FEEDING CONTROL OF AUTOMATIC BAGGING SCALE

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ABSTRACT
This paper describes the feeding control of automatic bagging scale which weighs and discharges the bulk material.

We have incorporated a new concept in its construction, and have adapted the original algorithm to the feeding control. Consequently weighing time could be shortened remarkably, while maintaining high accuracy.

KEYWORDS: automatic bagging scale, dynamic programming, weighing time, high accuracy

1. INTRODUCTION
In such fields, where bulk materials are generally disposed of, as chemical, pharmaceutical or food stuff industries, automatic bagging scale are being used, which are designed to fill sacks or containers with a proportioned quantity of final products at the last production stage. The capability of an automatic bagging scale originally is dependent on the weighing speed beside the weighing accuracy. For a bagging scale it is essential to accelerate the weighing speed in view of the economy of production.

As the feeding rate of a bagging scale increases, the weighing time will certainly be shortened. However, merely increasing the feeding rate would degrade the weighing accuracy since a wider dispersion of value will occur in the proportioning operation.

To overcome such difficulties the conventional bagging scale incorporates the 2 or 3 staged feeding system, i.e. material will be supplied at a higher rate at the first stage to accelerate the weighing speed, and subsequently additional material will be supplied at an appropriately lowered rate to satisfy the requirement in weighing accuracy. However, due to inadequacy in the design concept, the requirement for higher feeding rate with higher accuracy is satisfied only limitedly in such case.

Through an experiment intended to improve such deficiency of conventional system with a new idea incorporated in the control of feeding operation, some successful results were obtained, which were found satisfactory in terms of shortening the weighing time as detailed later in this paper.

The second chapter in this paper describes the feeding process by conventional automatic bagging scale, and in the third chapter the construction of the newly developed automatic bagging scale.

A new feeding process is introduced in the fourth chapter with an explanation of "optimal control theory" which has helped us to determine an algorithm of the new feeding process. The experimental results of the new feeding process that can afford a higher weighing speed of automatic bagging scale, while maintaining high accuracy, will follow.

2. FEEDING PROCESS BY CONVENTIONAL AUTOMATIC BAGGING SCALE
The object of an automatic bagging scale is to obtain a target value
quickly and accurately. In general, increasing of feeding rate inevitably brings about a proportional degrading of weighing accuracy, because of:

1. a larger fluctuation in feeding rate of material to be weighed.
2. a larger dispersion in values due to a larger feeding rate per sampling time, when mass is converted from analog to digital.

To achieve a higher accuracy the feeding rate must be reduced, which, however, is not allowed in view of the proposed speedy weighing. To cope with this problem the conventional automatic bagging scale incorporates a feeding process represented by Fig.1. According to Fig.1 showing 3 staged feeding system the feeding operates first at a higher rate of Q1. The feeding rate is then to be reduced down to Q2 and to Q3 each time when the pre-set masses M1 and M2 has been reached respectively. The weighing accuracy associated with feeding rate Q3 at the last stage must satisfy the requirement provided. The above process is accompanied by the following drawback.

Whenever the feeding rate is changed over, an indented response appears due to a sudden variation of feeding rate. Particularly in the section (II) the feeding curve experiences a slight descending due to an adverse effect attributable to a shock load, in which case the weighing time will inevitably have to be prolonged. Also in the section (III) an indented response appearing at change-over will give an adverse effect on the weighing signals, resulting in an unwanted dispersion of weighing accuracy.

As a result the intervals for feeding operation have to be prolonged until the indented response ceases. This is why the conventional type is not able to reduce the weighing time.

In view of the foregoing a key factor for being able to shorten the weighing time depends on how to suppress the indented response taking place at each change-over of feeding rate.

3. CONSTRUCTION OF NEW SYSTEM

An outward-view of the new automatic bagging scale is shown in Fig.2 and a schematic diagram of new system in Fig.4. The machine is designed as an automatic gravity bagging scale. The mass of bulk material supplied into the weighing hopper is measured by a strain gage type load cell which directly supports the weighing hopper. The measured mass is then turned into a digital signal through strain gage amplifier and A/D converter and then sent to a micro computer. In response to the said signal an operational signal is calculated by an algorithm being programmed in the micro computer, and is to be sent to the drive section through the D/A converter. The drive section will provide an arbitrary gate positioning subject to the operational signal produced, since it consists of servo circuit for position control.

An outward-view of the control device is shown in Fig.3. This type of