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# FeedSafe Mixer Efficiency Testing Guideline.

This document is provided to SFMCA full members as a guide to conducting a feed mixer efficiency test so as to be compliant with the FeedSafe™ Code of GMP.

FeedSafe™ requires all stock feed manufacturers to achieve an acceptable level of homogenous products through feed mixing. This requires written protocols for testing mixer efficiency and retention of mixer efficiency testing records.

This document provides guidelines manufacturers can use to implement mixer efficiency testing.

## Objective

Mixers are used within feed manufacture to blend raw materials in either dry or liquid forms. The objective is to provide a homogenous mix that is transferred to the next stage of the manufacturing process.

Raw materials used in feed manufacture vary greatly in their physical, chemical and nutritional properties. The definition of a homogenous mix encompasses the notion that the resulting blended mixture is the same or consistent, showing the same nutrient content throughout. In reality due to the variable nature of raw materials and difficulties in taking representative samples, mixed feed products are never 100% homogenous.

The stock feed manufacturer needs to complete the mixing process to ensure thorough mixing based upon established measures of mixing efficiency. The design and maintenance of the mixer, mixing time and sequence of adding raw materials can have significant impacts upon mixer efficiency.

## Measures of Homogenous Mixing

Mixer efficiency is based upon taking samples that are analysed for a defined raw material or nutrient, with statistical analysis completed to determine the standard deviation and co-efficient of variation. The co-efficient (CV) of variation provides a measure that is comparable between mixers. The interpretation of CV shown below should be used in interpreting test results. The goal is to have a CV less than 10%.

*Co-efficient of Variation Interpretation – Feed Mixers*

*CV Less than 7% Excellent mixer efficiency – TARGET*
*CV 7-12% Acceptable mixing efficiency – Improvement required*
*CV 12-15% Marginal acceptability, definite room for improvement*
*CV 15-20% Poor mixer efficiency – CORRECTION ACTION REQUIRED*
*CV Greater than 20% Unaceptable – CORRECTIVE ACTION REQUIRED*

Note that for the manufacture of premixes and medicated feed concentrates a CV of less than 7% is required.

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# Efficiency Testing Methodology

Within these guidelines are directions on how to complete a mixer efficiency test, this being taken from the EU Guide to Good Practice for Feed Additives and Premixtures Operators.

The following additional notes are provided.

1) The feed selected for testing should be a typical product, representative of the feed products being manufactured. If the site manufactures a wide range of differing feeds, it is advisable to repeat the mixer efficiency test using differing feed types. i.e. high roughage feeds may mix very differently from heavy mineral based concentrates.
2) The test must be conducted using the normal mixer cycle time of mixer filling, mixing and emptying. The test results need to reflect the real mixing situation.
3) Selection of the ingredient or nutrient for analysis can be either:
    a. Mineral – such as chloride where salt is added to the feed at levels > 0.5kg/tonne. If using salt as the test material, utilise fine salt as coarse salt particles can bias the results.
    b. Trace Mineral – copper or zinc where these minerals are added to feeds at levels above that typically supplied in vitamin/mineral premixes.
    c. Medication – some medication suppliers can assist in assessing mixer efficiency.
    d. Micro Tracers – products manufactured for inclusion in feed to assess mixer efficiency. Typically dye coloured iron particles that can be identified in finished feed.
    e. Do not use nutrients such as protein, fat or fibre to assess mixer efficiency as these nutrients are present in many raw materials.
4) To increase the sensitivity of the test, two different nutrients can be analysed, for example test samples for both a trace mineral and a medication.
5) Laboratory Testing - ensure the laboratory has sufficient capability in performing the required analysis. Some medications are difficult to assay, and the analysis error may greatly influence the mixer efficiency test results.
6) Sample collection – samples need to be collected either directly from the mixer or as the mixer empties.
    a. Where samples are taken as the mixer empties, a minimum 10 grab samples should be taken at even time spacing as the mixer discharges. Note that as feed is transferred via conveyors, elevators and augers feed separation may occur. The emphasis is on testing the mixer and the further the sampling point is from the mixer, the greater the chance of feed separation.
    b. Where access to the top of the mixer is possible, when stopped take a minimum 10 spear samples from different areas of the mixer.
7) Co-efficient of Variation Calculation – it is important having obtained the sample results to calculate the CV. Results from each mixer efficiency test should be kept on file.
8) What to do if not right?

If the mixer is found to provide unacceptable CV, the following actions can be taken:

- Consult with the manufacturer that supplied the mixer
- Modify mixer cycle times, increasing time to provide acceptable CV. With some mixers OVERMIXING can cause separation too.
- Review mixer filling and sequence of ingredient filling.
- Mixer may be over filled, where bulkier ingredients are in use, mix size may need to be reduced.
- Review addition of liquids and use of spray nozzles
- Consult with your premix and/or medication suppliers who can often provide additional advice on mixing efficiency.

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# Finished Feed Testing

As noted, these guidelines relate to testing the mixer, of equal importance is what happens after mixing and whether feed products being supplied are homogenous. Poorly designed or maintained conveyors, elevators, augers, holding bins and silos can result in segregation of raw materials so that the finished product is not consistent.

Stock feed manufacturers should assess post mixing segregation through the use of sampling and testing of finished feeds to assess homogeneity. A similar process for finished feed can be used as that employed for the mixer efficiency test. Finished feed samples are collected for analysis and CV calculated.

The following has been extracted from the EU Guide to Good Practice for Feed Additives and Premixtures Operators (Version 2, 2007)
https://www.eesc.europa.eu/sites/default/files/resources/docs/131-sante-community-guide-to-good-practice-for-feed-additive-and-premixture-operators-version-2.pdf

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## Annex 5: GUIDANCE ON HOMOGENEITY

Introduction:

This example procedure can be used to determine the efficacy of blending procedures at producing a product within which all ingredients are uniformly distributed.

As a basic guide, homogeneity trials should carried out biannually. Frequency should be amended according to results. ie. Where mixing times have been adjusted following unacceptable results in a homogeneity trial, the frequency of testing should be increased. Where homogeneity has proven satisfactory over a long period of time frequency may be reduced, bearing in mind that the frequency of testing should always be in line with the frequency noted in quality policies and procedures.

Procedure:

| | Instruction | Guidance |
|---|---|---|
| 1. | Determine product/raw materials to be tested. | Minerals are suggested as an appropriate active ingredient as they are easily assayed and subject to relatively narrow limits of variation. |
| 2. | Take and test retention samples of each raw material before production commences. | |
| 3. | Mix the raw materials in accordance with normal procedure | Mixing times should reflect those used in the normal course of production |
| 4. | When the product and packaged (but not sealed) representative samples should be removed from the batch. A sample must be taken from the first 25Kg of product made and regularly thereafter. | For example, were product packaged into 40 x 25Kg bags, samples should be taken from the first bag and every fifth bag thereafter, (ie every 125Kg) and labelled in accordance with the bag they were removed from, ie, 1, 5, 10, 15, 20, 25, etc. |
| 5. | Each retention sample must be tested for the active ingredients and results recorded. | |
| 6. | The efficacy of the mixing process should be determined by calculating the standard deviation and coefficient of variation of the results. | Standard deviation measures the spread of data about a mean (average) value. The formula is given below.<br>The Coefficient of Variation is the standard deviation expressed as a percentage. Each statistic gives us an impression of how much the distribution of product varies from the mean value. Formula is given below.<br>Quality procedures must define an acceptable limit of variation for Coefficient of Variation. |
| 7. | Records of testing should be maintained in accordance with documented procedures. | |

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CALCULATION OF STANDARD DEVIATION:

The formula for calculating standard deviation is:

$$\sigma = \sqrt{\frac{\Sigma(x - \bar{x})^2}{n - 1}}$$

$\sigma$ = lower case sigma

$\Sigma$ = capital sigma

$\bar{x}$ = x bar

Lower case sigma = 'standard deviation'

Capital sigma = 'the sum of'

x bar = 'the mean'

'n' = number of values

To calculate the Standard Deviation of a group of results, for example, 4, 9, 11, 12, 17, 5, 8, 12, 14

1. Calculate the mean: $\frac{(4 + 9 + 11 + 12 + 17 + 5 + 8 + 12 + 14)}{9}$

$$= \frac{92}{9}$$

$$= 10.222$$

2. Subtract the mean individually from each result and square the result.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| x | 4 | 9 | 11 | 12 | 17 | 5 | 8 | 12 | 14 |
| $(x - \bar{x})^2$ 38.7 | 1.49 | 0.60 | 3.16 | 45.9 | 27.3 | 4.94 | 3.16 | 14.3 | |

3. Add the results in step 2.

$\Sigma(x - \bar{x})^2 = 139.55$

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4. Divide by n-1.

$$\sigma = \frac{\Sigma(x - \bar{x})^2}{n - 1} = \frac{139.55}{8}$$

$\sigma = 17.44$

5. Square root:

$$\sigma = \sqrt{\frac{\Sigma(x - \bar{x})^2}{n - 1}} = 4.18$$

CALCULATION OF CO-EFFICIENT OF VARIATION:

1. Co-efficient of variation (CV) is the standard deviation expressed as a percentage of the mean.

In this example CV = 40%

As a guide, a CV of less than 10% is desirable with respect to homogeneity of additive mixes. Operators should establish an acceptable limit for CV based on scientific research and in consideration of specific mixers (refer to HACCP Principles!). Where the CV is greater than the limit set by the operator, corrective action should be implemented. This may include increasing mixing time, looking for worn equipment or overfilling of mixer, or amending the order in which ingredients are added to the mixer.