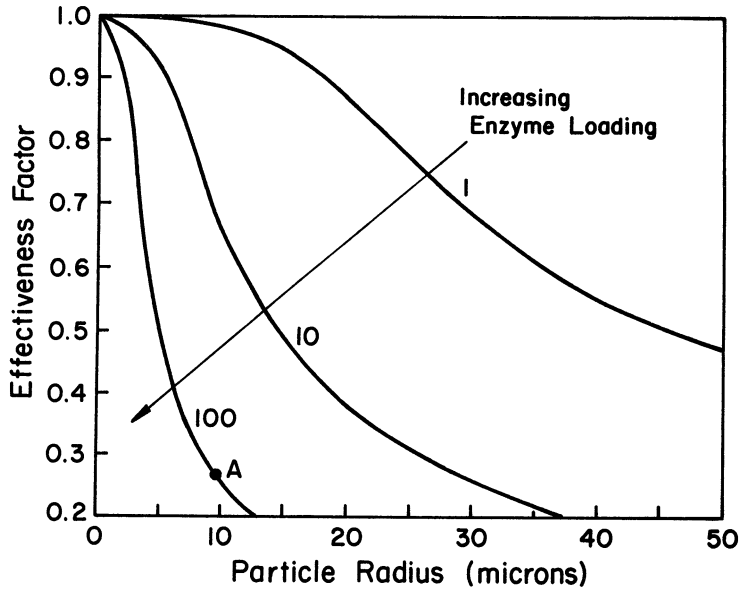

Figure 3.21. The effectiveness factor decreases with increases in enzyme loading or with increases in particle diameter. Point A represents the value of the effectiveness factor for a particle radius of 10 μm with an enzyme loading of 100 mg/cm^3, an enzyme activity of 100 μmol/min per mg enzyme, a substrate diffusivity of 5×10^{-6} cm^2/s, and a bulk substrate concentration tenfold higher than K_m.

When designing immobilized enzyme systems using a particular support, the main variables are V_m and R, since the substrate concentration, K_m, and D_e are fixed. The particle size (R) should be as small as possible within the constraints of particle integrity, resistance to compression, and the nature of the particle recovery systems. The maximum reaction rate is determined by enzyme activity and concentration in the support. High enzyme content will result in high enzyme activity per unit of reaction volume but low effectiveness factor. On the other hand, low enzyme content will result in lower enzyme activity per unit volume but a high effectiveness factor. For maximum conversion rates, particle size should be small ($D_p \leq 10$ μm) and enzyme loading should be optimized. As depicted in the example in Fig. 3.21, $D_p \leq 10$ μm and enzyme loadings of less than 10 mg/cm^3 are required for high values of the effectiveness factor ($\eta \geq 0.8$).

Example 3.5

D. Thornton and co-workers studied the hydrolysis of sucrose at pH = 4.5 and 25°C using crude invertase obtained from baker's yeast in free and immobilized form. The following initial velocity data were obtained with 408 units of crude enzyme (1 unit = quantity of enzyme hydrolyzing 1 μmol of sucrose/min when incubated with 0.29 *M* sucrose in a buffer at pH 4.5 and 25°C).