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INSTRUMENTATION OF A KENWOOD MAJOR DOMESTIC-TYPE MIXER FOR STUDIES OF GRANULATION

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ABSTRACT

The mixer was reconstructed and equipped with a torque transducer consisting of a steel beam, with strain gauges in a full bridge circuit, which prevented the rotation of the bowl.

Repeated loadings of the separate steel beam with weights resulted in a relative standard deviation of less than 0.2%. However, tangential loading of the equipment with a dynamometer resulted in a relative standard deviation of 1-2% because of the inaccuracy of the dynamometer load. The smallest detectable load was about $98 \cdot 10^{-3}$N, corresponding to 1-2% sensitivity within the interesting part of the granulation curve.

The average torque was calculated.

The recording mixer was simple to handle and proved a suitable tool for granulation studies.

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INTRODUCTION

For several years the cereal chemist has used recording mixers for the purpose of evaluating the mixing properties and the baking potential of wheat flours. The record of the torque required to mix the dough provides a quantitative measure related to the rheological properties of the dough[1]. Where smaller mixers are concerned, the most reliable method is to measure the reaction of the mixing bowl, as the frictional effects in the mechanism driving the mixing paddle are eliminated. This method was applied when a food mixer was converted to record the torque during mixing[2].

The use of recording mixers is also valuable when studying the granulation process for pharmaceutical applications.

An earlier instrumentation of the Kenwood Major mixer was of the transmission type for measuring torque[3]. The load on the rotating beater was measured indirectly by a coil-spring in the reconstructed clutch dog. The stretch of the coil-spring was indicated optically. Although the instrumentation was very simple and cheap, it had the drawbacks of hysteresis and friction of the spring. Therefore, a new instrumentation without these disadvantages was designed and evaluated.

EXPERIMENTAL

Mixer

A domestic-type planetary mixer, Kenwood 707A with a bowl capacity of about 7 dm^3.

Instrumentation and reconstruction of the mixer

The numerals in parenthesis refer to Fig. 1. A base plate (1) of steel with a circular hole for the bowl was attached to a hole in the table. The bowl (8) was

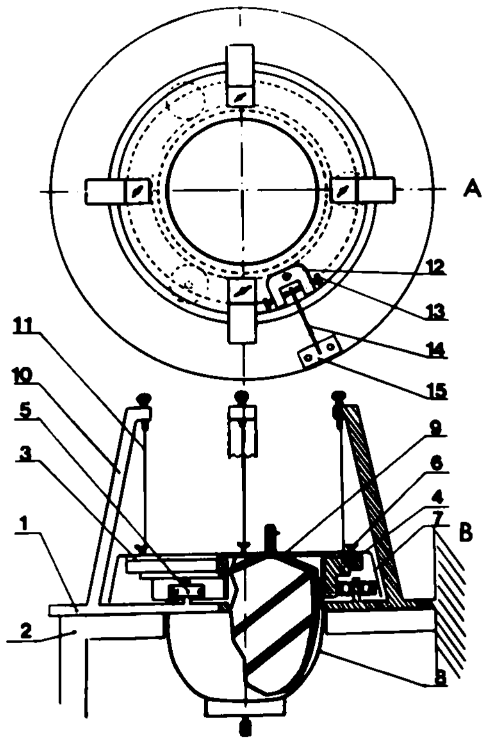

FIGURE 1

Principal sketch of instrumented mixer

A	Plan view	B	Side view		
1	Base plate	2	Table	3	Supporting collar
4	Bush collar	5	Ball bearing	6	Thumb screw
7	Rubber cover	8	Bowl	9	Beater

10 Column for wires suspending the bush collar

11	Metal wire	12	Cradle	13	Stop screw
14	Steel beam with strain gauges			15	Beam mounting

fastened between bush collar (4) and supporting collar (3) with thumb screws (6). The bowl rotated against three ball bearings (5), one adjustable and two rigid, attached to the base plate. A rubber cover (7) around the supporting collar protected the ball bearings from dust. Vertical stress on the ball bearings was minimized by hanging the bush collar in four 1 mm thick metal wires (11).

The rotation of the bowl was prevented by a 2-mm steel beam (14), bolted to the base plate and loosely attached between two stop screws (13) in a cradle (12) on the supporting collar.

Four strain gauges, 120Ω and gauge factor 2.0, were bonded to the steel beam in a full bridge circuit. A cured silicone rubber protected the circuit. The bridge was supplied by 11 V DC. The output from the bridge was connected to the 5 mV range of a strip-chart recorder, Servogor 220, which had about 1 s full-scale pen response time. This slow response was used to damp down torque fluctuations during mixing so that the average torque was recorded. The signal from the bridge was further filtered by shunting the input of the recorder with a 1000 μF capacitor.

The mixing head of the machine which was hinged and opened or closed with a spring and push button assembly, was lengthened by 38 cm on account of the dimensions of the base plate. At the same time the original large pulley assembly, timing belt and small pulley were exchanged for new parts in order to accomodate the lengthened head. The clutch dog was removed as it was no longer necessary. The head of the machine was stabilized by a bar which was fixed to the table.

The original pedestal was removed. A reconstructed pedestal was placed in a box below the table.

The bowl was braced by a coil-spring at the bottom connected to a wire fixed in the floor.

A plastic lid was attached to the gear box cover. This lid did not completely cover the bowl.

Calibration

The calibration of the separate steel beam with circuit, mounted with the broad sides in a horizontal position, was performed by gravity weights.

The torque transducer and recorder were calibrated by attaching a cord to one of the thumb screws. This cord was loaded tangentially by a calibrated spring dynamometer (0 - 50N). Thus a known torque was applied. The calibration was performed with the required amount of powder in the bowl.

Pump and nozzle

The granulating solution was added through the nozzle of a two-fluid type, from an Aeromatic STREA-1 fluidized-bed drier. The nozzle was attached to the gear box cover of the mixing head. The distance between powder bed and nozzle opening was about 11 cm. The nozzle was directed vertically down into the bowl about 7 cm beside the centre of the bowl.

The granulating solution was added from a gear pump with a variable flow rate between 19 and 155 ml water/min.

Granulation

1 kg of lactose 350 mesh was granulated with water.

RESULTS AND DISCUSSION

Instrumentation

The instrumentation required considerable reconstructions of certain parts of the machine.

After reconstruction, the lowest available rotation rate of the beater was 106 rpm. The lid did not influence the rotation of the bowl.

Lengthening of the mixing head caused a hard swaying during the granulation. This swinging was minimized by means of the bar which was fixed to the table.

During granulation, swinging also occurred in those wires in which the bush collar was suspended. This swaying was damped by the spring-loaded wire between bowl and floor. The damping did not influence the recordings.

By using a slow-response recorder, the fluctuations were reduced, and the curve was closer to the average mixing torque[4]. The capacitor shunting the input of the recorder had the same influence, i.e. to attenuate the amplitude.

The instrumented mixer was simple to handle.

Calibration

When the steel beam with circuit was separately loaded with weights, before it was attached to the mixer, a linear response through the origin was obtained. Repeated loadings of ≤ 8.8 N resulted in very small variations, the relative standard deviation being less than 0.2%. There was no hysteresis. The smallest detectable load was about $98 \cdot 10^{-3}$ N.

Linear response through the origin was also the result when the steel beam with circuit was attached to the mixer and loaded tangentially. Repeated loadings resulted in small variations, with a relative standard deviation of about 1% at a force of 9.8 N and about 2% at 2.45 N. However, these variations reflected the accuracy of the dynamometer load and not the precision of the transducer. The smallest detectable load was about $98 \cdot 10^{-3}$ N. This must be compared with a load of

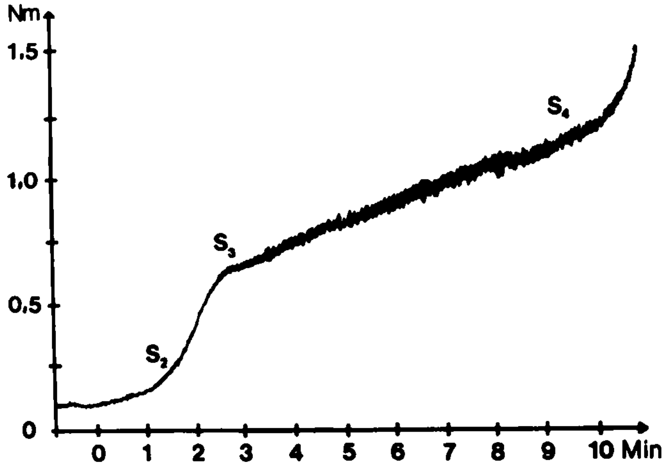

FIGURE 2

Average torque versus time, t (or amount of added water).

t<0: dry mixing

t≥0: addition of granulating solution

S-limits according to Bier et al.[5].

about 4.6 N at the S_3-limit of Bier et al.[5] and a load of about 8.4 N at the S_4-limit for 1 kg of lactose powder, i.e. a sensitivity of 1-2% within the interesting part of the granulation curve.

The calibration curve was independent of the mass of powder in the bowl.

There were no changes in the calibration curves when these were tested before and after a granulation.

The average torque was calculated as the product of the distance between the centre of the bowl and the attachment of the dynamometer in a thumb screw and the load. Thus, a load of 9.8 N corresponds to an average torque of 1.28 Nm.

Granulation

When 1 kg of lactose 350 mesh was granulated, an average torque of about 0.6 Nm was obtained at the S_3-limit according to Bier et al.[5], Fig. 2. At the S_4-limit the average torque was about 1.1 Nm.

REFERENCES

1. P.W. Voisey, in "Theory, determination and control of physical properties of food materials", Cho Kyun Rha ed., D. Reidel Publishing Company, Dordrect 1975, Chapter 6, p. 106-107.

2. P.W. Voisey and J.M. de Man, Can. Inst. Food Technol. J. 3, 130 (1970).

3. N-O. Lindberg, L. Leander and C.J. Lamm, Acta Pharm. Suec. 18, 102 (1981).

4. P.W. Voisey, V.M. Bendelow and H. Miller, Cereal Sci. Today 15, 341 (1970).

5. H.P. Bier, H. Leuenberger and H. Sucker, Pharm. Ind. 41, 375 (1979).