i'Tec_T7
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Results of delivery truck carry-over assessments

In 2002, amid questions over the part played by animal feed bulk delivery trucks in the BSE crisis and demands under the order of 28 February 2000 for control over drug-related carry-over up to this workstation, Tecaliman carried out a study aimed at drafting a set of technical rules for assessing the level of additive carry-over in delivery trucks.
The study was carried out in two phases and assessed carry-over levels in 10 trucks. Even if the individual assessments made in this context depend not just on the trucks, but also on their related maintenance and work practices (the results should not characterise all the trucks of a given model in use), certain general conclusions could be drawn in terms of methodology and technology.

1. Method

1.1. Basic principles

On each truck, a carry-over test was performed involving one tracer batch and two collector batches. The method was designed based on the following principles:

- Search for maximum carry-over: animal meals, longest possible transfer circuit (in the truck), other empty boxes that limit the efficacy of blower purge systems.
- Batches delivered at identical rates
- Batches of an identical size (maximum of the smallest box)
- Use of one tracer batch and two collector batches
- Collector batches produced before the tracer batch in order to prevent carry-over in the plant

1.2. Trucks

The selected truck fleet comprises:

- Semi-trailers and straight trucks
- Various purge systems (Gravity, Ecofan, DKS, DTS)
- Deck-based chain conveyors and screws
- Mechanical, pneumatic or pressurised delivery systems
- Reverse or horizontal V-flaps
- Trucks of all ages.

1.3. Tracers

Two tracers are used for each test: one RF-blue lake microtracer and one drug molecule (Oxytetracycline or Chlortetracycline). These tracers were incorporated into the same premix, introduced at 5 to 10 kg/t, so as to obtain concentrations of 250 ppm and, 200 to 1000 ppm respectively).

1.4. Feedstuffs

Three different types of feedstuff were used: Laying hen, Pig feed and Duck feed. They had median diameters of between 400 to 760 µm and bulk densities of between 530 to 690 g/dm^3.

1.5. Test set-up

The first test plan was as follows (Figure 1):

- Production of 2 collector batches
- Production of the tracer batch
- Arrival of the truck at the loading station
- Loading of the 1st collecteur batch into the box 1 : Sample **L1**
- Box 1 covered with a tarpaulin
- Loading of the tracer batch into the box 2 : Sample **L2**
- Removal of the tarpaulin
- Positioning of the truck next to another truck to simulate delivery of the batches
- Delivery of the tracer batch (circuit carry-over) : Samples **L3**
- Possible purge of : Sample purge after **L3**
- Delivery of the 1st collecteur batch: Assessment of : Sample interbox carry-over **L4**
- Possible purge of : Sample purge after **L4**
- Truck returns to the loading station
- Loading of the 2nd collecteur batch into the box 2 that previously contained the : Sample tracer batch **L5**
- Truck returns next to another truck to deliver the 2nd collector batch
- Delivery of the 2nd collecteur batch: Assessment of : Sample interbox carry-over **L6**
- Possible purge of : Sample purge after **L6**

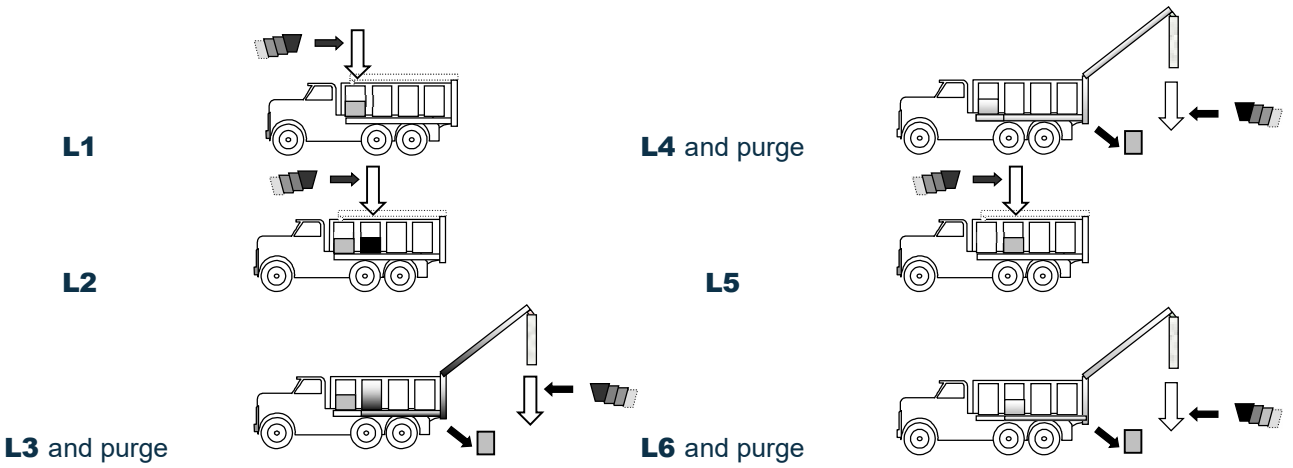

Figure 1: Diagram of the test plan

This test structure was then simplified over the next phases.

1.5.1. Processing the samples

During phase 1, the aggregate samples were formed using equal aliquots of constant mass from each sample taken at L1, L2, L3 and L5. Conversely, all samples taken at L4 and L6 were analysed.
During phase 2, the sample taken at L2 was withdrawn and the aggregate samples made up directly at L1, L3 and L5.

Figure 2: Diagram of phase 2 sample processing

At L4 and L6, the samples were taken at constant periods and additional samples taken between the first two based on a shorter period. The analysis only concerned samples 1 and 2, the additional samples and one aggregate sample formed of aliquots of all the samples above No. 3 (Figure 2).
Purge samples were divided to obtain representative samples.

1.6. Calculation and expression of the results

The mean concentration of the collector batches was established based on the sum of the concentrations of each sample, divided by the number of samples. This calculation method tacitly implies several assumptions:

- Flow homogeneity during the sampling process: the same mass of feedstuff runs through between two samplings.
- Each sample represents the feedstuff that passed through during the period after its sampling up to the next sampling.
- The sampling period used is tailored to fit the phenomenon under study.

Failure to comply with any one of these assumptions would bias the assessment. Given that the phenomenon is continuous and that the sampling is carried out at discrete intervals, there will always be a gap between the calculated and actual overall carry-over in a batch.
If a collector batch carry-over were to be identified at plant output (L1 and L5), the mean carry-over at truck output would have to be corrected by subtracting it. This means, L4 analyses would be corrected by the results at L1, while those at L6 would be corrected by the results at L5. The batch's mean carry-over was calculated either by aligning it with the expected carry-over in the tracer batch using the equation and weighing made on-site (percentage of expected carry-over), or by aligning it with that of the tracer batch analysed at L3 (percentage of measured carry-over).

2. Results

2.1. Technical findings

The choice of internal tracer, from among a narrow range of products, combined with fixed feedstuff constraints (liquid content, meal presentation) greatly inhibits the feasibility of this type of test (see **i'Tec_T6**).
In practice, only 2 active substances, among the drugs, were used as an internal tracer. There are two possible reasons for this: the low number of suggestions from industrials concerning drug molecules that could be used as an internal tracer, and analytical limitations that hindered the accuracy of the results.
It also had to be possible to produce the chosen feedstuff with or without a drug-based internal tracer, meaning that it would be useful to have this type of formula.
If the plant does not have a given formula in versions with or without the targeted drug, or if the chosen formula is not sold in meal format, then it would have to repass or recycle batches used for the test.
Lastly, it should also be noted that using a drug as an internal tracer would mean having to carry out the tests with a minimum incorporation rate of 5 kg/t, while the accreditation relating to additives applies to

minimum incorporations of 2 kg/t. Incorporating a drug at a rate of 2 kg/t would require a specific marketing authorisation or the destruction of the manufactured feedstuffs.
One of the main difficulties also involved the sketchy awareness of loading and delivery rates. Selecting an animal meal formula, which is not necessarily loaded or delivered in this format, does not help to clarify this datum.
Furthermore, large variations in loading and delivery rates were recorded, especially for loading, depending on the cells or the level in the cells. Conveyor transfer, even if this involves a risk of carry-over, helps to achieve a loading rate that is slightly less sensitive to the level of feedstuff in the cell.
In terms of sampling, unloading a batch into a box that has too tight a volume, and positioning the discharge outlet too low in the box may make it very difficult to take samples at the end of a batch.
Note that as the tarpaulin covering the collector batches during loading at L2 never showed any sign of a deposit after loading the tracer batches, no sample was taken. It can therefore be stated that, during the tests, no carry-over could have been caused by airborne transfer from the tracer batch to the collector batch.
Generally speaking, as most of the operations were performed outdoors with animal meals, it was important to have good weather conditions on the day of the test (light wind and no rain). Under these conditions, on average, it would take 3 hours to carry out the tests with two trucks for tests involving mechanical delivery, and one truck for the test with pneumatic delivery. This time was shortened to 2.5 hours for phase 2. The test required at least 3 people to take the samples, one person to manage the loading station and at least one driver/delivery person for loading and delivery operations.

2.2. Carry-over profiles

The phase 1 tests revealed that carry-over in the collector batches reduced rapidly, as seen in the example of truck A (Figure 3).
Due to the speed of this decrease, the design and sampling assumptions were not fulfilled (see § 1.6). For this reason, sampling times were shortened at the start of the collector batches in the phase 2 tests and other calculation methods were used.

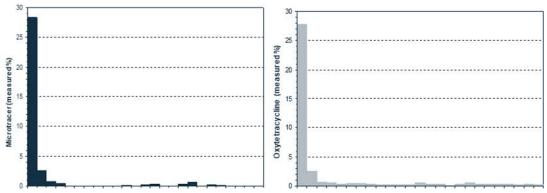

Figure 3: Interbox carry-over in truck A

Instead of an arithmetic mean, the method used to calculate mean carry-over was modified. The concentration of the quantity of feedstuff running through between two samples may be taken to be equal, not to the previous sample, but to the average of those of the two samples on either side. This gives a better view of the change in the carry-over curve and limits over-estimation of the actual mean concentration of the collector batch.
Taking intermediate samples between samples 1 and 2 at the start of the collector batches gives a third expression for mean concentration, referred to as C''_m. The excellent linear relationships between the results of these various calculation methods made it possible to estimate the latter for the trucks in phase 1.

2.3. Size of the purges

The possible impacts of forgetting to purge the trucks after delivering a batch of medicated animal meal was assessed. This type of oversight would result in extra-carry-over of the "collector" batch, generally around 0.68% (of the concentration measured on the tracer batch at truck output). This assessment demonstrated that purging a truck after delivering an "at-risk" batch is an effective preventive measure.
Note also that the practice of incorporating the products of purges performed after collector batches does not cause any significant extra-carry-over of the corresponding collector batch (+ 0.14%) assuming that these purge residues were evenly distributed throughout the collector batch.

3. Conclusions

Table1 illustrates the results for each truck. In this table, the order letters simply provide a "visual" classification, and do not indicate any statistical comparison of the results These results cannot be generalised to cover all trucks of the same type.
However, interbox carry-over obtained with straight trucks was approx. 0.1% below that of similar semi-trailers: comparison C/H or I/F. In this context, it is not hard to imagine that carry-over in semi-trailers would be of the same order of size, or slightly less at least, if using rear boxes that open onto a circuit of a similar length to that of a straight truck.

Trucks	Type	Age Box/Transfer system	C''m interbox (% measured)		Order	C''m intrabox (% measured)		Order
A	SR, Screw, TpV, gravity purge	14 years/ 6 years	0.55	0.65	b	0.09	0.04	bc
B	SR, Tc, TpV, Pneumatic	2 years/ 2 years	0.12	0.12	c	0.05	0.05	c
C	SR, Tc, TpV, Ecofan	2 years/ 2 years	0.15	0.05	cd	0.03	0.02	c
D	SR, Vis, TpV, Pg gravitaire	14 years/ 12 years	0.61	0.45	b	0.04	0.05	c
E	SR, Tc, TpV, DKS	4 years/ 4 years	1.41	1.41	a	0.05	0.03	c
F	SR, Vis racleuse, TpH, TDS	8 months/8 months	0.14	0.18	c	0.01	0.02	c
G	SR, Vis racleuse, TpV, TDS	12 years/3 months	0.14	0.15	c	0.01	0.00	c
H	Pt, Tc, TpV, Ecofan	2 years/ 2 years	0.02	0.04	d	0.03	0.02	c
I	Pt, Tc, TpH, TDS	1 year/1 year	0.02	0.08	d	0.04	0.25	bc
J	Pressurised SR	9 years	0.14	0.17	c	0.37	0.44	a

Table1: Summary of the results for all tested trucks

SR: Semi-trailers – Pt: Straight truck - Tc: Chain conveyor – TpV: Reverse V-flap – TpH: Horizontal flap

It would also appear that, due to their onboard technology and the work practices, including purge systems, the most recent trucks show fewer signs of carry-over. One exception to this observation is truck E, where the results could be related to incorrect use of the DKS system.
The result for the pressurised truck J, concerning intrabox carry-over, can be explained by a deformation of the bottom part of box 2 and possible formation of a deposit of tracer feedstuff. It should also be noted that interbox carry-over is the same as that obtained with recent trucks using mechanical delivery systems. This interesting result will need to be confirmed.
Overall, and in relation to the figures obtained at the plants, the carry-over recorded with this fleet of trucks are very low for interbox examples, and negligible, or even at the very edge of the detection limit for intrabox examples. Note also that these figures were obtained under very strict assessment conditions:

- Animal meals
- Boxes furthest from the output
- Additional empty boxes.

As most feedstuffs are delivered in pellet format, it is highly likely that the most common cases of carry-over are actually less.
Only three cases of carry-over higher than the other were recorded for the batch, and two of these characterise the oldest trucks. In this context, truck G revealed that an old truck that has been modified can achieve results on a par with those of more recent trucks, even if the purge system does not include the deck screw.
These results would suggest that the following should be recommended for the transport of medicated feedstuffs:

- Use of recent trucks,
- Use of rear boxes, implying delivery at the start of the round,
- Systematic post-delivery purge.

The negligible levels of intrabox carry-over are supported by the visual observations and photographs taken during the tests. These demonstrated that making a visual check on the internal cleanliness of the boxes following delivery of an animal meal would give sufficient warning of any risk of carry-over. As such, an analytical carry-over assessment has been abandoned in favour of the recommendation to make a visual assessment of the level of cleanliness of the box after each delivery. This recommendation simplifies the truck assessment process described in **i'Tec_T8.**

4. Bibliographic references

i'Doc_T8, 2003 - Elaboration d'une méthodologie pour l'évaluation des contaminations croisées par des additifs dans un camion de livraison d'aliment du bétail
i'Tec_T6, 2003 – Comparing internal tracers internes/ external tracers
i'Tec_T8, 2003 – Technical rules for assessing carry-over in delivery trucks.