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Level Controls in Solids Handling

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Füllstandsmessung in der Schüttgut-Fördertechnik
Contrôle des niveaux lors de la manutention des solides
Controles de nivel en el manejo de sólidos

粉体取り扱い時のレベルコントロール

液体处理的水平控制

وسائل التحكم في المستوى أثناء مناولة المواد الصلبة (غير السائلة) . بقلم اف . جيه . دوي .

Summary

The Bin-Dex system, continuous indication and level control equipment, a relatively new concept, is introduced. The basic philosophy leading to the original design is highlighted and actual operational constraints and equipment performance indicated.

1. Introduction

The use of level sensing devices in bulk solids storage and handling complexes ranges from simple indication of levels to the control of material movements by conveyors and other bulk transfer systems. Today these functions are increasingly complex and require level controls that are technically advanced and suitable for use in data processing and computerised automatic transfer complexes.

Level controls meet automation needs by providing a signal which can be utilised to start and stop bulk transfer systems. In this way predetermined quantities can be shifted from point to point, stocks of material can be maintained between limits, bins can be protected against emptying or overfilling, and the quantities of material in transit can be tightly controlled.

2. Bin-Dex in Outline

The servo-controlled plumb-line is well established as a basically simple and reliable system for the continuous checking of solid material levels over their full range within a bin. It has an ability to discriminate between small differences of level to a far greater degree than is possible with, for example, echo-sounding techniques.

The 30—98 Company Ltd., England, specialist level control engineers, have in the latest version of their Bin-Dex, combined the essential simplicity of this system with advanced techniques to meet modern needs.

The sensing bob checks the material level at a pre-selected frequency, providing a signal for indicator meters, which can be sited at remote points, grouped for multiple displays, and built into control room panels and mimics. The signal is held in a memory circuit between checking cycles so that data logging can be carried out at any time; the signal is also compatible with advanced computer systems.

High and *low* limit relays are provided, adjustable to pre-selected levels, for indication, alarm and plant control functions. Additional switching units for *intermediate* control positions are also available to cater for more comprehensive indication and plant automation.

3. Continuous Indication

A Bin-Dex solution to a basic continuous indication problem is illustrated at the Hanningfield Treatment Works of the Essex Water Company. Lime and soda-ash for dosing water in vertical-flow softening tanks are stored in ten bunkers; six of 120 tons capacity for lime and four of 80 tons capacity for soda-ash (Fig. 1).

Fig. 1: Bin-Dex repeater indication of chemical levels at the Hanningfield Water Treatment Works, England

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The level of chemical in each bunker is displayed continuously, by Bin-Dex level indicators, in the bunker operations central control area. Repeater indicators are also given in panels at the lime and soda-ash loading points where road tanker deliveries are connected to the bunker feed ducts.

Hanningfield uses approximately 100 tons of lime and 80 tons of soda-ash each week, and when a Bin-Dex on the mimic panel shows a lime or soda-ash bunker to be half empty, the chemical is re-ordered. The indicators at the loading points are used for checking during the tanker deliveries.

4. Milling Plant Control

A more comprehensive indication system, with automatic operation of plant, is illustrated by Bin-Dex installations at Cranfield Bros. Flour Mills, Ipswich, where the levels of wheat, flour and other materials in over 60 bins are continuously monitored and indicated on a mimic diagram in a central control room. The level indications are also shown on a number of local control panels (Fig. 2).

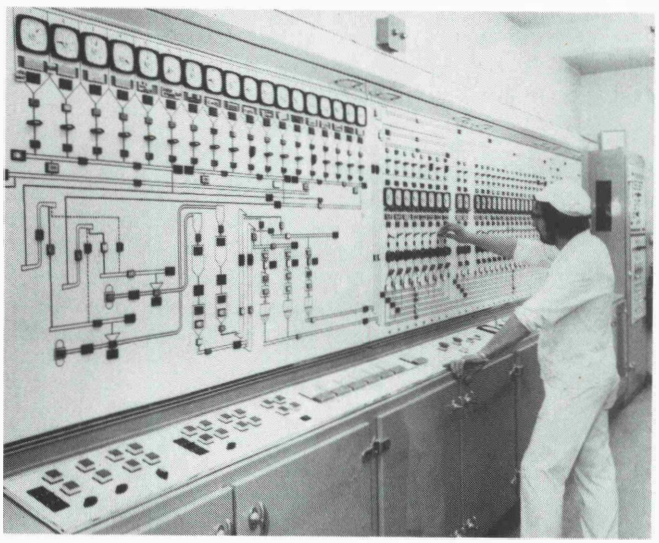

Fig. 2: Bin-Dex display meters in the central control room, Cranfield Bros. Flour Mills, Ipswich, England

Since 1968 Cranfield Bros. have progressively centralised plant control at their two Ipswich mills, and the single control room now provides overall control for both mills. For these arduous level control duties the choice lay between Bin-Dex and alternative designs in which the sensing bob is wound to the top of the bin after each check. Because of the quickly changing levels of the materials in the bins — throughputs range up to 90 tons an hour — Cranfield opted for the virtually continuous readout of the Bin-Dex.

In addition to providing data for control panels, the Bin-Dex units also initiate visible and audible warnings, and operate bin outlet slides and conveyors, when the bin materials reach pre-selected high, low and intermediate levels (Fig. 3).

5. Quarry Storage and Loading

An illustration of the ability of Bin-Dex to provide data for complex operator-controlled bulk handling is illustrated at the Foster Yeoman quarry, Shepton Mallet. Bin-Dex units are installed both in the main crushed-limestone storage bunkers and the road and rail loading hoppers (Figs. 4, 5).

Fig. 3: Inspection of a Bin-Dex head unit at Cranfield Bros. Flour Mills

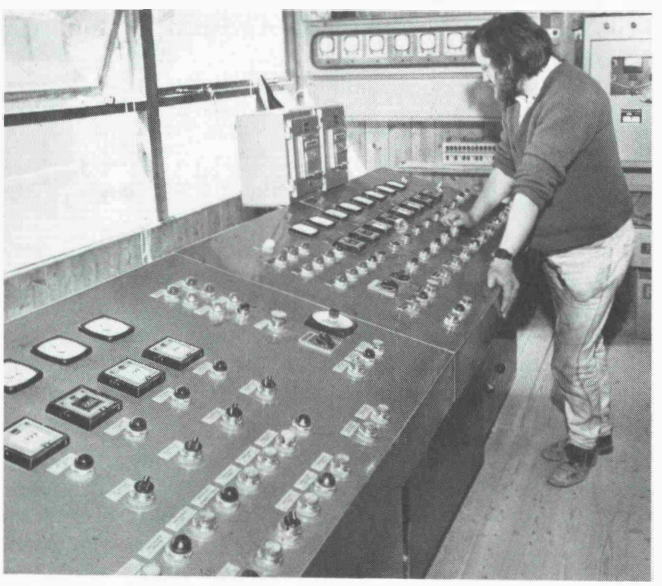

Fig. 4: Rail loading hopper control room at Foster Yeoman, England. Bin-Dex indicators show material levels in the main storage bunkers

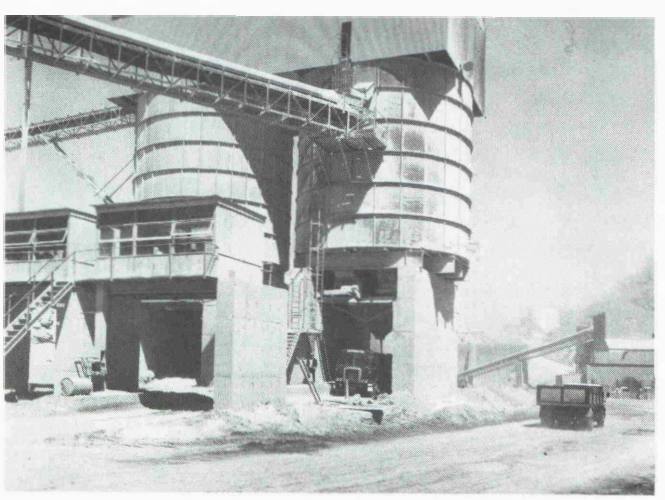

Fig. 5: Road and rail loading hoppers at Foster Yeoman Quarry

Stone reaches the 16 main storage bunkers after being screened into eight sizes ranging from 2 inches to dust. Indication of the level in each bunker is shown by an indicator mounted in a panel in a control room sited above the final screens. With the aid of an adjacent mimic diagram, the indicators enable the operator to control the movement of stone to the screens, and hence to the bunkers, as well as from the bunkers to road and rail loading hoppers.

The eight sizes of limestone are transferred from the storage bunkers to the loading hoppers by conveyors. Both hoppers are subdivided, the four sections of the rail hopper and the eight sections of the road hopper each being equipped with a Bin-Dex. The total throughput of material is around 1,000 t/h and extremely erratic.

The rail loading hopper sections are fed with stone of single sizes, or with blended stone, while the road loading hopper sections each contain stone of one size and blending is carried out at the hopper.

The two hoppers have separate control rooms. In the rail control room, which has overall control of both hoppers, level indicators are provided both from the rail and road loading sections. In addition, remote repeater indicators from the main storage bunkers are also displayed.

In the road loading control room the levels of materials in the road hopper sections are indicated, and indications from the main storage bunkers are again repeated. The control room operator has full facilities for stone blending, which is carried out by a proportioner with a loading capacity of 800 t/h.

Despite extremely high dust levels the Bin-Dex equipment at Foster Yeoman operates reliably with only simply routine maintenance.

6. Rapid Loading

A related materials loading application, to which newly-developed heavy-duty versions of Bin-Dex can be applied, is in rapid-loading bunkers, and it well illustrates the simplicty of the system for coping with quickly changing levels (Fig. 6).

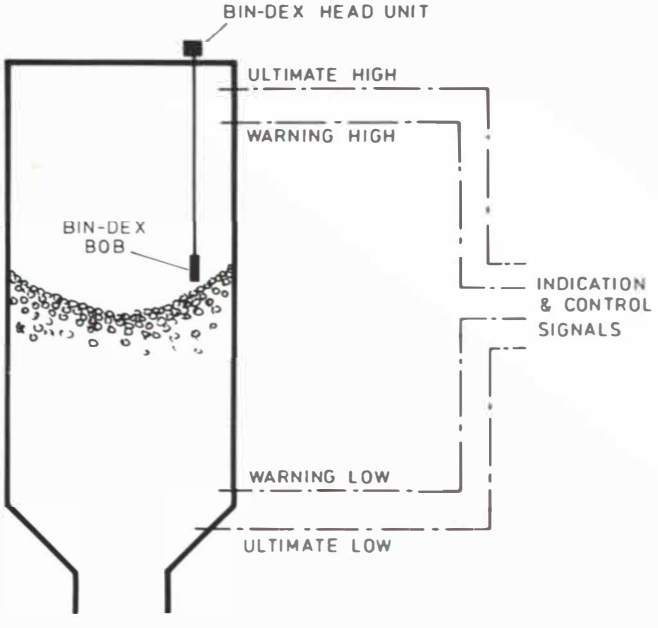

Fig. 6: Control system for high-throughput storage bunker

The lowest level signalled is an *ultimate low* danger level, and the signal automatically closes the bunker outlet gate, leaving, in the bunker, a bed of material required for safety in the loading of wagons. Above this is a *warning-low* level, which initiates visible or audible warnings.

Near the top of the bunker is a *warning-high* level, the signal from which shuts down the supply of material from incoming conveyors. The topmost signal, an *ultimate-high* warning level, is a back-up facility vital for the safe operation of many such automated process systems.

7. Mobile Bin-Dex

In this successful application, a Bin-Dex attached to a travelling conveyor is used to control the distribution of china clay over an extensive storage floor. As shown in Fig. 7 the distribution system comprises a central conveyor together with an extensible cross conveyor, on which is mounted the Bin-Dex. Material passes from the central to the cross conveyor wherever the latter may be situated.

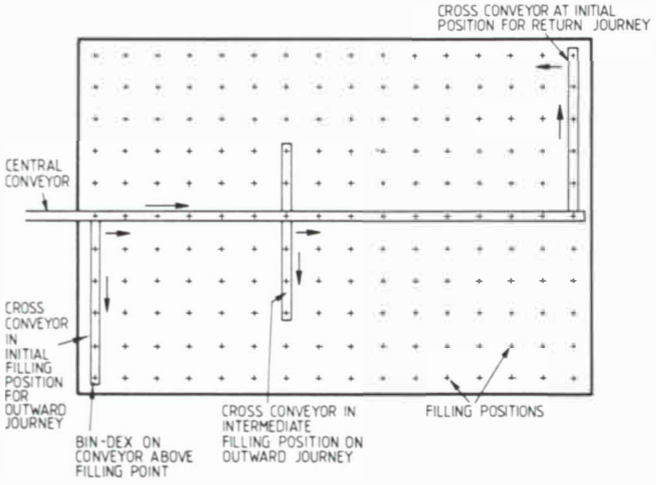

Fig. 7: Conveyor control system, with mobile Bin-Dex, for distribution of material over storage flow

The loading operation commences with the cross conveyor fully extended at one end of the floor, so that it deposits material in a corner loading position. When the Bin-Dex senses that the clay has reached the required level, its signal is used to automatically retract the cross conveyor to the next loading position. When the cross conveyor has completed the filling of the first row of positions it is automatically moved forward, and again fully extended, by the Bin-Dex signal, to commence filling the second row.

When all rows on one side of the storage floor have been completely filled, the cross conveyor is automatically traversed to the other side of the central conveyor to fill the remainder of the floor.

This mobile Bin-Dex can also be used for topping-up operations, by checking the level of material at each loading point in turn, and automatically switching on the conveyors when a low level at any point indicates a need for more clay.

In a related application, a mobile Bin-Dex has been used to control the distribution of fertilizer over a storage floor. This case clearly illustrates the high reliability of Bin-Dex as, during the loading operations, access to the floor by operators is impossible due to the toxic nature of the dust and fumes.

8. Flameproof Versions

Hazardous atmospheres occur in plants ranging from collieries and petroleum refineries to flour mills, and it is an obvious advantage to the engineer if equipment used in his plant generally is also available for any hazardous areas (Fig. 8).

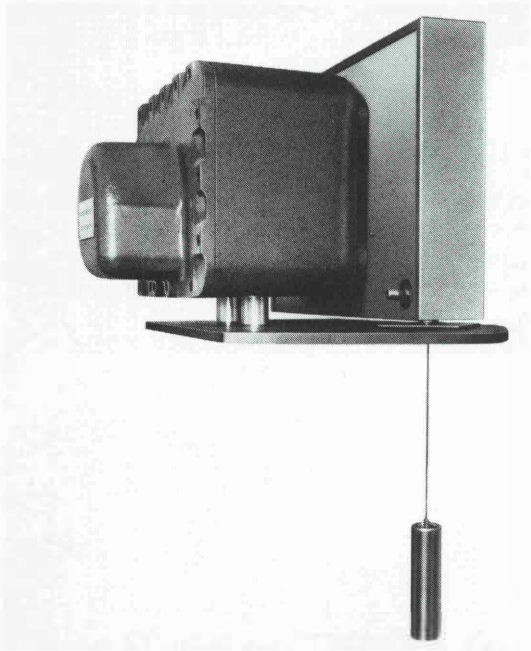

Fig. 8: Flameproof Bin-Dex enclosure, showing sensing bob

Such areas are classified into Group I for mining applications, and Group II, for other environments containing potentially explosive vapour. Group I equipment must possess a certificate issued by the SMRE (Safety in Mines Research Establishment) and, if intended for use by the NCB, an NCB Acceptance Number. For Group II equipment, the certifying authority in Great Britain is BASEEFA (British Approvals Service for Electrical Equipment in Flammable Atmospheres).

Hazardous environments in Group II are further subdivided into Zone 0, when an explosive mixture is continuously present or present for long periods, Zone 1, when such a mixture is likely to occur in normal operation, and Zone 2, when the mixture is not likely to occur in normal operation or, if it occurs, is present for a short time only.

Fully certified flameproof versions of Bin-Dex are available for hazardous environments Group I and Group II (Zones 1 and 2).

9. Rotary-Paddle Design

For indication and control of solid materials at pre-selected levels, a rotary-paddle level control, known as the Roto-Bin-Dex, is also available from 30—98. Its purpose, where continuous indication is not needed, is to eliminate overfilling and inadvertent emptying of bins, choked conveyors and elevators, and the damage and waste that results from such mishaps (Fig. 9).

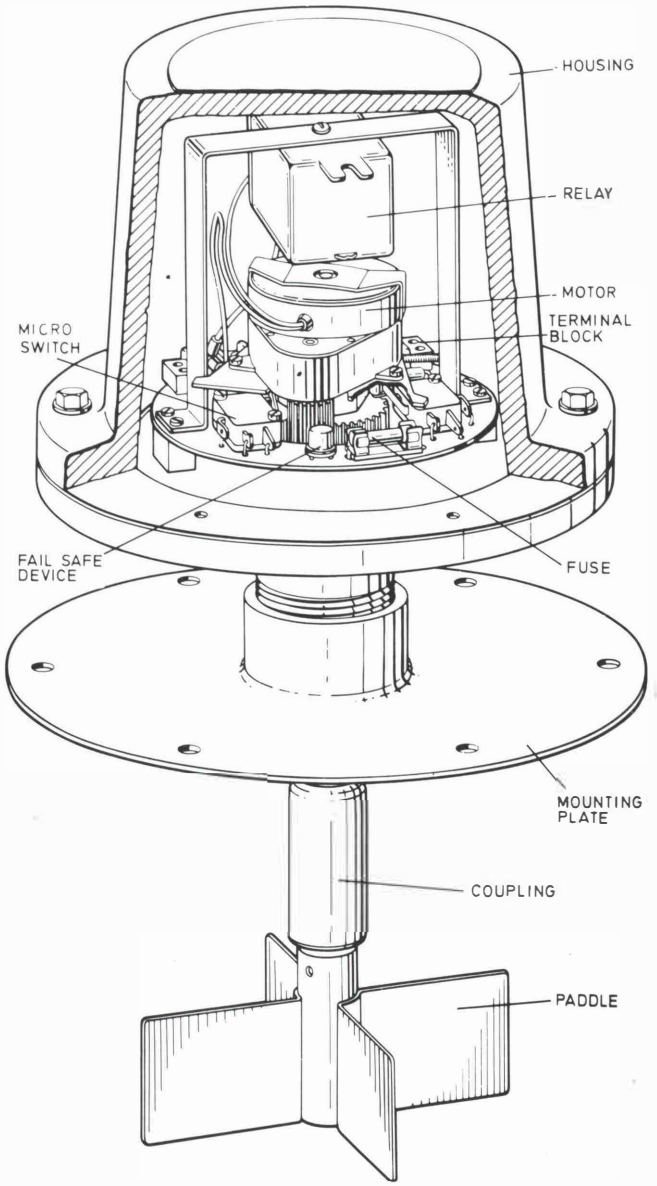

Fig. 9: Principal components of the standard Roto-Bin-Dex paddle type unit

The Roto-Bin-Dex is applicable to almost any bulk solid. The level of material is sensed by rotary paddles which protrude into the bin and rotate slowly, driven by a synchronous motor. Whenever the paddles are covered by material, signals actuate circuits and switch off the motor.

A fully-certified flameproof Roto-Bin-Dex is available for hazardous areas Group I and Group II (Zones 1 and 2). It can also be employed in a Zone 0 environment which is restricted to the interior of the bin or bunker.

10. Diaphragm-Operated

In addition, diaphragm-type level controls for the indication of solids and liquids, at pre-selected levels, are available. These simple positive-action devices are simple to install and virtually maintenance free, and are ideal for basic indication and control systems for materials handling.