ADVANCED MATERIALS HANDLING

Estimating Molecular Weight

Nicomp

OVERVIEW

It is possible to use the Nicomp to estimate the average molecular weight, MW, of particles or macromolecules suspended in solution. The word "estimate" is emphasized because of the fact that the measurement of molecular weight using the technique of dynamic light scattering (DLS) is not as accurate as the determination of particle size, for which all DLS-based instruments are primarily designed.

INTRODUCTION

The fundamental quantity measured in a DLS-based instrument is the particle diffusivity, or diffusion coefficient, D. There is a simple empirical formula that can be used to relate the MW of a suspended particle (or macromolecule) to D:

 $D = \alpha MW^{-\beta}$(Equation 1)

The pre-factor constant, α , is related to the specific composition of both the diffusing particles and the surrounding solvent. The pre-factor depends on the temperature, T, and solvent viscosity, n, as well as the mass density of the particles. Constant ß in the exponent is related to the shape/configuration of the particles and macromolecules (which may also be a function of particle and solvent composition, as in the case of polymers). Exponent ß depends on the relationship between the hydrodynamic radius and the MW for simple spheres, ß equals 1/3.

From Equation 1, a simple, general expression for the MW, as a function of D is shown in Equation 2:

 $MW = (\alpha/D)^{1/\beta}$ (Equation 2)

In the Nicomp (Figure 1), MW is computed from Equation 2 using the mean D (intensity-weighted) obtained from the simple Gaussian Analysis. Values for α and β are entered in the Control Menu shown in Figure 2.



Figure 1. Nicomp DLS system

| 380 Control Menu | | | × | |
|---|--|----------------------------------|---|--|
| Menu File: C:\Particle Sizi Channel Width Temperature Liquid Viscosity Liquid Index of Refraction Intensity Setpoint First Channel Used | ng Systems 12 23 0.933 1.333 300 2 | CPW38 CP CP KHz deg. | 88-V2.17\zpw388.tbl Autodilution/Drop-In | |
| Laser Wavelength External Fiber Angle Scattering Angle Print Molecular Weight Alpha Beta | 658 90 90 1 0.5 | | Cum. % Set Pt. 80 % Autodilution ND position 100 OK Cancel | |

Figure 2. Nicomp control menu

In order to obtain reliable estimates of the mean MW of the particles, reliable estimates of constants α and β must be available. Values for a few representative polymer/solvent systems are listed in Table 1.

| Polymer | Solvent | т | α | β |
|-----------------------------|------------------|------|-------------------------|------|
| Polyacrylamide | Water | 20°C | 8.46 × 10 ⁻⁴ | 0.69 |
| Polyacrylonitrile | DMF | 25°C | 3.2×10^{-4} | 0.63 |
| Polyacrylonitrile | DMF | 35°C | 2.19 × 10 ⁻⁴ | 0.58 |
| Polyvinyl acetate | MEK | 20°C | 7.8×10^{-4} | 0.63 |
| Polystyrene | MEK | 25°C | 3.1 × 10 ⁻⁴ | 0.53 |
| Polyisoprene chloroform | МЕК | 20°C | 3.5×10^{-4} | 0.42 |
| Poly methyl methacrylate | Ethyl acetate | 20°C | 1.61 × 10 ⁻⁴ | 0.48 |
| Polyvinyl alcohol | Water | 20°C | 5.5×10^{-10} | 0.68 |

Table 1. α and β for the particle/solvent systems



SAMPLE RESULT

Immunoglobulin G (IgG) lyophilized powder (Athens-Research) was prepared at 1% weight percent by dissolving in PBS buffer and then diluting to 10 mg/mL. The particle size and molecular weight estimate analysis was performed using the conditions shown in Figure 3.

The sample was analyzed seven times; Control Menu settings and the final result showing both particle size and MW results are shown in Figure 4.

The expected MW value for IgG is 145 kDa or 1.45e5 in Daltons, the units shown in Figure 4. The value is slightly higher than the reference value, probably due to aggregation and/or non-expert sample preparation.

CONCLUSIONS

The Nicomp DLS system is primarily a particle size and zeta potential analyzer. Better and more preferred techniques are available to determine the MW of polymers and proteins, but an estimated value can be calculated using the approach described in this document.

| Auto Print/Save Menu | × |
|---|------------|
| Menu File: C:\Particle Sizing Systems\ZPW388-V2.18\zpw388.tbl | |
| Data Directory: C:\Users\Mark\Documents\2017 DLS\Mark Feb 8 DLS Dat File Name: zrs sy d2.3 | ta\ Browse |
| Automatic Temperature Sequencing # Automatic Temperature Sequences | |
| Auto Titration for each Run | |
| Printout ID: IgG 10 mg/mL | |
| Auto Operation Options No. Print/Save Cycles 2 © Using Run Time 2 min | |
| Using Fit Error; < 1.2 | |
| Clear Autocorrelator | |
| Print Result; Printout Option | |
| Automatic Choice of Distrib. (Gauss vs NICOMP) | ОК |
| ✓ Store Data on Disk ✓ Overwrite Old File ✓ Save Data Log | Cancel |

Figure 3. Auto print/save menu

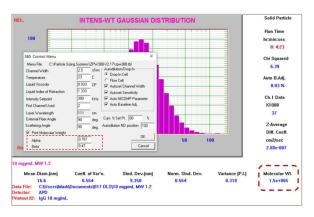


Figure 4. Size and MW results for IgG

FOR MORE INFORMATION

Please call your Regional Customer Service Center today to learn what Entegris can do for you. Visit <u>entegris.com</u> and select the <u>Contact Us</u> link to find the customer service center nearest you.

TERMS AND CONDITIONS OF SALE

All purchases are subject to Entegris' Terms and Conditions of Sale. To view and print this information, visit <u>entegris.com</u> and select the <u>Terms & Conditions</u> link in the footer.



Corporate Headquarters 129 Concord Road Billerica, MA 01821 USA Customer Service Tel +1 952 556 4181 Fax +1 952 556 8022 Toll Free 800 394 4083

Entegris[®], the Entegris Rings Design[®], and other product names are trademarks of Entegris, Inc. as listed on <u>entegris.com/trademarks</u>. All third-party product names, logos, and company names are trademarks or registered trademarks of their respective owners. Use of them does not imply any affiliation, sponsorship, or endorsement by the trademark owner.

©2018-2019 Entegris, Inc. | All rights reserved. | Printed in the USA | 7130-10579TAN-0719