

Fly Ash Characterization

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Precipitator performance is very sensitive to two particulate properties: resistivity and particle size. These properties can be determined quickly, economically and accurately in the laboratory.

Resistivity is determined as a function of temperature in accordance with IEEE Standard 548. This test is conducted in an air environment containing a specified moisture concentration. The test is run as a function of ascending or descending temperature or both. Data are acquired using an average ash layer electric field of 4 kV/cm. Since relatively low applied voltage is used and no sulfuric acid vapor is present in the environment, the values obtained indicate the maximum ash resistivity.

Usually the descending temperature test is suggested when no unusual circumstances are involved. Before the test, the ash is thermally equilibrated in dry air at 850°F for about 14 hours. It is believed that this procedure anneals the ash and restores the surface to pre-collection condition.

If there is a concern about the effect of combustibles, the residual effect of a conditioning agent other than sulfuric acid vapor, or the effect of some other agent that inhibits the reaction of the ash with water vapor, the combination of the ascending and descending test mode is recommended. The thermal treatment that occurs between the two test modes is capable of eliminating the foregoing effects. This results in ascending and descending temperature resistivity curves that show a hysteresis related to the presence and removal of some effect such as a significant level of combustibles as shown in Figure 1.

Resistivity is also determined isothermally as a function of electric field intensity using an air environment containing concentrations of moisture and sulfuric acid vapor or other specified agents. This procedure is described in EPA Report 600/7-78-035.

Instead of the guarded, parallel plate test cell geometry described in IEEE Standard 548, a radial test cell is used. An ash layer 5 mm wide and 1 mm thick is subjected to the applied potential. The ash is held in the test environment for 48 hours prior to determining resistivity as a function of electric field intensity from 2 kV/cm to 12 kV/cm or break down, whichever comes first. Typically the test is performed at two temperatures to bracket the process temperature. One or more sulfuric acid concentrations are employed depending on the circumstances.

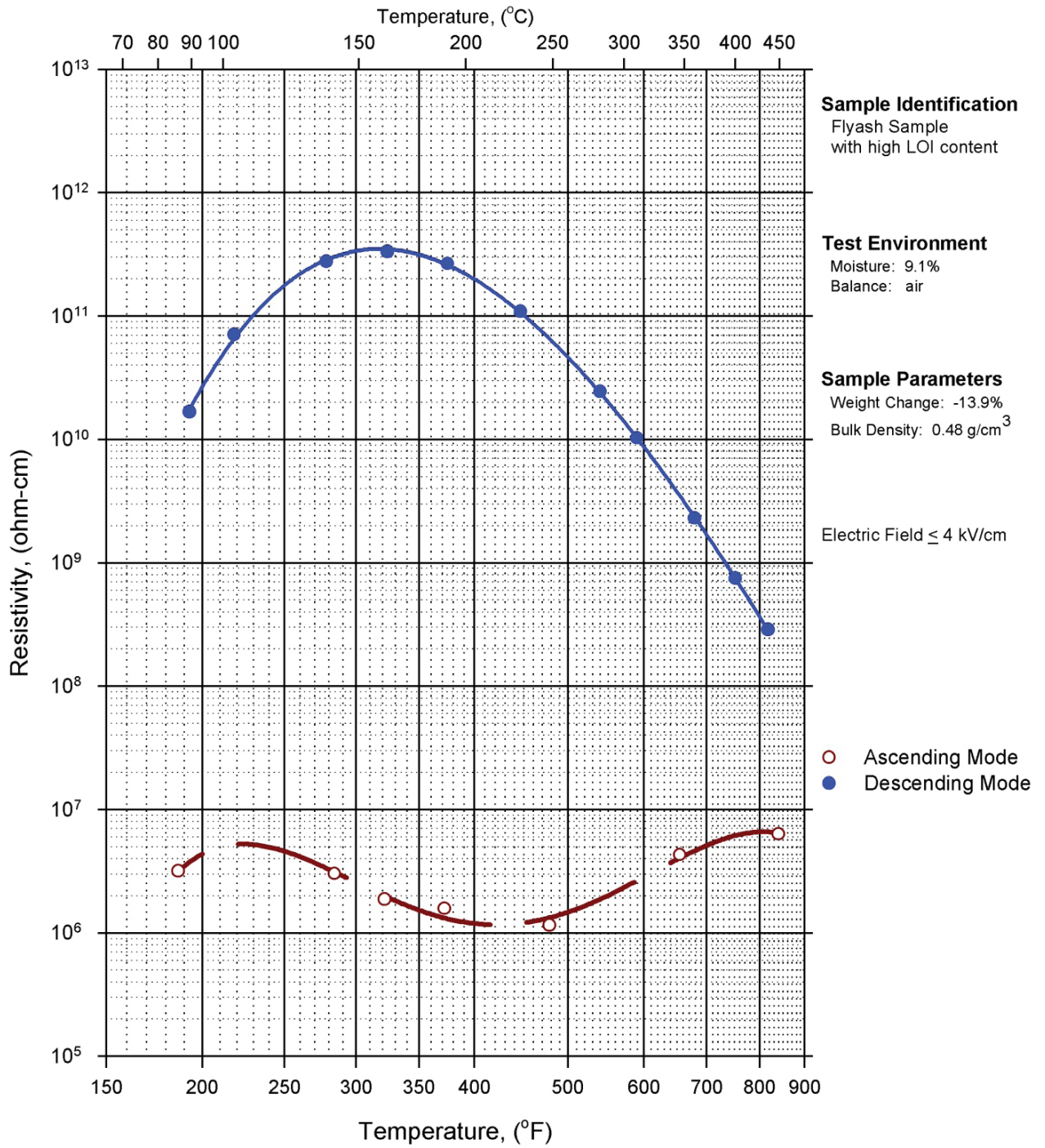


Figure 1: Resistivity in Accordance with IEEE Standard 548-1984, Ascending and Descending Temperature Modes.

Figure 2 shows the results for this type of test. Electric field can have a much greater effect on resistivity when conduction is dependent of adsorbed acid vapor. In some cases, the increase in field strength from 4 kV/cm to 12 kV/cm causes a decrease in resistivity of more than an order of magnitude. In Figure , the ash resistivity determined in accordance with IEEE Standard 548 at 4 kV/cm and a similar temperature (311°F) and environment without acid vapor was 5×10^{10} ohm-cm. Figure 2 shows the great effect acid vapor can have on ash resistivity.

As stated above, the IEEE Standard 548 test determines a maximum expected resistivity. If sulfuric acid vapor is present in the flue gas, the laboratory resistivity test should also be conducted with a commensurate acid concentration to determine a true picture of the resistivity level that the precipitator will experience.

Using the ultimate coal analysis or a given flue gas analysis and the ash chemical composition, resistivity can be predicted as a function of temperature and environmental conditions. Resistivity is modeled in accordance with EPA Report 600/7-86-010. An example of the model's output using the data supplied in Table 1, is shown in Figure 3. If one wishes to check the validity of the modeled data, a minimum amount of laboratory data can be acquired for comparison. A reasonable agreement between the modeled data and laboratory data allows one to utilize the modeled information to anticipate resistivity at all temperatures and

Table 1: Coal and Ash Chemistry

Coal Analysis (Wt %)	
Carbon	72.30
Hydrogen	4.53
Oxygen	7.46
Nitrogen	1.41
Sulfur	0.69
Moisture	3.74
Ash	9.88
Sum	100.00

Predicted Flue Gas Make-Up (Wet Volume %)	
N ₂	74.70
O ₂	4.60
CO ₂	13.30
H ₂ O	7.40
SO ₂ (Wet ppmv)	460
SO ₃ (Wet ppmv)	1.8

Ash Analysis (Wt %)	
Sodium (Na ₂ O)	0.30
Potassium (K ₂ O)	2.40
Magnesium (MgO)	0.81
Calcium (CaO)	1.92
Iron (Fe ₂ O ₃)	8.52
Aluminum (Al ₂ O ₃)	27.83
Silica (SiO ₂)	54.11
Titanium (TiO ₂)	1.45
Phosphorous (P ₂ O ₅)	0.17
Sulfur Trioxide (SO ₃)	0.13
Sum	97.6
LOI	3.8

Since the performance of many precipitators deteriorates when the resistivity value exceeds 2×10^{10} ohm-cm, resistivity data are used in many ways:

- Coal selection
- flue gas conditioning
- environmental conditions
- precipitator trouble shooting, etc.

Resistivity data are also used in the selection of allowable voltage/current relationships for computer modeling of precipitator performance.

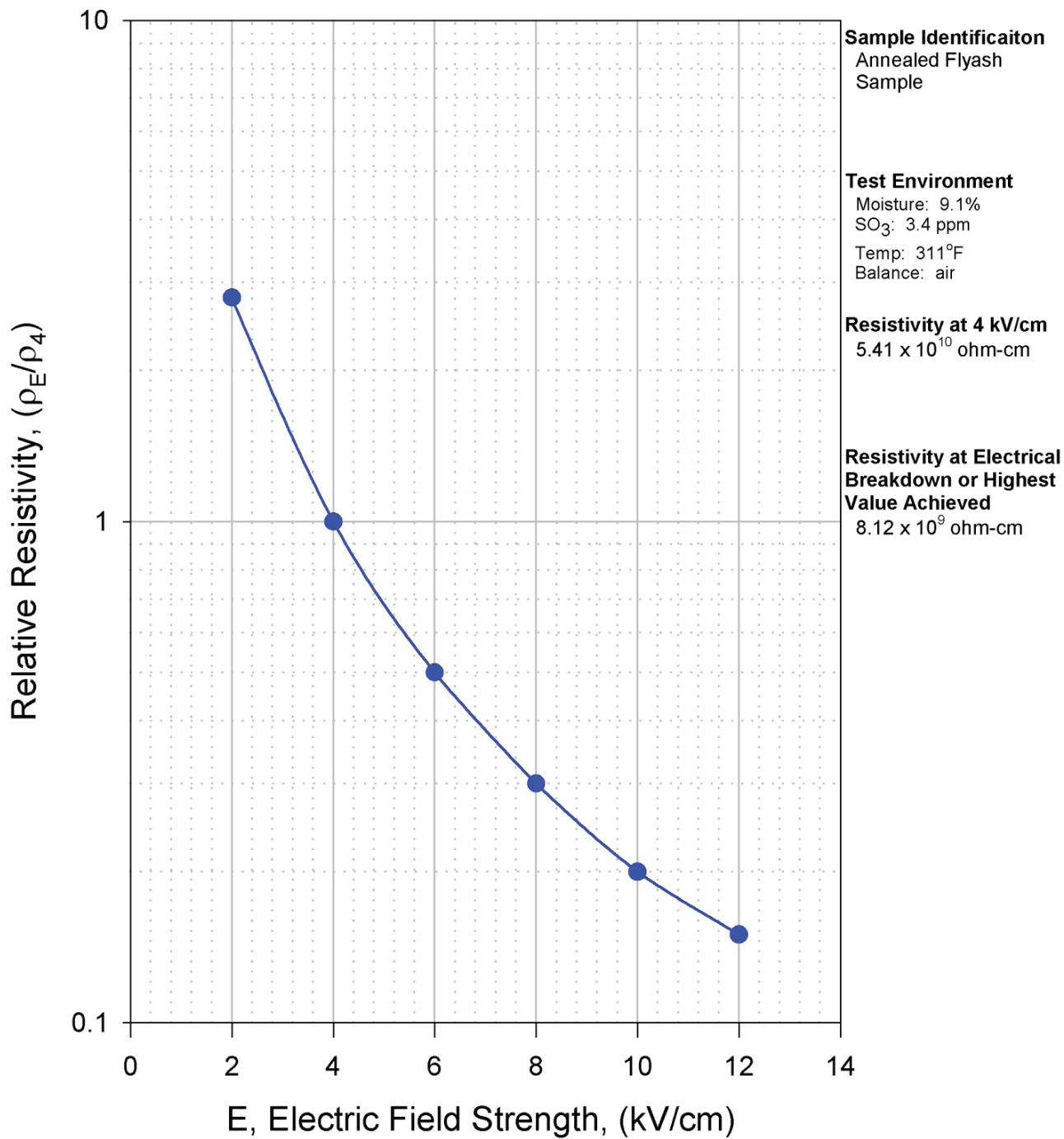


Figure 2: Resistivity as a Function of Applied Electric Field Potential

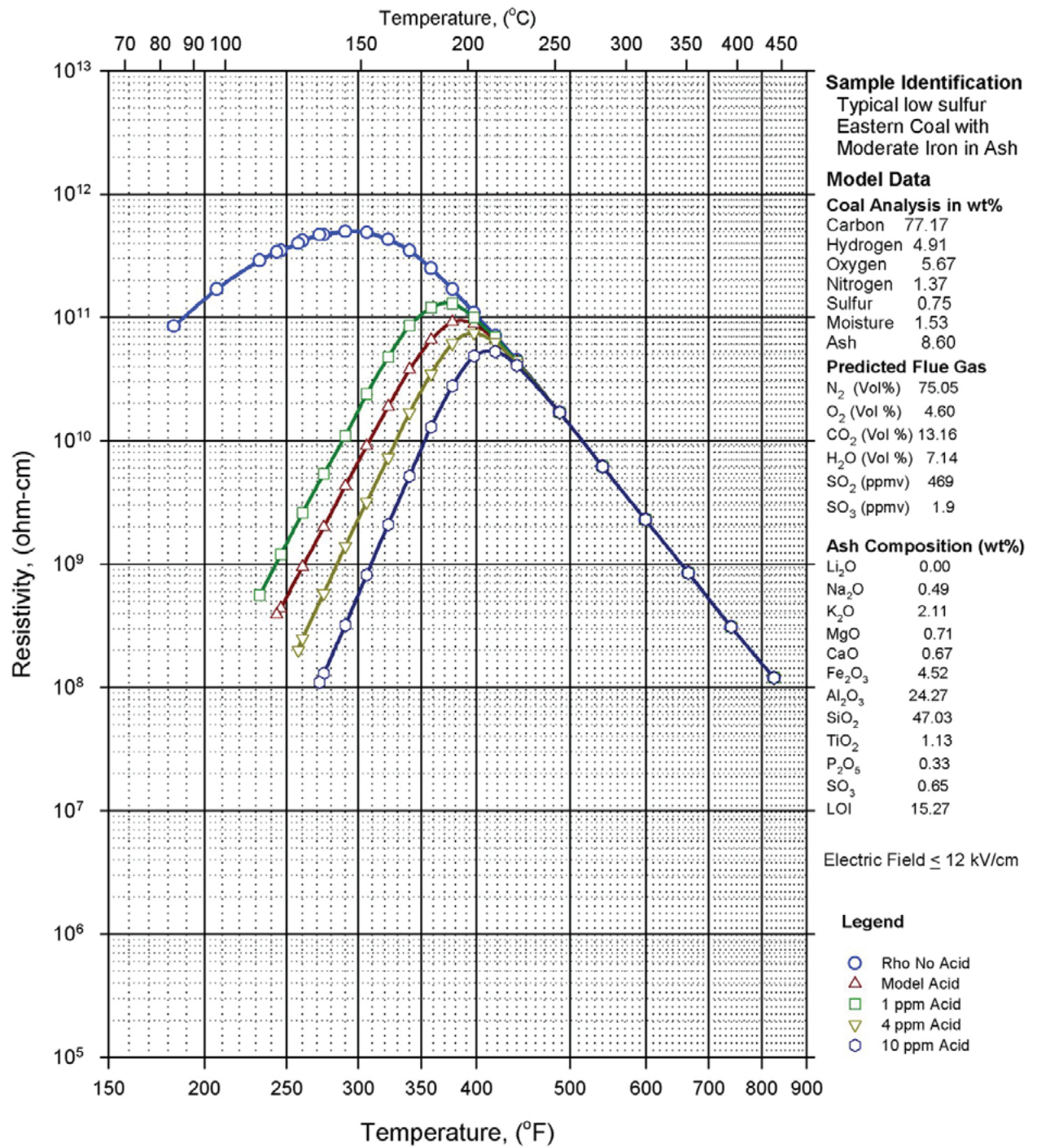


Figure 3: Resistivity Modeled in Accordance with EPA Report 600/7-86-010.

Particle size distribution is determined using the Bahco Micro Particle Classifier or one of several sedimentation techniques. The data are used to compare dusts with respect to electrostatic collectibility based on the amount of material finer than 10 μm and 2 μm . The particle size distribution is also key information needed to model the precipitator performance. Particle size distribution as illustrated in Figure 4, is determined in accordance with ASME Power Test Code 28, Section 4. A sieve analysis had also been performed on the sample. Those data are also shown in Figure 4.

The recommended sample for particulate characterization is a proportionately blended hopper sample representing inlet through outlet hoppers for a given precipitator chamber. Knowing the electrical section and hopper layout and the design or measured efficiency, calculations are made to determine the amount of dust to use from each hopper to reconstitute the original inlet sample. The blended hopper sample is large enough to permit a variety of tests to be conducted. Isokinetically obtained samples, individual hopper samples and samples removed from wires and plates are also useful for specific purposes.

Other available particulate characterization techniques include:

- Chemical analysis
- True particle density
- Scanning electron microscopy
- X-Ray diffraction
- Unique resistivity tests involving collection plate sections or unusual test conditions and procedures.

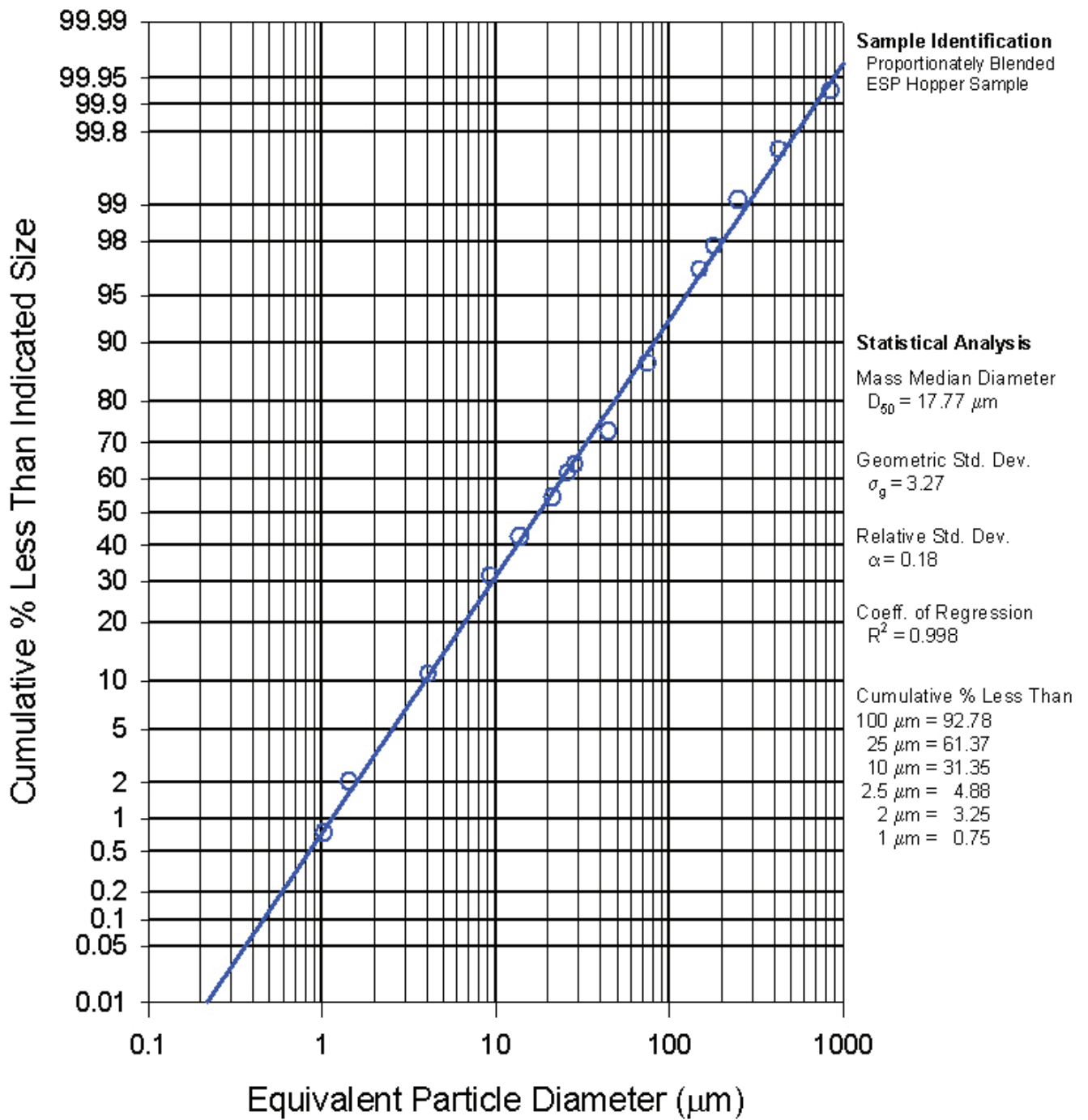


Figure 4: Bahco Particle Size Classification Along with Sieve Data