Key issues in batching and weighing:

Micro-proportioning

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MILL MANAGEMENT

Whether the feedmill is labour or equipment intensive, ingredient proportioning is one area where automation can improve quality and reduce waste. This is especially true with micro-ingredient proportioning, where consistent accuracy is required because of the high value of the raw materials.

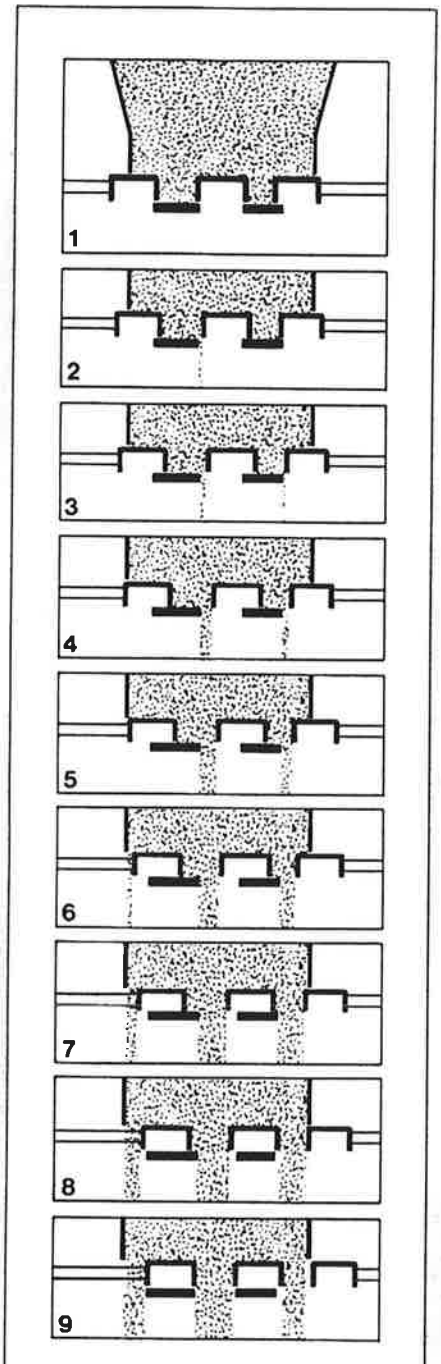

Figure 1. A schematic view of the action of the slide gate in Stork Alfra's MCD automated micro-proportioning system. The hydraulically actuated proportioning slide has different widths of openings. To dump, the slide moves over a stationary grate which also features different widths of openings. The computer controlling the action of the slide determines the area of the dump opening according to the pre-programmed particle size or flowability of the ingredient.

Although they are common now in both premix and main mixing lines, automated micro-ingredient proportioning systems began as a means for the direct addition of components to batch mixers. Automated systems appeared in the USA, UK and Holland in the early 1970s.

The earliest known installation in the USA was a hydro-feed machine designed for beef feedlot mixing operations that was adapted to the batch mixing system of a commercial feedmill (McEllhiney, 1985). In 1971 the first production model of a micro-ingredient feeder was installed in an American feedmill. This unit could meter and feed 16 dry micro-ingredients and an almost unlimited number of liquid ingredients. Also, it could control remote feeders for the direct addition of ingredients such as salt, urea, dicalcium phosphate, iron oxide and others.

Since the 1970s, the number of commercial micro-ingredient proportioning systems available to feed compounders has increased substantially. The acceptance of these devices has increased due to the development of improved control devices—computers, microprocessors, programmable controllers, etc. Advances in weighing and volumetric feeder technology have contributed to their accuracy and durability on the production floor.

In the early 1980s, accuracy to less than 5 grams was claimed by most suppliers of micro-ingredient proportioning systems. Today, suppliers report achieving a tolerance of 0.025% of the scale capacity—1 g per 4 kg maximum load (Stork Alfra, 1989). A number of new design features contribute to this heightened accuracy:

- Variable flow slide gates (Figure 1) or screw feeders on micro-ingredient hoppers to adjust for ingredient particle size and increments of addition;
- Use of hydraulic and electric actuators over pneumatic actuators;
- Pneumatic cleanout or aspiration of hoppers, funnels and weighing platforms;
- Larger number of bins per weighing unit;
- More sensitive electronic loadcells;
- More sophisticated computer control of the proportioning system.

Like their predecessors, the newer micro-ingredient proportioning systems can be used for premix manufacture or

Table 1. Analytical results of drug assays in the final diet at different dilution levels (20 samples per treatment).

Dilution ratio	Analytical results[a] Mean[b] (g t^{-1})	Range (%)	Coefficient of variation
Control	249	231-300	6.59
1:1	248	224-265	4.34
1:5	247	212-279	6.56
1:10	244	218-268	6.64
1:25	244	220-280	7.17
1:50	243	227-274	4.97

[a]Expected recovery = 264 g t^{-1}.
[b]Treatment means did not differ significantly.
Source: Adapted from McEllhiney, 1985.

Table 2. Results of iron particle counts in the final diet at different dilution levels (20 samples per treatment).

Dilution ratio	Analytical results[a] Mean[b] (count)	Range (count)	Coefficient of variation (%)
Control	14.25	10-21	18.82
1:1	13.85	9-22	23.34
1:5	13.85	8-19	22.87
1:10	13.40	8-24	30.09
1:25	14.00	10-19	21.11
1:50	13.50	7-18	25.38

[a]Expected recovery = 12 counts per 50 g sample.
[b]Treatment means did not differ significantly.
Note: Analysis by rotary detector from Microtracers, TM, Microtracers, Inc., San Francisco, California.
Source: Adapted from McElhiney, 1985.

for direct addition to compound feeds. The the direct addition of micro-ingredients has a number of advantages over in-plant premixing of micro-ingredients, the use of purchased premixes or the manual weighing and addition of micro-ingredients or premixes into the batch mixer. These advantages include:

- Manufacturing cost reductions through the elimination of in-plant premixing, the storage and handling of packaged premixes, the cost of packaging supplies for premixes, and the labour of hand additions of micro-ingredients into the mixer.
- Improved vitamin stability and savings in the purchase price of vitamins and other micro-ingredients.
- A reduction of batch cycle time of 1-2 min. per batch.
- Improved accuracy of micro-additions and product quality enhancement, plus the same flexibility for micro-ingredient additions to formulas as with macro-ingredients.
- A reduction of the warehouse space allotted for the storage of micro-ingredients and premixes and better inventory control.
- Reduced shrink due to breakage, obsolescence, over usage and overfill of packages.
- Reduced exposure of employees to potentially hazardous additives.

However, there was some question whether direct addition of micro-ingredients would achieve the same degree of dispersion in the finished feed as the addition of a previously prepared premix. Kansas State University indicated that the dispersion of micro-ingredients in finished feeds is not sig-

nificantly affected by diluting micro-ingredients in a premix or by the level of dilution in a premix (McEllhiney and Tangprasertchai, 1983).

In these experiments, a drug and an iron particle tracer were added into the batch mixer undiluted, as supplied by the manufacturers as a control. Then, premixes were prepared by diluting the drug, the tracer, vitamins and trace minerals at one part micro-ingredient to one part diluent (1:1). Other dilution ratios were 1:5, 1:10, 1:25 and 1:50. Each dilution was added to a separate batch of 32% protein medicated supplement for feedlot beef cattle. The researchers drew 10 samples of the final feed from each batch of supplement. These were assayed for the test materials. Then, the entire six-batch series of tests was duplicated.

Table 1 describes the analysis of the drug assays and Table 2 describes the results of the tracer ingredient counts. Statistical analyses of both the drug and iron particle tracer results indicated there was no significant difference among the dilution-level treatments. This means that there is no particular quality advantage to feed manufacturers resulting solely from the dilution of micro-ingredients in premixes. An approximately equal degree of dispersion of micro-ingredients takes place with either direct addition or addition of a premix.

If the mixer functions properly, the amount of diluent in a premix or supplement does not alter the ultimate dispersion of the micro-ingredients. This means that greater dispersion of micro-ingredients—including drugs—in a premix or supplement does not necessarily improve their dispersion in the final feed (Swan, 1981).

As a practical matter today, however, an increasing number of feed companies view premixes—especially vitamin-mineral mixtures—as a necessary complement to the business of feed manufacturing. More full range feedmills are being built with extra premix capacity and separate premix bagging lines to service satellite feedmills or on-farm mixers. In these feedmills, conveyors—usually pneumatic—simply channel finished premixes in bulk to the main mixing line for incorporation in supplements or complete feeds.

There is also more attention to control of drug use in animal feeds. Automated micro-proportioning systems can provide detailed drug inventories and records of use routinely or at a moment's notice. The human role in micro-ingredient additions shifts from repetitive hand labour following a recipe to monitoring the performance of a process. The latter is certainly a step up in skill and safety. **FI**

References

Anonymous, 1989, product literature, Micro-proportioning installation Type MCD, Stork Alfra BV, Bladel, Holland.

McEllhiney, R.R., ed., 1985, Micro-ingredient Proportioning and Mixing, Feed Manufacturing Technology III, American Feed Industry Association, Inc., Arlington, Virginia, USA, 164-165.

McEllhiney, R.R., and P. Tangprasertchai, 1983, The Effect of Dilution Levels in Premixes on Micro-ingredient Dispersion in Animal Feeds, Animal Feed Science and Technology, Elsevier Scientific Publishing Company, Amsterdam, The Netherlands 8:139-146.

Swan, J.W., 1981, The Other Side of the Fence—Cattlemen's Comments on Proposed Medicated Feed Regulations, Feed Management, Watt Publishing Company, Mount Morris, Illinois 32(11):38.

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