Explanation of Data Reported by Microtrac Instruments

(Terminology, abbreviations and calculations shown on reports)


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Applications Note

SL-AN-16 Rev B

Provided By:
Microtrac, Inc.
Particle Size Measuring Instrumentation

Microtrac data include many values that are essential to developing particle size distribution specifications and evaluating data. Each of these items is explained as well as changes to be expected. The display provides a quick look at values while actual printed reports and exported data are developed in the "Reports" section. For more detailed information, please refer to the "User's Manual" in the HELP section of Microtrac FLEX software or contact the Microtrac, Inc at 727 – 507 – 9770 in Largo, FL.

PARTICLE SIZE DATA and INFORMATION
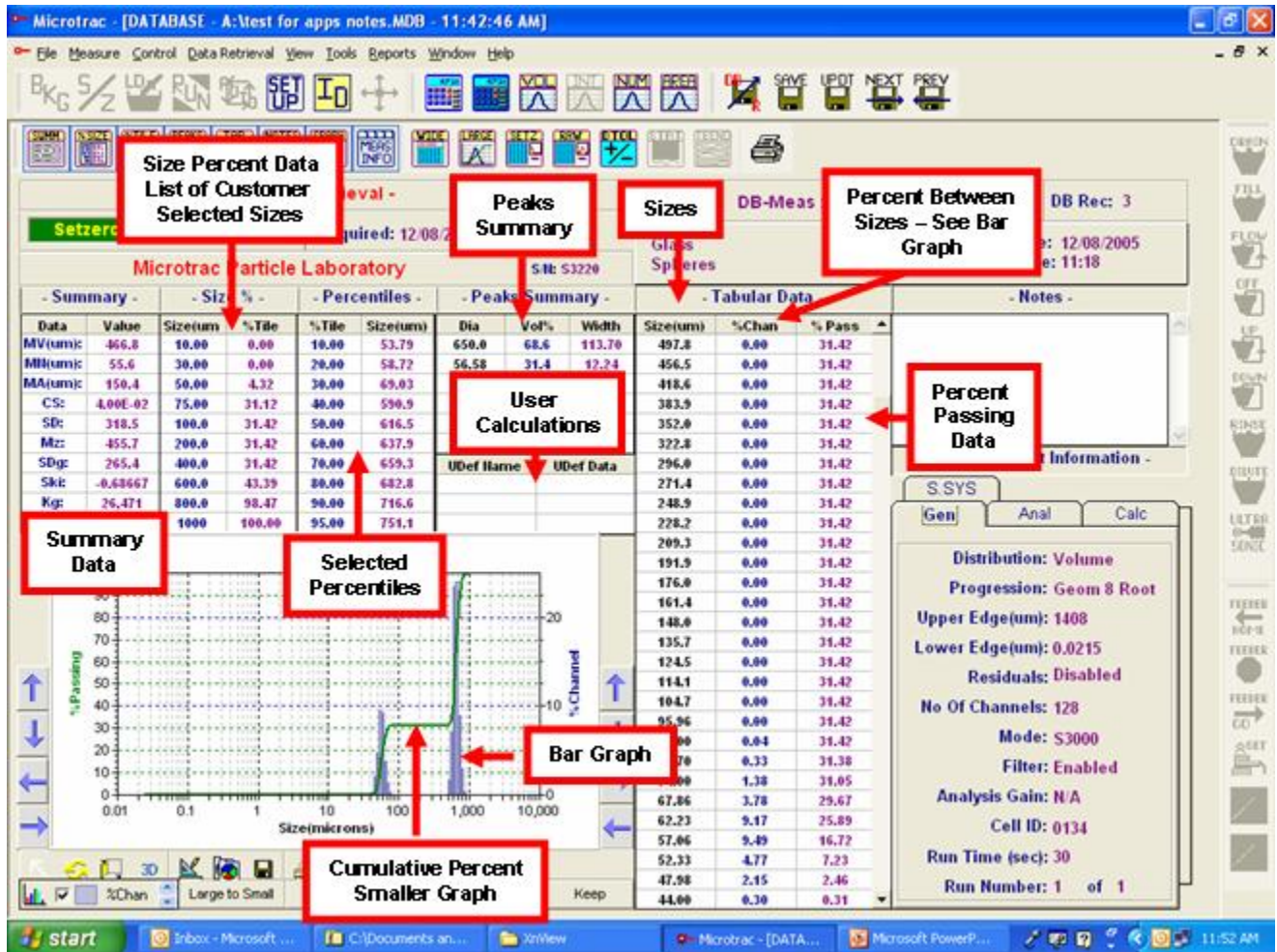
Sizes – The default unit for size is micrometers (microns). The sizes in this table are not customizable and are determined by the optical of the instrument. Customized sizes are selectable in the SETUP portion of the software and are displayed in Size Percent Data

Percentiles – Software selectable Percentile Points in microns, show the percentage of the volume (or weight if the density for all the particles is the same) that is smaller than the size indicated. Percentiles can be shown as percent larger and indicates the volume percent larger than the size shown. The "50 percent point" is the "median diameter" or D50 and represents one type of average particle size.

Summary Data –

MV – Mean diameter in microns of the "volume distribution" represents the center of gravity of the distribution. Mie or modified Mie calculations are used to calculate the distribution. Implementation of the equation used to calculate MV will show it to be weighted (strongly influenced) by a change in the volume amount of large particles in the distribution. It is one type of average particle size or central tendency.

MI – (Nanotrac only) Mean diameter of the intensity distribution. Intensity distribution is not calculated using Mie theory or Modified Mie theory.

Molecular Weight (MW) – A calculation to provide molecular weight (grams/mole). See equation below for details.

MN – Mean diameter, in microns, of the "number distribution" is calculated using the volume distribution data and is weighted to the smaller particles in the distribution. This type of average is related to population or counting of particles.

MA – Mean diameter, in microns, of the "area distribution" is calculated from the volume distribution. This area mean is a type average that is less weighted (also less sensitive) than the MV to changes in the amount of coarse particles in the distribution. It represents information on the distribution of surface area of the particles of the distribution.

CS - Calculated surface – Provided in units of M^2/cc, the value provides an indication of the specific surface area. The CS computation assumes smooth, solid, spherical particles. It may be converted to classical units for SSA of M^2/g by dividing thru value by the density of the particles. It should not be interchanged with BET or other adsorption methods of surface area measurement since CS does not take into effect porosity of particles, adsorption specificity or topographical characteristics of particles.

SD – Standard Deviation in microns, also known as the **Graphic Standard Deviation (σ_g)**, is one measure of the width of the distribution. It is not an indication of variability for multiple measurements. Equation to calculate is: (84% - 16%)/2.

SDg or **Ai – Often known as σ$_i$** - Inclusive Graphic Standard Deviation. Includes more than 90% of the distribution and includes tails of distributions. The SD includes only 67% of the distribution.

SD$_g$ Value	Terminology
0.35	Very well sorted (Very narrow)
0.35 - 0.5	Well sorted
0.50 – 0.710	Moderately well sorted
0.71 – 1.0	Moderately sorted
1.0 – 2.0	Poorly sorted
2.0 – 4.0	Poorly sorted
> 4.0	Extremely poorly sorted (very broad)

K$_G$ - Often known as SKg - Kurtosis (peakedness) of a distribution is taken from sedimentology and uses phi values for calculation. It measures the departure from normality of a curve. Peakedness refers to "how sharp" a peak is. Terms exist to describe the magnitude of kurtosis or how sharp the peak is. Platykurtic (from the Greek meaning "fat") describes a distribution having low kurtosis while leptokurtic (Greek meaning "slim") describes a distribution having high kurtosis. The following describes values for **K$_G$**

K$_G$ Value	Terminology
< 0.67	Very Platykurtic
0.67 – 0.90	Platykurtic
0.90 – 1.11	Mesokurtic
1.11 – 1.50	Leptokurtic
1.50 – 3.00	Very leptokurtic
> 3.00	Extremely leptokurtic

Ski – Inclusive Graphic Skewness – Skewness is a measure of how asymmetrical a curve is and how it varies from a normal, bell-shaped curve. Ski includes 90% of the distribution and includes the "tails" of the distribution. A symmetrical curve has a Ski value of 0.00. Values of 1.00 to 0.30 show fines influencing the skew. Values of -0.30 to -1.00 show coarse particles as influencing the skew.

Mz – Graphic Mean provides a less coarse-particle weighted mean particle size than **MV.** While it includes the median value, it can provide a different and possibly better control value since both small particles and large particles are included in the calculation.

Peaks Summary– Microtrac software automatically provides information on multi-modal distributions. The "Dia", "vol%" and "width" identify individual modes.

Dia – The 50% (D50) of each mode is calculated after determining the minimum and maximum sizes contributing to the specific peak under consideration. For two modes, each will have a separate 50%. When only one mode is present, the **Dia** will equal the 50% of the particle distribution.

Width – Indicates the width of the peak under consideration. For two modes, each will have a calculated width given in microns. When only one mode is present in the distribution, the width = 2 (SD) = 84% - 16%.

Vol – The calculated contribution in percent of each peak to the total volume of the distribution.

RMS Residual – (Root mean square) Microtrac performs calculations to provide particle size distributions. The calculation is completed when software-decided least error is attained. The RMS is presented as percent.

UDEF Name and UDEF Data – Microtrac software allows the user to perform special calculations to suit a customized need. Each calculation is given a name (UDEF Name) by the user. The result is presented as the data (UDF Data).

Percent Passing, Percent Retained and Percent Channel Data

Percentiles - Values are selectable over the range 1% to 99% in 1% increments. They are calculated and then located in the table. Use SETUP command to access selections.

Tabular Data - The measuring range of the instrument is divided into fixed "channel" or particle sizes. Particles sizes are identified on the left column in units of microns or sieve sizes as selected by the operator. Cumulative data values are on the same line as the particle size and are read as "percent smaller (passing) than". The data may also be displayed as "percent larger (retained) than". For data presented as "percent smaller than", volume percent-in-channel (%-CHAN) values are read as volume percent between the particle size on the same line and the line below. For data presented as "percent larger than" or "%RETN", the volume percent between sizes is read as the amount between the size on the same line and the size above.

Example: In the data display shown (percent smaller than), 24.06% of the volume is smaller than 44 microns. The **percent between** adjacent sizes for percent passing format is shown beside the larger size, e.g., 5.19% lies between 44.00 microns and 40.35 microns. When data are presented in the PERCENT RETAINED format, as indicated at the top of the data column, the percent between sizes would be located beside 40.35 microns

Size Percent Data – Operator may enter up to 100 desired particle sizes. Microtrac will calculate the associated volume percentile.

Cumulative Graph – A cumulative graph, with "%PASSING (pass)" or "%RETAINED (Ret)" tabular data are presented as a line graph or in 3-D as selected by the 3D button part of the GRAPH TOOLBAR. Graph may be modified by using scrolling arrows and icons located in the graph area. The values used to produce the graph are those in the tabular data identified as "%Smaller" or "% Larger". The percent point for a specific size may be found by determining the point of intersection of the desired

size and the cumulative curve for any size interest and then determining the volume percent from the vertical axis on the left. See above for information on percentile calculation and display.

Microtrac only presents data within the particle size range of a given model or instrument set-up. Particles larger than or smaller than the instrument measuring range are not included as part of the distribution or other data. For this reason, "percent smaller or larger than data begin with 100% at the largest or smallest size measured in a sample, even though some particles may exist outside the measuring range

Relative Graph (%CH) - When bar graphs are printed or displayed, midpoints of channel sizes are used. Line graphs are automatically developed by connecting the midpoints. Graphical data provide an opportunity to view the distribution at a glance. In the example data display, 5% (using the right axis) of the volume is indicated at approximately 90 microns. Best quantitative data are obtained from the numerical data in the tables. Volume percent in channel data are used to produce the graph.

$$MV = \Sigma V_i d_i / \Sigma V_i \qquad MN = \Sigma(V_i d_i^2) / \Sigma(V_i d_i^3) \qquad MA = \Sigma V_i / \Sigma(V_i / d_i)$$

$$MI = \Sigma I_i d_i / \Sigma I_i \qquad MW = \rho N_A (\pi/6)d^3 \qquad SD = (84\%-16\%)/2$$

$$Width = 84\% - 16\%$$

Where: V = Volume percent between sizes.
d = Size represented by the center between any 2 sizes.
I = Intensity percent between sizes
ρ = Density of the particles

$$Mz = (16\% + 50\% + 84\%) / 3$$

$$SDg = [(84\% - 16\%) / 4] + [(95\% - 5\%) / 6.6]$$

$$Kg = (95\% - 5\%) / [2.44(75\% - 25\%)]$$

$$Ski = \{[16\%+84\%- 2(50\%)] \ / \ 2(84\%-16\%)\} + \{[5\% +95\%- 2(50\%)] / \ 2(95\%-5\%)\}$$