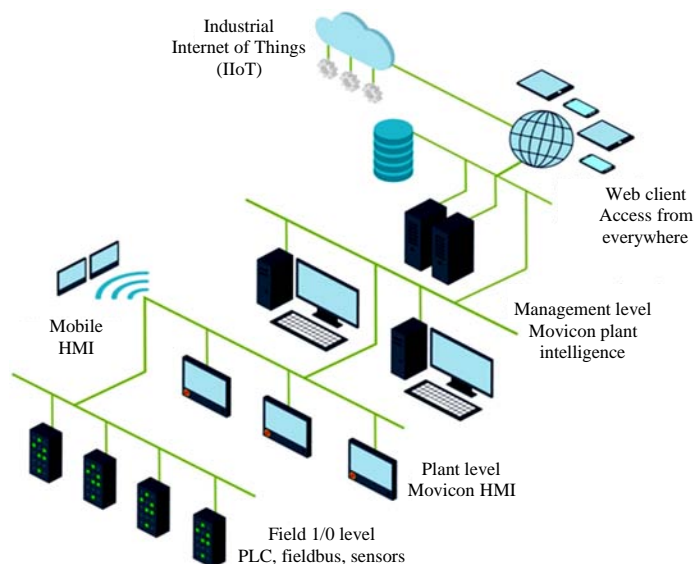

Fig. 6: ORB inventory management system

Fig. 7: Software for remote monitoring cement Silo stock data

users about emergency situations. ORB inventory management system provides a reliable tool for collecting and transmitting inventory information in real time from anywhere and anytime through a local network or the internet.

Software component: Software designed on the basis of iLevel Web platfrom (Fig. 7), it is possible to monitor cement stocks in Silo remotely via. the internet, regardless of geographic location (Ostroukh *et al.*, 2013; Ostroukh *et al.*, 2015a; Ostroukh and Pomazanov, 2014).

Software allows you to track trends in the flow and accumulation of cement and manage its reserves rationally. Software also allows for remote calibration of all Silos which further reduces the costs and time of on-site staffing.

CONCLUSION

Automated control system for remote monitoring cement Silo stock data provides people's safety and equipment safety and also eliminates the risk of erroneously loading the material into the wrong Silo. The system independently determines the need for maintenance and cleaning of the filter, monitors the level of loading and pressure in the Silo, directs the supply of compressed air to the check valves, activates and stops the procedure for cleaning the filters.

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