III. Appendix 3

Performance of Blending Equipment

This section describes a procedure which can be used to evaluate how well a given mixer blends the ingredients used in a batch of blended fertilizer. This may vary for different sized batches and blends of different type materials. By carrying out the procedure for various mixing times, you can determine the optimum mixing time. By varying the order of the addition of the materials, you can determine the optimum order of inclusion. (Some mixers will “float” light materials or appear to direct the lightest/heaviest materials into the corners or outside edges of the mixer.) Mixing times and order of inclusion can have as big an impact on performance as size guide number (SGN) variance. The most important point to consider is that different mixers of the same brand/model can react differently (due to pitch of the ribbon, angle of the paddles, cant of a side panel, etc.) Every mixer is different and parameters for use of each must be tested and established separately.

After ascertaining that the system is clean, make sure that the scales and all other equipment are properly functioning, including scale calibration before and after the test. Take a sample of each material being weighed and charged to the mixer. These samples should be analyzed for N-P-K, with the actual formula weights, recorded individually from the scales, accumulated during formulation, totaled/reconciled during the evaluation and used to calculate the expected value for the blended product. Before performing the test, it is also necessary to know the time it takes to discharge the mixer.

It is recommended that you take at least 10 samples of blended material at equally spaced intervals during the discharge of the mixer. Choose a location as close as possible to the mixer discharge where stream samples can safely be taken. Assume for this example that we will mix a two ton batch of 17-17-17 and that the mixer discharge time has been determined to be 145 seconds. This can be divided into 10 samples taken 15 seconds apart with the first stream cut taken 5 second after discharge begins. The stream should be cut quickly and evenly every time, each cut put into a separate container and sent to a competent lab for analysis.

After the results are obtained, we can perform a simple statistical analysis. Assume the results of the stream cuts are as follows:

Sample Time	N	AP	K_2O
5 seconds	17.0	16.6	17.9
20 "	18.0	17.6	17.7
35 "	17.2	18.5	17.6
50 "	17.6	17.1	18.6
65 "	18.6	17.1	16.6
80 "	17.8	15.6	17.9
95 "	17.6	17.6	17.5
110 "	17.2	18.1	16.0
125 "	16.8	19.0	17.9
140 "	18.0	17.6	17.0
Average	17.58	17.48	17.47

Since the raw materials had also been analyzed, we can calculate from the weights of each material used what the average analysis should be. If it does not compare closely with the calculated analysis of the stream samples, there has been either an equipment problem, such as a scale malfunction or misread, or a problem in obtaining or analyzing the samples.

In an ideal situation, there would be no difference between the individual stream samples. In actuality, however, there will always be some variability present. In order to determine how much variability is acceptable, we need to apply some statistical calculations to the values obtained for the stream samples. Using a statistical calculator, we can easily determine the standard deviation for the N, P, and K values. We are now in a position to determine the minimum 95% confidence limits for the data we have collected, and thus, come to a conclusion about the efficiency of the mixer. Since we had ten samples, we use 9 degrees of freedom (df=10-1); df for this work will always be one less that the number of stream samples taken and refer to the table of "t" values at the end of this appendix. Since we want 95% limits, we look under the t .95 column for df--9 and find the multiplier 1.833. We then multiply each standard deviation by this value and subtract the result from the average N, P, and K and determine our minimum 95% CL as follows:

	N	**AP**	**K_2O**
Average X	17.58	17.48	17.47
std. dev. (s)	0.545	0.960	0.748
95% min. CL (X - 1.833 s)	16.58	15.72	16.10

When total plant nutrients are considered, the above indicates that in this example 95 of 100 stream samples will contain 92% or more of the indicated plant nutrients. A suggested recommendation is that for a mixer to be acceptable, the 95% minimum CL values should indicate that 95 of 100 stream samples will contain 90% or more of the expected nutrients. The square of the standard deviation is called the variance. If one uses similar materials and grades, two or more mixers can be compared by calculating the individual variances, adding the variances of N, P, and K together to determine the total variance for each mixer, and then compare the results to see which mixer has the lowest total variance and, therefore, does the best mixing job. The same scheme can also be followed with the same mixer but using different mixing times to determine the optimum mix time.

"T" TABLE

Percentile of the t distribution*

df	$t_{.60}$	$t_{.70}$	$t_{.80}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$
1	0.325	0.727	1.376	3.078	6.314	12.706	31.821	63.657
2	0.289	0.617	1.061	1.886	2.920	4.303	6.965	9.925
3	0.277	0.584	0.978	1.638	2.353	3.182	4.541	5.841
4	0.271	0.569	0.941	1.533	2.132	2.776	3.747	4.604
5	0.267	0.559	0.920	1.476	2.015	2.571	3.365	4.032
6	0.265	0.553	0.906	1.440	1.943	2.447	3.143	3.707
7	0.263	0.549	0.896	1.415	1.895	2.365	2.998	3.499
8	0.262	0.546	0.889	1.397	1.860	2.306	2.896	3.355
9	0.261	0.543	0.883	1.383	1.833	2.262	2.821	3.250
10	0.260	0.542	0.879	1.372	1.812	2.228	2.764	3.169
11	0.260	0.540	0.876	1.363	1.796	2.201	2.718	3.106
12	0.259	0.539	0.873	1.356	1.782	2.179	2.681	3.055
13	0.259	0.538	0.870	1.350	1.771	2.160	2.650	3.012
14	0.258	0.537	0.868	1.345	1.761	2.145	2.624	2.977
15	0.258	0.536	0.866	1.341	1.753	2.131	2.602	2.947
16	0.258	0.535	0.865	1.337	1.756	2.120	2.583	2.921
17	0.257	0.534	0.863	1.333	1.740	2.110	2.567	2.898
18	0.257	0.534	0.862	1.330	1.734	2.101	2.552	2.878
19	0.257	0.533	0.861	1.328	1.729	2.093	2.539	2.861
20	0.257	0.533	0.860	1.325	1.725	2.086	2.528	2.845
21	0.257	0.532	0.859	1.323	1.721	2.080	2.518	2.831
22	0.256	0.532	0.858	1.321	1.717	2.074	2.508	2.819
23	0.256	0.532	0.858	1.319	1.714	2.069	2.500	2.807
24	0.256	0.531	0.857	1.318	1.711	2.064	2.492	2.797
25	0.256	0.531	0.856	1.316	1.708	2.060	2.485	2.787
26	0.256	0.531	0.856	1.315	1.706	2.056	2.479	2.779
27	0.256	0.531	0.855	1.215	1.706	2.056	2.479	2.779
28	0.256	0.530	0.855	1.313	1.701	2.048	2.467	2.763
29	0.256	0.530	0.854	1.311	1.699	2.045	2.462	2.756
30	0.256	0.530	0.854	1.310	1.697	2.042	2.457	2.750
40	0.255	0.529	0.851	1.303	1.684	2.021	2.423	2.704
60	0.254	0.527	0.848	1.296	1.671	2.000	2.390	2.660
120	0.254	0.527	0.845	1.289	1.658	1.980	2.358	2.617
	0.253	0.524	0.842	1.282	1.645	1.960	2.326	2.576
df	$t_{.40}$	$t_{.30}$	$t_{.20}$	$t_{.10}$	$t_{.05}$	$t_{.025}$	$t_{.01}$	$t_{.005}$

Introduction to Statistical Analysis, Dixon & Massey, 1950

When the table is read from the foot, the tables' values are to be prefixed with a negative sign. Interpolation should be performed using the reciprocals of the degrees of freedom.

*The data of this table extracted from Table III of Fisher and Yates. Statistical Tables, with the permission of the authors and publishers, Oliver & Boyd, Ltd., Edinburgh and London.

BLENDER FORMULATION SHEET

GRADE____ DATE ____________________________

FORMULA NO. ____

PLANT________________________________ PREPARED BY ____________________________

POUNDS	TOTAL SETTING	MATERIALS	MATERIAL ANALYSIS %	N	P_2O_5	K_2O	MgO			MATERIAL COST PER TON	MATERIAL COST PER POUND	POUNDS	FORMULA MATERIAL COST
TOTAL:			PLANT FOOD UNITS									TOTAL	

NITROGEN BREAKDOWN

TOTAL "N"	NO_3	NH_3	WSO	WISO	

MINOR ELEMENTS				

Handling and Blending Coated Fertilizers

The slow release properties of coated fertilizers can be degraded by ordinary fertilizer mixing and handling equipment. Damage to the thin coating of soluble materials will result in the catastrophic release of the nutrient and poor product performance. This damage can be minimized by proper equipment selection and careful handling of materials. Forces that can negatively impact the slow release properties of coated fertilizers are: high drops, drops onto hard surfaces with flat angles, fast moving elevators, blenders with fast moving internal parts, screw or drag conveyors with pinch points or bottlenecks causing pressure buildup on flights or screw surfaces.

Equipment Selection

All equipment selected for a plant where coated slow release fertilizers will be handled should be selected with gentle handling in mind. Gentle handling is accomplished by utilizing belts to move product when possible, slow equipment speeds and short drops.

Testing

Testing of the coated product as it travels through the blending process is very important to determine if and where degradation is occurring. Samples should be taken at every possible access point but certainly from the storage bin after unloading, after the blender and after the bagging process. The blending facility can work with the coated fertilizer manufacturer or with an independent lab set up to perform slow release measurements to evaluate changes to the slow release properties. Periodic testing of the slow release properties of the finished product should be done on a regular basis to confirm good handling practices and label claims. Microscopy can also be used to observe material for evidence of rough handling in some cases.

Modifications

If a problem with a particular operation or piece of equipment is noted, steps should be taken to minimize damage to materials. These could include use of cushioning materials such as conveyor belting inside chutes, reducing the speed of falling material by decreasing the height or angles of chutes, using e-z let down chutes, decreasing blender speed, rebuilding or replacing screw conveyors or drag chains, converting elevators to continuous bucket design or similar improvements. Some elevators use plastic buckets which do not impact the coatings as severely as do metal buckets.

Warehousing and Handling Tips

When picking up coated products from a bin or storage pile with a front end loader keep the loader bucket off the floor. Sweep the material back into the pile rather than pushing with the loader bucket. Avoid running over product with loader or spinning tires to force bucket into pile. Minimize reuse of sweepings from coated product storage and take into account possible damage when formulating with previously handled materials. Many times it is possible, and more efficient to utilize bulk bags for transporting, handling and storing coated materials. If used efficiently they can minimize shrink of valuable raw materials. Do detailed bin and equipment inspections on a regular basis.