Comparison of homogeneity tests

Part II. Tests with tracers present in lower and higher numbers

In this set of tests, we used dyed iron particles from the company Micro Tracer, Inc., San Francisco. According to the supplier, one gram of tracer has 25,000 particles of the granulation 150-500 μ. However, normal distribution in this range cannot be guaranteed.

The density of the tracers is 7.6, as opposed to 1.3 by methyl violet. This means that there are great differences here, as well as by the granulation (granulation range of methyl violet = 1 - 100 μ). The tracer can be delivered in violet, blue, red, green and orange. If they are to be used together with methyl violet, as in our tests, it is advisable to use red tracers so that the colors can be easily identified. It is also advisable to demagnetize the iron tracer before use. This can be carried out with "Magnetic Bulk Tape Eraser" from the Micro Tracer, Inc. 40-50 g of tracer were added to each ton of mixed feed.

The iron tracers have to be removed from the mixed feed by magnet. This can easily be carried out with the rotating Detector from the firm Micro Tracer, Inc. The nonmechanized "Mason Jar" manufactured by the same firm is considerably more primitive and less suitable for this purpose. By both of these apparatuses the iron particles are drawn off by a strong ring-shaped magnet covered with a paper filter.

The iron particles are now on the filter, in circles, almost in military order, though partly agglomerated, and must, therefore, be spread over the whole filter surface and split up into single particles.

Finally about 10-15 drops of alcohol are placed in the middle of the filter. As the alcohol spreads out over the filter the dye is removed from the tracer and left on the filter. Thus, the tracer can: (1) be counted more easily and (2) cannot be mistaken for any iron particles which are accidentally in the feed mixture.

The main problem, especially difficult with higher numbers of particles to be counted, is that agglomerated tracers cannot always be detected as such, when dampened with alcohol. It is essential that the agglomerates are separated. Here the analyzer can develop his own method. The main thing is to deliver reliable results continuously.

The tests were first carried out with two pig feeds and one chicken feed (Figure 1) in the 5-ton mixer (capacity 12.5m³).

Subsequently, a further test was made with a premix mixture in the 2-ton mixer (5m³). The tracers were added slightly left from the mixer center. As tracers both iron tracers and methyl violet were used. The samples were taken in the 2-ton mixer according to the usual scheme (12 samples) in the 5-ton mixer 20 samples, according to the scheme in Figure 1.

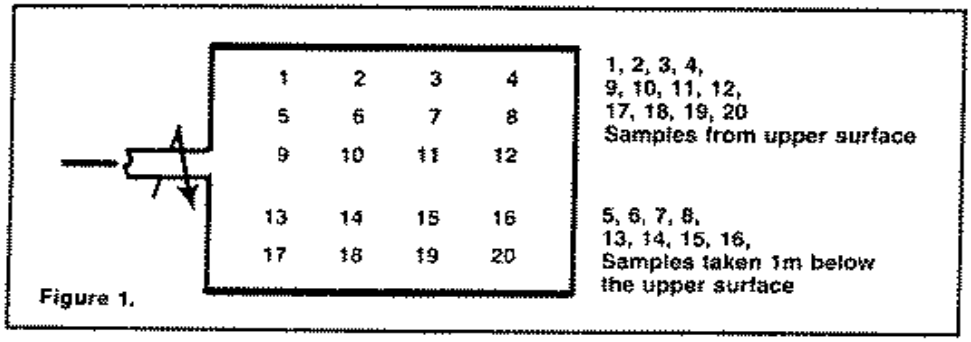

Figure 1.

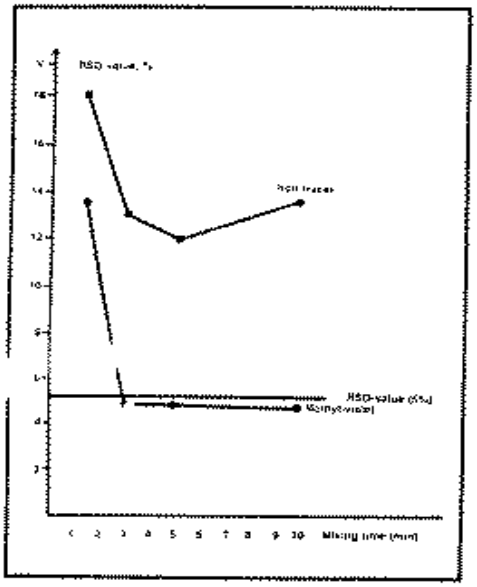

Figure 2. The results of tests with the 2-ton premix. The V-values of methyl-violet and iron tracer tests (12 samples per serie).

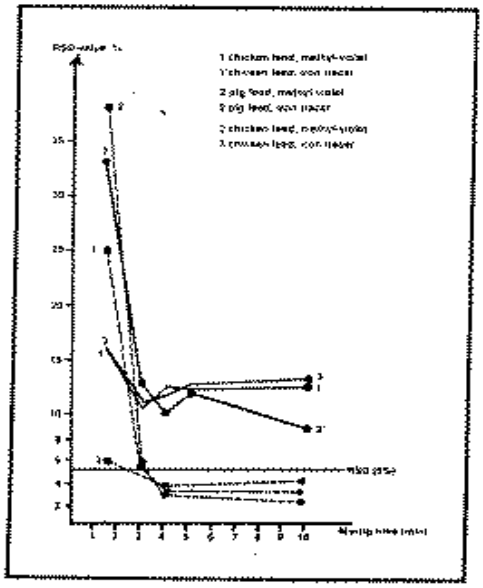

Figure 3. The RSD-values of the 5-ton mixing tests with methyl-violet and iron tracers.

Firstly, the RSD-values of the methyl violet and iron tracer tests were graphically recorded. The individual data of the iron tracer tests were then summarized in table form, and finally the results were discussed. The same applies for the 2-ton tests.

In general there is once again a parallelity between the RSD-values, this time between those of the iron tracer and the methyl violet which is rather surprising as these tracers are so different from one another. The deviations are, however, larger at the iron tracer tests within the series.

Now the iron tracer test as such (see table 2). According to the delivery firm, the tracer has 25,000 particles per gram. On counting we achieved the following results:

per 10 mg	274 particles
	298 particles
	414 particles
	306 particles
Average	323 particles

This means an average of 32,300 per gram, whereby this result has risen above 30,000 due to a definite spreading value. For the evaluation of the tracer loss we have, therefore, taken an average of 30,000, i.e. per ton of mixed feed with 45 g of tracer 1,350,000 particles and per weigh-in of 50 g about 67, whereby this value is most likely very inaccurate.

As you can see in the table, the recovery percentage is not satisfactory (67-90%). Contacts with another firm which had carried out these tests, too proved that they had about the same losses, so that we did not bother to go

Table 1. The characteristic data of iron tracer tests with the five-ton mixtures (20 tests per serie).

Mixing tests	Mixing time in mins.	number of particles added per ton	number of particles per weigh-in of 50 g	counted average number of particles per series $\bar{N}$	approx. loss in %	stand. deviation s	stand. deviation $s^* = \sqrt{\bar{N}}$	Relative standard deviations RSD %	Relative standard deviations RSD* %	Results outside the 1s* range in series of 20 tests	Results outside the 2s* range in series of 20 tests
No. 1	1.5	45 g		54.8	19	8.8	7.4	16.1	13.5	7	3
Chicken	3	or		53.3	21	5.8	7.3	10.5	13.7	5	0
feed	4	1,350,000	67.5	53.5	21	6.5	7.3	12.2	13.7	7	0
	5	particles		50.8	25	6.14	7.11	12.1	14.1	3	0
	10	per ton		58.4	13	7.13	7.64	12.2	13.1	7	0
No. 2	1.5	50 g		60.5	19	19.9	7.8	32.8	12.9	14	9
pig	3	or		69.6	7	8.8	8.3	12.7	12.0	6	3
feed	4	1,500,000	75	64.1	15	6.4	8.0	10.0	12.5	4	0
	5	particles		64.1	15	7.5	8.0	11.8	12.5	7	1
	10	per ton		65.9	13	5.6	8.1	8.6	12.3	2	0
No. 3	1.5			45.5	33	7.4	6.75	16.2	14.8	7	1
Chicken	3	45 g	67.5	45.4	33	4.9	6.7	10.8	14.8	3	0
feed	4			48.7	28	5.6	7.0	11.5	14.3	2	0
	5			49.9	26	6.3	7.1	12.5	14.2	6	0
	10			47.8	29	6.4	6.9	13.4	14.5	4	0

Table 2. The characteristic data of the iron tracers

Mixture	Mixing time	g iron tracer per ton	theor. no. of particles counted per 50 g	Average particles counted per series $\bar{N}$	approx. loss of particles %	standard deviation s	standard deviation s*	Relative standard deviations RSD %	Relative standard deviations RSD* %	results outside 1s* range in series of 12 tests	results outside 2s* range in series of 12 tests
Mineral-	1.5			49.8	17.0	9.0	7.1	18.0	14.2	5	1
stuff	3	40g	60	44.5	25.8	5.7	6.7	12.9	15.0	2	0
premix	5			47.5	20.8	5.7	6.9	11.9	14.5	2	0
	10			43.6	27.3	5.9	6.6	13.5	15.1	2	0

into this point any further.

As you will also see from the table, by the tests with iron tracers the so-called 1-S rules did not apply, as apparently even 20 results per series are not sufficient. Theoretically six results of each serie should be outside the 1 s range ($S_* = \pm \sqrt{\bar{N}}$).

By the 2-S rules the situation is