

Method used to assess the anticaking agents used to coat feed pellets

Coating feed pellets rich in sticky substances with anticaking agents during the manufacturing process helps to resolve problems with caking and flow.

To assess the efficacy of these anticaking agents, TECALIMAN performed several flow tests and a crush-resistance test following a pellet caking simulation.

The caking test already used by Tecaliman (Tecaliman 1984) required the manufacture of a pellet compression machine that simulates pellet storage in an industrial silo.

1. Apparatus and methods

1.1. Pelleted feedstuffs

Two types of pelleted feedstuffs with different caking properties were selected:

- A pig feed - identified by the manufacturer as having no caking issues was used as a control.
- A cattle feed - with recognised caking issues.

Both feedstuffs were produced as pellets with diameter 4.7 mm and length between 1 and 2 cm. The feed samples were collected from six industrial batches produced over several days.

1.2. Anticaking additives

- Additive A with a median diameter or d50 of 50µm (particle size formulation, see **i'Tec_B6**, Tecaliman Newsletter No. 44).
- Additive B with a d50 equivalent to that of Additive A.

1.3. Coating

Only the cattle feed pellets were coated using a cement mixing machine. The incorporation rate for both anticaking agent additives was 1.5%.

Prior to coating, each pellet sample was roughly sieved through a mesh with diameter 27 cm in order to remove the fines.

The total quantity of additives A and B placed in the cement mixer was not fully incorporated into the cattle feed pellets. The samples were sieved again after coating using a sieve with mesh diameter of 0.630 cm (see table below). This made it possible to identify how much of the additives were actually incorporated (Table 1).

| | Processing | | |
|----------------------------------|---------------------|---------------------|---------------------|
| | Cattle feed control | Cattle feed +1.5% A | Cattle feed +1.5% B |
| % theoretical additive | 0 | 1.5 | 1.5 |
| % additive actually incorporated | 0 | 1.13 | 1.11 |

Table 1

1.4. Measuring pellet flow behaviour

Four methods were used; three methods made it possible to define pellet flow prior to caking, (angle of slope, angle of repose [flow], angle of repose [distribution]), while the fourth method was used to evaluate the caking phenomenon (caking test).

1.4.1. Angle of slope (AOS)

This is the angle above which one bed of pellets slides over another bed of pellets when the surface on which both beds of pellets have been placed is raised to the vertical.

The steeper the angle, the more erratic the flow. The apparatus used is illustrated in Figure 1.

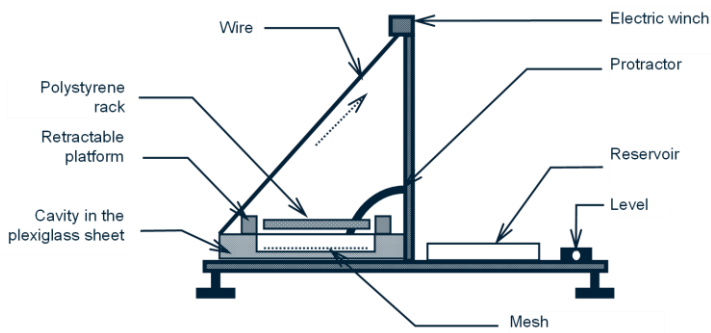


Figure 1

In the horizontal position, a first layer of pellets was laid down at the bottom of a plexiglass cavity fitted with a mesh screen.

A polystyrene rack was fitted horizontally over this layer.

A second layer of pellets was laid down, filling the cavity to the brim.

The retractable platform was removed.

The pile of pellets prepared as described was then tipped up slowly using the electric winch.

At the precise moment when the rack separates from the first layer of pellets, the Angle of Slope was recorded with a protractor.

1.4.2. Angle of repose (flow) (ARF)

This involves measuring the angle α at the base of a cone formed by the pellets between the free surface of the resting pellets and a horizontal base. The pile of pellets is obtained by the fall of a quantity of pellets in a container as it is pulled vertically.

The steeper the angle, the more difficult the flow (Tecaliman 1998).

1.4.3. Angle of Repose (distribution) or ATEI (standard I.S.O. 8383)

This involves measuring the angle at the base of a cone or slope of pellets. This slope is obtained by running a known quantity of pellets through a funnel.

The steeper the angle of the slope, the more erratic the flow.

The apparatus used is illustrated in Figure 2.

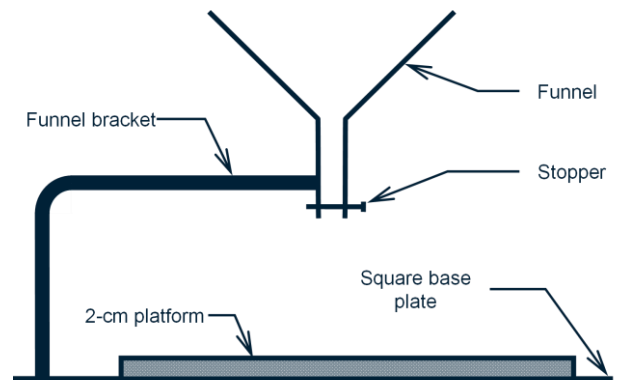


Figure 2

Place the pellet test portion in the funnel, first making sure that the flow hole is plugged.

Release the stopper and let the pellets flow over the base until they reach the bottom of the funnel.

Trace the circumference of the base of the pellet cone and measure the 4 perpendicular diameters.

The angle of repose is determined using the following equation:

$$\text{tg } \alpha = \text{Cone height} / \frac{1}{2} \text{ diameter}$$

1.4.4. Caking test on pellet test specimens (Figure 3)

The method involves measuring the cohesiveness of a pellet test specimen that has first been subjected to vertical stress.

A 150-g sample of pellets was placed in a cylindrical mould. A stress of 1.7 kg/cm² was applied to the sample over a 24-hour period.

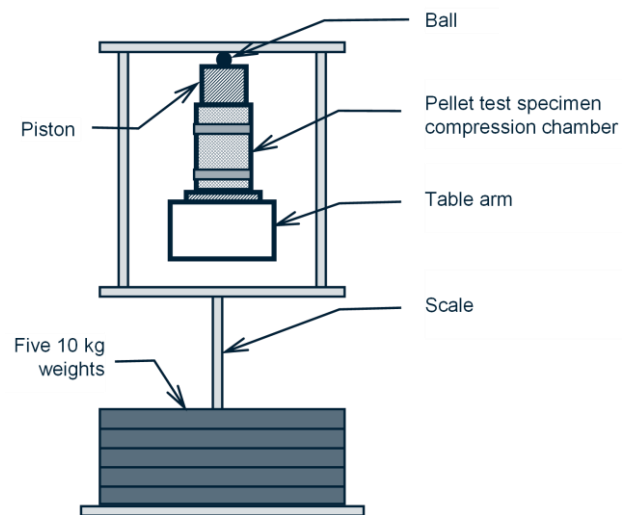


Figure 3

1.4.4.1 Cohesion measurement

After un moulding the pellet cylinder, the cohesiveness of the pellet test specimen was measured using a Lhomargy CLM12 compression tester (Figure 4).

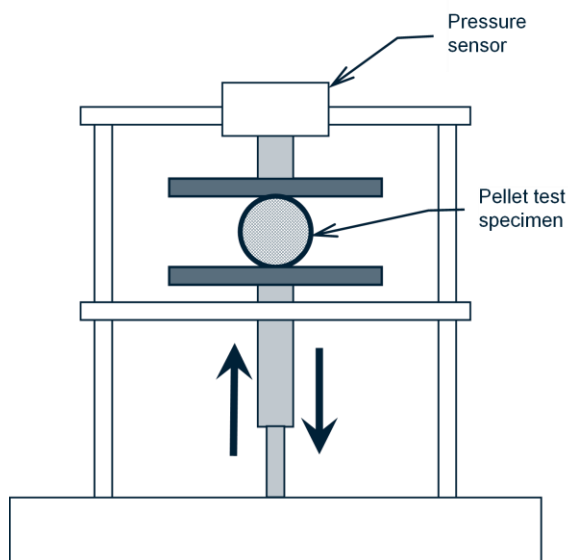


Figure 4: LHOMARGY compression tester

Caking of the pellet batch is considered to increase as the cohesiveness of the pellet test specimen increases.

2. Results

2.1. Flow tests

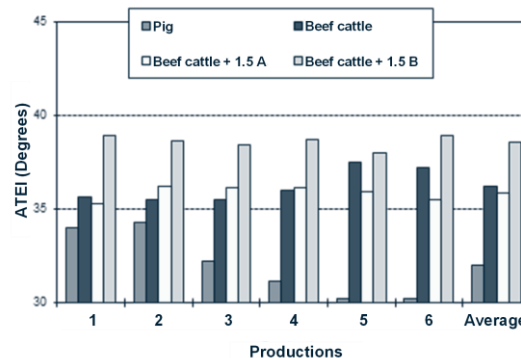
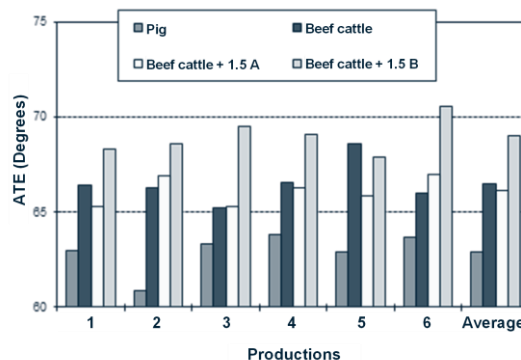
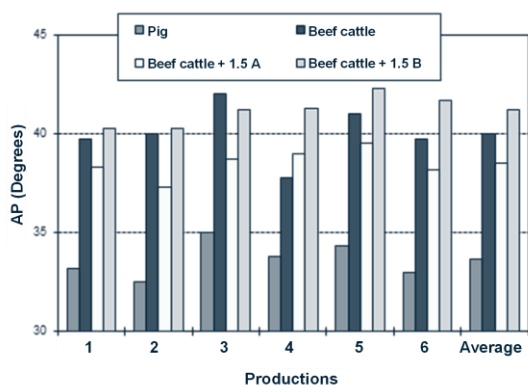
The results are given in Table 2 and Figures 5, 6 and 7.

| Feedstuff | Pig | | Cattle | |
|-----------|---------|---------|---------|---------|
| | control | control | +1.5% A | +1.5% B |
| AS | 33.6 a | 40.0 b | 38.5 c | 41.2 d |
| AOR | 62.9 a | 66.5 b | 66.1 b | 69.0 c |
| ATEI | 32.0 a | 36.2 b | 35.9 c | 38.6 d |

a,b,c,d: the various letters indicate that the variances obtained between the mean values are statistically significant.

Table 2

Figures 5, 6 and 7



In all cases, pig feed demonstrates higher flowability than cattle feed (whether in the form of controls or treated with an additive).

The 2-factor Variance analysis demonstrates behavioural differences between the additives and that these differences depend on which method is used.

2.1.1. Additive A

- Angle of Slope (AS) and Angle of Repose [Distribution] (ATEI)

The results obtained with these two methods demonstrate that, in relation to the untreated control, additive A significantly improves the flow of cattle feed pellets.

- Angle of repose (flow) (ARF)

This method does not allow for differentiating between the flow properties of the cattle feed control and the cattle feed coated with additive A.

2.1.2. Additive B

Whichever method is used, additive B has a significant adverse effect on pellet flow.

2.2. Pellet caking

Table 3 lists the compression strength of the pellet test specimens, expressed in daN/cm.

| Sample cohesiveness (daN/cm) | Pig feed control | Cattle feed control | Cattle feed +1.5% A | Cattle feed +1.5% B |
|------------------------------|------------------|---------------------|---------------------|---------------------|
| Mean value | 0.27 a | 5.01 b | 0.01 a | 0.00 a |

a,b: the various letters indicate that the variances obtained between the mean values are statistically significant.

Table 3

The control feeds demonstrate greater compression strength than the coated products. The in-storage caking capacity of the control feeds chosen for the study (pig, cattle) was confirmed by the results.

The cohesion values equal to 0 demonstrate that some pellet test specimens did not cake.

Coating cattle feed with additive A or B results in too little caking of the test specimen. The test specimen breaks on being un moulded, thus making it impossible to measure its cohesiveness. Pig feed test specimens either show less caking than the cattle feed control, or are too fragile to be measured.

The variance analysis reveals that only the cattle feed control is significantly different to the other pellet feeds.

Therefore, the cattle feed with a 1.5% coating of

additive A or B shows a similar behaviour to a feed with low cakeability, such as the pig feed.

3. Conclusion

While it is possible to evaluate the effectiveness of an anticaking agent in a laboratory, the results of this study nevertheless demonstrate that the treatment rankings depend on which method used.

Before undertaking a study of this type, it is therefore necessary to select the method that most closely matches industrial production conditions.

The anticaking test should be selected to study the anticaking agents' ability to resolve caking issues in storage silos. Note that this method has been adapted from the method used by BMP for several years now to study these phenomena during the storage of fertilizers.

4. Bibliography

- Tecaliman 1984, **Newsletter No. 11**
Tecaliman 1998 **i'Tec_Q3**, Newsletter No. 49.