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Measuring pellet durability using the "Lignotester" machine

1. Introduction

The Borregaard company asked TECALIMAN to carry out a study on a new pellet durability tester.
This device, referred to as a LignoTester, was also tested against other devices using the Borregaard operating procedure.

2. Principle of the apparatus

This apparatus consists of a rectangular body with a perforated plate sample-holder hopper and a blower. One hundred grams of pellets were placed in the sample-holder, and then run through a 30-second test cycle in the air flow produced by the blower.
The pellets were sieved during the test.
The "LignoTester" control settings were pellet test cycle time and air pressure (70 mbar).
The air pressure setting was tested by a pressure gauge; a control button let the operator adjust the pressure if the blower deviated from the original setting.
The apparatus was designed to minimise handling of the pellets at the end of the test (weighing, sieving).

3. Operating procedure

This consists in:

- sieving the pellet sample through a sieve with a mesh hole diameter that is approximately 0.8 times the nominal pellet diameter
- weighing out exactly 100 g of this sample, free of fines (Pi)
- introducing the 100 g of pellets into the perforated hopper
- placing a filter on the upper part of the apparatus
- closing the cover
- setting the timer to 30 seconds, if necessary
- switching the durability tester on
- extracting the sample from the apparatus, by rotating the perforated hopper on the weighing container
- weighing the collected sample (Pf)
- expressing durability as a %: Durability (%) = Pf / Pi

4. LignoTester accuracy

The accuracy was established by repeating the measurement 15 times, on eight different feed samples. These measurements were made with or without hand sieving of the tested samples.
The results demonstrate that in both cases, i.e. whether or not the tested samples were hand sieved, the measurement accuracy was very good for 6 repeats (table 1, next page), similar to that of "Caisson" (US PDI), "Eurotest " and "Quick Test" pellet durability testers.

5. LignoTester operation

The study was designed to test whether pellet-sieving during the test is as effective as hand sieving, which is the method used during conventional durability tests (e.g. "Caisson" testing).

Durability measurements, with or without hand sieving, were repeated 6 times on each sample. They were performed on pellets with diameter 4 mm, corresponding to 41 different feed formulas.
The results demonstrate that while hand-sieved samples have lower durabilities than unsieved samples, this difference is not significant (table 2).

Feedstuff Pellets ∅ 4 mm	HAND SIEVING Sieve diameter 3 mm		NOT HAND SIEVING	
	Durability %	% Accuracy for 6 repetitions	Durability %	% Accuracy for 6 repetitions
Rabbit	98.0	+ or - 0.050%	98.2	+ or - 0.028%
Ruminant	98.4	+ or - 0.047%	98.7	+ or - 0.034%
Pig	96.9	+ or - 0.071%	97.4	+ or - 0.044%
Gestating sow	98.2	+ or - 0.023%	98.3	+ or - 0.018%
Dairy cow	98.3	+ or - 0.018%	98.5	+ or - 0.014%
Duck	95.0	+ or - 0.069%	95.6	+ or - 0.038%
Goat	95.7	+ or - 0.084%	96.3	+ or - 0.040%
Bullock	98.8	+ or - 0.006%	99.0	+ or - 0.007%

Table 1: Review of LignoTester accuracy

Method LignoTester	Durability	
	Mean (%)	Standard deviation
Hand sieving (3 mm sieve)	97.16	2.04
Not hand sieving	97.59	1.58

Table 2: Using the Lignotester with or without hand sieving

To sum up, the manufacturer's recommended method (no hand sieving of the final sample) can therefore be selected to establish the durability of pellets with diameter 4 mm.

6. Comparison with other types of durability tester

This activity was designed to identify the correlations between the various durability measurement methods.

The durabilities obtained with the "LignoTester" were compared with those obtained using "Caisson" PDI, "Holmen " and "Eurotest" machines.

The tests were performed on feed pellets with diameter 4mm, sampled from 41 different feed formulas (rabbit, beef cattle, pig, dairy cow, duck, goat).

The measurements were repeated 6 times for each machine and each sample. All the pellet samples were sieved prior to testing using a 3-mm sieve. Table 3 summarises durability tester operating conditions.

Durability tester	Weight of the tested sample (g)	Cycle time in the durability tester (sec.)	Sieving of the samples after the durability tester cycle
"LignoTester"	100	30	No
"Caisson" PDI	500	600	Yes, 3 mm sieve
"Holmen"	100	60	Yes, 3 mm sieve
"Eurotest"	500	20	Yes, 3 mm sieve

Table 3: Durability tester operating conditions

Preliminary analysis of the results (Table 4) reveals that the "Eurotest" and "Holmen" durability testers were more discriminating than the "LignoTester" and "Caisson" PDI machines (standard deviation greater than 4).

	Durability	
Method	Mean (%)	Standard deviation
"LignoTester" with no hand sieving	97.59	1.58
"Holmen"	93.57	4.36
"Eurotest"	88.65	5.18
"Caisson" PDI	98.49	0.91

Table 4: Comparison between the various durability measurement methods

Statistical analysis of the results demonstrates that:

- all the differences observed between the methods are significant (Table 4)
- that the various methods show good correlation (Table 5), particularly between the "LignoTester" and "Holmen" machines (R = 0.99).

	"Holmen"	"Eurotest"	"Caisson" PDI
"LignoTester" with no hand sieving	0.99	0.94	0.94
"Holmen"	1	0.94	0.94
"Eurotest"	0.94	1	0.95
"Caisson" PDI	0.94	0.95	1

Table 5: Comparison between the various durability measurement methods - Correlation factor (R)

Linear regressions between the durabilities obtained using the various methods were computed in order to formulate crossover equations from one method to another (Table 6). Figure 1 gives an example of a regression line.

Durability	Equation
Caisson (Y) as a function of the LignoTester (X)	Y = 0.5407 X + 45.719
Eurotest (Y) as a function of the LignoTester (X)	Y = 3.1192 X -215.67
Holmen (Y) as a function of the LignoTester (X)	Y = 2.7342 X - 173.36
Caisson (Y) as a function of the Eurotest (X)	Y = 0.1637 X + 83.64
Eurotest (Y) as a function of the Holmen (X)	Y = 1.1333 X - 17.315
Caisson (Y) as a function of the Holmen (X)	Y = 0.195 X + 80.236

Table 6: Regression equation between the various durability measurement methods

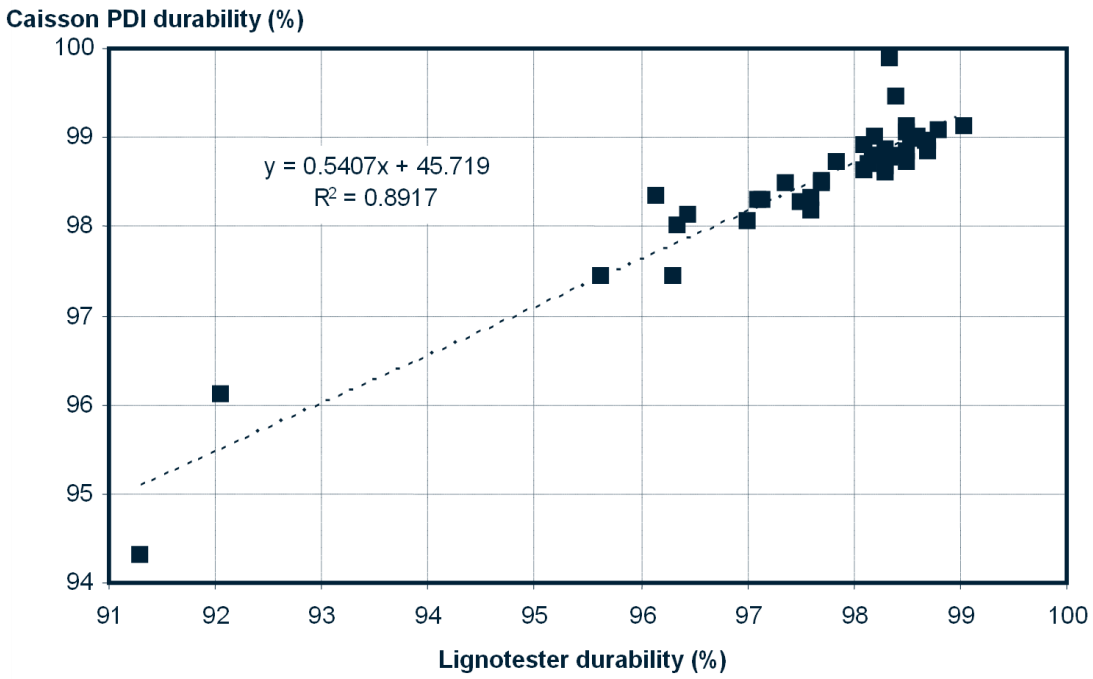

Figure 1: "Caisson" PDI durability as a function of Lignotester durability

7. Conclusion

The "LignoTester" durability tester is a compact, simple-to-use machine. It provides fast (30 seconds) and accurate durability measurements. Its design allows the user to control its principal operating parameter, air pressure, thus making it possible to include this durability tester in ISO 9000 procedures.

However, the results also demonstrate that the durability values obtained with this machine are higher than those obtained with Eurotest and Holmen machines. One way of solving this problem would be to increase pellet cycle time in the "LignoTester", which would minimise the speed-of-measurement advantage.

8. List of durability tester suppliers

- LignoTester: Borregaard France 86 avenue de Saint-Ouen 75018 Paris, Tel.: +33 (0)1 53 06 60 40
- Holmen: Borregaard France 86 avenue de Saint-Ouen 75018 Paris, Tel.: +33 (0)1 53 06 60 40
- Caisson: Tripette et Renaud Agro, 20 avenue Marcellin-Berthelot, ZI du Val-de-Seine, 92396 Villeuve-la-Garenne, Tel.: +33 (0)1 41 47 50 41
- Eurotest: Sabe La Perrauderie 85140 Chauché, Tel.: +33 (0)2 51 41 84 45