Tecaliman
Center of expertise for a sustainable feed business

i'Tec_G7
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Pellet durability measurement procedure

Pellet quality has always been of key importance for farmers and animals alike.
For many years now, animal feed manufacturers have been using simulators to meet requirements for pellet robustness and resistance to the various impacts and mechanical stimuli inherent to their production and distribution systems. Originally known as friability testers, since the last twenty years or so they have been referred to as durability testers.

1. Measurement method

The durability measurement involves stressing a defined quantity of feed pellets in a pellet testing machine, and then determining the ratio of pellets that have remained whole by sifting.
Originally, this measurement was designed to simulate the natural process of pellet breakdown and crumbling during the various transfer and spill operations at the production plant.
The animal feed sector uses several tried and tested methods to do this. This datasheet sets out the operating procedures for the principal methods used at Tecaliman based on the protocols developed at the time of their initial deployment (some methods have been modified by users).
All durability measurements involve sifting the sample both before and after it has been through the pellet tester.
The sifter must have a mesh aperture diameter equal to approx. 80% of the nominal pellet diameter.
Durability is expressed as the percentage of sample that remains on the sifter screen after passing through the selected pellet tester.

2. Methods

2.1. Tumbling boxes (Pfost)

The first method, introduced in the 1960s and considered an industry benchmark, breaks feed pellets down mechanically (Pfost and Allen, 1962 - Schulz, 1965). This is referred to as the tumbling box method, or the Pfost method, named after its inventor, and is the standardised method in the USA (ASAE S 269).

A 500-g sample of pellets free of fines (sifted) is stressed for 10 minutes inside a standard size tumbling box (rotating at 50 rpm) (Figure 1).

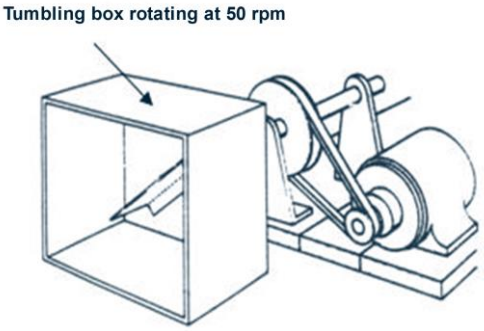

Figure 1: Tumbling box durability tester

2.2. Pneumatic method (Holmen)

The second method, developed some 20 years later, breaks feed pellets down by blowing them around in an air jet (Payne 1979).

This is the air flow unit method proposed by the Holmen company (Figure 2). The result is commonly known as the Holmen durability.

A 100-g sample of pellets free of fines (sifted) is blown around in an air-supplied pneumatic circuit for periods ranging from 30 seconds to 2 minutes, depending on the nominal pellet diameter (Table 1).

Pellet diameter	Cycle time
6-8 mm	2 minutes
4-5 mm	1 minute
1/8" – 3 mm	30 seconds

Table 1: Holmen recommendations

In the Holmen pellet tester, the sifter screen is placed in the designated vessel inside the pneumatic circuit. Holmen supplies all the necessary sets of sifter screens.

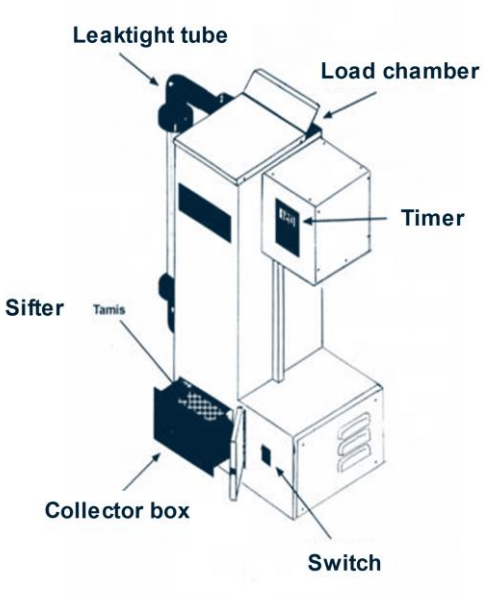

Figure 2: Holmen durability tester

2.3. Rotary vaned impeller (Eurotest)

The third and last method, developed in France in 1994, breaks feed pellets down using a "coarse crushing" technique.

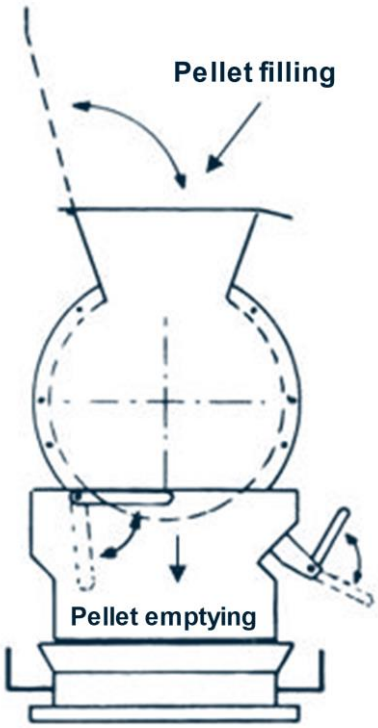

Figure 3: Eurotest durability tester

This is the Eurotest method, the pellet tester as named by the company Sabe Distribution. This method is based on an adaptation of a German machine, the "Quicktest". The Eurotest pellet tester is gaining in popularity in France, where it is beginning to be seen as a sector benchmark.
The machine comprises a more or less cylindrical chamber, containing a flat rotary vaned impeller rotating at 1500 rpm (Figure 3).

A 500-g sample of pellets free of fines (sifted) is placed in the idling chamber. The sample is then stressed inside the chamber for 20 seconds.
While a recent Tecaliman study revealed that sifting with a screen aperture at 90% of the nominal pellet diameter provided greater discriminating power than the 80% screens used thus far, it was nevertheless decided to continue using the 80% screen.
It is recommended to sift the pellets mechanically (Figure 4) so as to ensure a stabilised sifting process that is identical for each sample.
The sifter screen should be changed according to the diameter of the tested pellets.
The automated version provides a faster result.

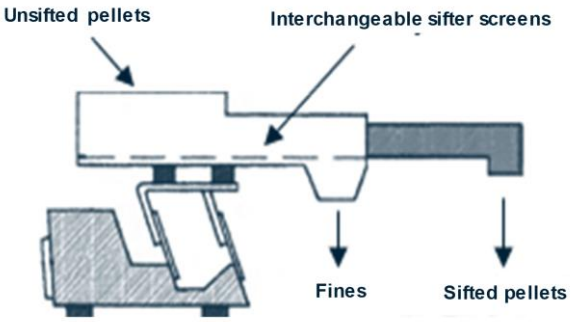

Figure 4: Mechanical sifter

3. Comparison of the methods

The 3 main methods were compared during a study conducted a few years ago on a collection of 41 industrial pellet samples (rabbit, beef cattle, pig, dairy cattle, duck and goat).
The pellets all had a diameter of 4 mm, and were sifted manually on a screen with 3.2-mm diameter square holes. Each sample was tested in the machine 6 times.

Durabilities (%)	Pfost	Holmen	Eurotest
Mean	98.5	93.6	88.6
Maximum	99.9	98.3	94.3
Minimum	94.2	76.0	67.2
Variance	5.7	22.3	27.1
Significantly different samples (out of 41)	24	20	27
Accuracy over 246 measurements (%)	0.1	0.3	0.4

Table 2: Table of values

Table 2 illustrates that area limit values and means differ significantly according to which method was used. Pfost durabilities are close to 100% within a very narrow area (variance of 5.7% between the min. and max. values).

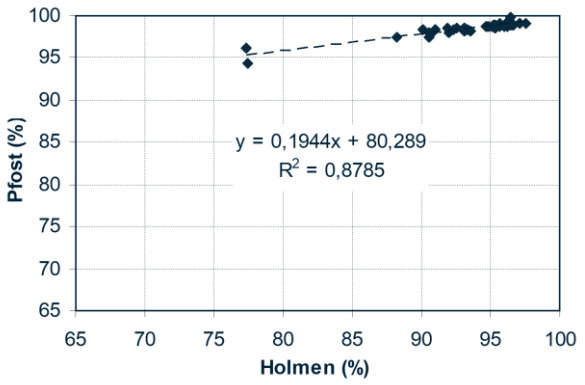

Figure 5: Pfost durabilities measured against Holmen Durabilities

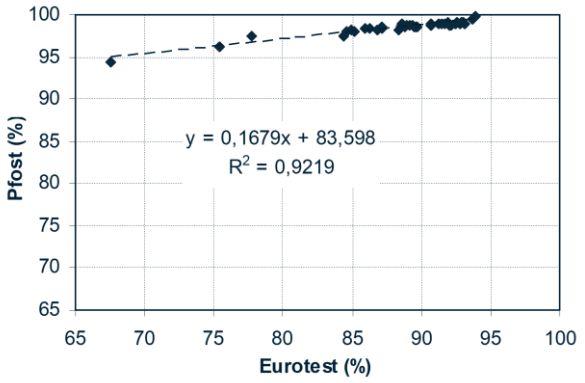

Figure 6: Pfost durabilities measured against Eurotest Durabilities

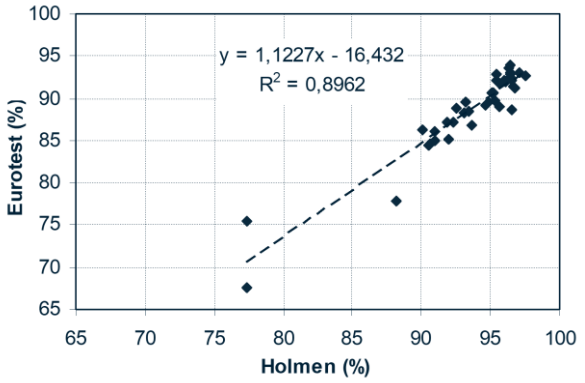

Figure 7: Eurotest durabilities measured against Holmen durabilities

Mean values for the Holmen and Eurotest machines were lower, with a minimum of 67.2% for Eurotest and broader area spreads (variance of 27.1% between the min. and max. values).
The Eurotest machine clearly distinguished 27 samples against 20 for the Holmen tester and 24 for the Pfost tester.
All three methods were accurate to under 0.5%, with the Pfost tester scoring a performance rating of 0.1%.

Figures 5 to 7 show strong correlations between the methods with a coefficient of determination (R^2) of 0.92 between Eurotest and Pfost, despite the difference in the results area.
Provided that the operating procedures set out in this datasheet are used, the regression equations given in Table3 can be used to calculate approximate durability values, switching between methods.

Durabilities	Equation
Pfost (Y) as a function of Holmen (X)	Y = 0.1944 X + 80.289
Pfost (Y) as a function of Eurotest (X)	Y = 0.1679 X + 83.598
Eurotest (Y) as a function of Holmen (X)	Y = 1.1227 X + 16.432

Table3: Regression equation between the various methods

4. Durability and hardness

Pellet quality can also be assessed in terms of hardness (see Technical datasheets No. 9 and No. 72).
While the relationship between these 2 measurements is not linear, the increase in the two parameters often coincides (Figure 8).

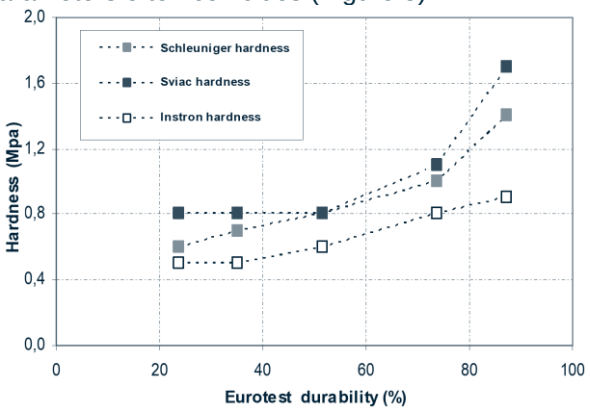

Figure 8: Hardness as a function of Durability

Despite the significant variability in populations, hardness appears to provide a linear response, while durability tends more towards an asymptotic response (Figure 9) depending on the treatment temperature.

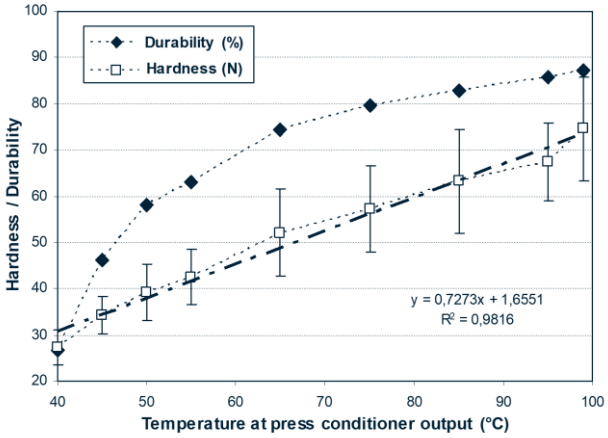

Figure 9: Hardness and Durability as a function of treatment temperature at press conditioner output

5. Conclusion

The 3 measurement methods described here provide a simple means of quantifying pellet durability (Table 4).

	Pfost	Holmen	Eurotest
Test portions	500 g	100 g	500 g
Cycle time	10 minutes	30 seconds to 2 minutes	20 seconds
Sieving	Sieve with mesh apertures that are 80% of the pellet diameter (or even 90%)		

Table 4: Summary of pellet tester use conditions

The Eurotest method, developed in France about ten years ago, gives the quickest results and has a high discriminating power. Industrials are using this method routinely in increasing numbers.

It is recommended to sift pellets mechanically in order to minimise the variations that can result when sifted manually by technicians.

The Pfost tumbling box method is a standardised E.U. procedure (ASAE S 269), giving it the advantage of being considered a reliable, benchmark method compared to other methods which are often adapted by industrials. However, the measurement procedure is more time intensive and has a lower discriminating power.

The term "durability" often leads to confusion, as the measurement describes the response to the effect of attrition rather than time.
While the term "friability" (100% – durability%) used previously was closer to the mark, the term "durability" has a greater commercial attractiveness.

6. List of durability tester suppliers

Caisson: Tripette et Renaud Agro, 20 avenue Marcellin-Berthelot, ZI du Val-de-Seine, 92390 Villeuve-la-Garenne, Tel.: +33 (0)1 41 47 50 99

Eurotest: Sabe La Perrauderie 85140 Chauché, Tel.: +33 (0)2 51 41 83 13

Holmen: Borregaard France 4 avenue de Saint-Ouen 75008 Paris, Tel.: +33 (0)1 53 06 60 40

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