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Subject: Preliminary Analysis of Comparative Results

Erodibility tests of a blend of fine sand and salt were performed to compare PM-10 emissions generated by the new reduced-scale wind tunnel and the MRI wind tunnel at nominally the same conditions of friction velocity. The test material consisted of a mixture of 80% U.S. Silica F-70 sand and 20% Mortin flour salt, by weight. The threshold friction velocity of the test material was determined to be 29.8 cm/s based on visual observation of the onset of particle movement within the wind tunnel working section. This corresponds to a velocity of 23 mph at a reference height of 10 m above the surface.

Comparative Testing

Table 1 gives a comparison of test results from the two wind tunnels, i.e. the MRI wind tunnel used to generate the AP-42 emission factor equation and the new reduced scale wind tunnel for the study of dry lake wind erosion. For a given wind speed, the MRI wind tunnel consistently was found to generate about three times the emission rate of the new reduced scale wind tunnel, based on the test series conducted in May 1990. There are several likely reasons for this difference:

1. In the MRI wind tunnel system, there is no elutriation chamber to separate coarse particles, so that all of the coarse particles pass by the point of isokinetic extraction of the PM-10 sample. Consequently, the cyclone may be subject to a small degree of coarse particle penetration having a major effect on the PM-10 filter loading.

2. The fetch (length of test surface) is twice as long in the MRI wind tunnel (3048 vs 1500 cm). We propose to investigate this effect by exposing only half of the normal test surface length in the MRI wind tunnel.

To provide additional data on the reproducibility of test results from the reduced-scale wind tunnel, four additional runs were performed on June 13, 1990. A freshly prepared blend of sand and salt was used for this purpose. In both series of two tests, the text mixture was eroded for 3 minutes each at reference (10 m) wind speeds of 25.5 and 29.0 mph. As indicated in Table 2, the results show good comparability for the total amount eroded in each series, although the first series showed twice the contribution at the 25.5 mph wind speed. This could have been the result of a slightly higher tunnel flow than indicated by the apparent manometer reading for Test 6-13-8. This would have depleted the amount of erodible material available for the higher wind speed (Test 6-13-9).

Overall, the tests on June 13 produced lower than expected erosion rates, as compared to the results obtained from similar reduced-scale wind tunnel tests on May 18. Even though the blended proportions of fine sand and salt were the same, there are a number of factors which could have produced erodibility differences. Most important, although the sand/salt test mixtures were carefully blended by hand, the salt flour had a variable tendency to cake as the result of moisture uptake. Consequently, the degree of disaggregation of salt particles in the mixture could have been affected. One reason for suspecting this effect is the lower proportion of PM-10 in the "suspended" particulate (SP) emissions (i.e. the particulate fraction lifted by the vertical air stream). On June 13, the PM-10/SP ratio was observed to range between 0.19 and 0.25, as compared to a range of 0.34 to 0.37 for the tests conducted on May 18.

Nonetheless, the important conclusion is that reasonably good reproducibility was obtained in the MRI wind tunnel test series (0.71 vs 0.99 $mg/cm^2/min$) and the reduced scale wind tunnel test series (0.088 vs 0.102 $mg/cm^2/min$) for repeated test conditions. Obviously the subject of test result reproducibility could be explored further through more extensive experiments.

Comparison with AP-42 Predictions

The final comparison has to do with the predictive AP-42 equation for wind erosion from surfaces with "limited" erosion potential. Our visual observations indicated a decaying erosion rate over a 3-min test period, especially at the lower erosion rates. This was determined by observing the intensity of the dust cloud at the tail end of the working section from the beginning of a test to the end. This characteristic of decaying erosion rate is basic to materials with limited erosion potential.

Table 3 compares the May 18 and June 13 test results in the reduced-scale wind tunnel with the predictions of the published AP-42 emission factor equation (as developed from earlier tests performed on several materials with the MRI wind tunnel). In making these comparisons the cumulative erosion rates are appropriate because it is assumed that the erosion rate from a freshly exposed surface at a given wind speed should include the contributions at lower speeds when a range of wind speeds are used to test the same surface.

This comparison indicates close agreement of the June 13 tests with the predictive equation, but poor agreement for the May 18 tests. This is consistent with the observation that the May 18 test material showed a much slower rate of decay in emission rate, indicating unlimited erosion potential characteristics.

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Conclusions

In summary the main conclusions of the comparative testing may be stated as follows:

1. The erosion rates of a given test material in a specific wind tunnel appear to be reproducible at a given wind speed.

2. The erosion rates generated by the MRI wind tunnel appear to be consistently larger than those generated by the reduced scale wind tunnel.

3. Because of the effects of humidity on the aggregation of salt flour, the erodibility of salt/sand mixtures may vary even though the composition is fixed.

4. Under conditions for which visible erosion rate noticeably decays over time (at a given wind speed), the AP-42 emission factor equation can be used as a reliable predictor of the PM-10 erosion rate.

These conclusions are subject to modification based on further review and final QA validation of test data.

TABLE 1
Comparative Test Results

Wind Tunnel[a]	Test No.	Velocity @ 10 m (mph)	PM-10 Emission Rate (mg/cm²/min)
RS	5-18-1	25.5	0.072
RS	5-18-2	27.0	0.14
RS	5-18-3	29.0	0.22
MRI	5-23-4	29.5	0.71
MRI	5-29-5	26.5	0.35
MRI	5-29-6	28.0	0.44
MRI	5-29-7	29.5	0.99

[a] RS = reduced scale

TABLE 2
Additional Reduced-Scale Wind Tunnel Tests

Test No.	Velocity @ 10 m (mph)	PM-10 Emission Rate (mg/cm²/min)
6-13-8	25.5	0.044
6-13-9	29.0	0.044
		0.088
6-13-10	25.5	0.022
6-13-11	29.0	0.080
		0.102

TABLE 3
Predicted vs Measured Erosion Potential for 29 mph Wind Speed at 10 m

Source of Data	Erosion Potential (g/m^2)
MEASURED	
• May 18	13.0
• June 13 Series 1	2.64
• June 13 Series 2	3.06
PREDICTED (AP-42)	2.47