CHAPTER VI

USEFUL QUANTITATIVE INDICES IN BINARY ADDITIVE SYSTEMS

From chapter V, it can be concluded that the normalized count-based and/or area-based fractal dimensions are suitable quantitative indexes for the evaluation of the dispersion state of additives in binary systems, both random and ordered mixtures. In addition, their values are not influenced by the particle size ratio.

The purpose here is to propose a systematic evaluation scheme on how the normalized count-based and area-based fractal dimensions are applied to evaluate the degree of dispersion and adhesion probability in binary additive systems. For simplicity, the less numerous and bigger particles will be called "core particles", "key component" or simply A particles, while the more numerous and smaller particles will be called "adhering particles" or B particles. An arbitrary binary component system is assumed to have of a given particle B : A concentration ratio and a known size ratio. The proposed evaluation procedure is shown in Figure 6.1 as follows:

1. First focus on the A particles and determine the normalized count-based or area-based fractal dimension for only A particles.
   1.1 If A particles essentially follow an ideal uniform random dispersion [$(F_C^*)_A \approx 1$ or $(F_A^*)_A \approx 1$], next determine the normalized count-based fractal dimension for B particles only, $(F_C^*)_B$. Proceed to 2.1.
   1.2 If A particles follow an ideal normal random dispersion, next determine the normalized area-based fractal dimension for B particles, $(F_A^*)_B$. Proceed to 2.2.
   1.3 If A particles follow neither an ideal uniform nor normal random dispersion, i.e. A follows a nonideal dispersion, next determine the normalized count-based fractal dimension for B particles only, $(F_C^*)_B$. Proceed to 2.3.

2. Depending on whether 1.1, 1.2 or 1.3 is true, proceed to 2.1, 2.2 or 2.3, respectively.

   2.1 Since the A particles have been found to follow a uniform random dispersion, the next question is whether the B particles follows an ideal dispersion (either uniform or normal random) or a nonideal dispersion. In the former case, Figure 6.2 and the value of $(F_C^*)_B$ can be used to estimate the adhesion probability of B on A. The figure should be applicable if B follows an approximate ideal uniform or normal dispersion.

   Otherwise, it is not possible yet to make a reliable estimate of the adhesion probability. Next proceed to 3.1.

   2.2 Since the A particles have been found to follow an ideal normal random dispersion, the next question is whether the B particles follow an ideal or nonideal dispersion. In the former case, Figure 6.3 and the value of $(F_A^*)_B$ can be used to estimate the adhesion probability of B on A. The figure should be applicable if B follows approximately an ideal uniform or normal dispersion.

   Otherwise, it is not possible yet to make a reliable of the adhesion probability. Next proceed to 3.2.

   2.3 Though the A particles follow a nonideal dispersion, Figure 6.4 can be used to characterize the nonideality of A by considering that a certain percentage of A follows the ideal normal dispersion while the rest of A follows the ideal uniform dispersion.

   In any case, it is not possible yet to estimate the adhesion probability of B onto A. Next proceed to 3.3.

3. Next determine the average coordination number of B with respect to A. From this value and the B : A concentration ratio, estimate the adhesion probability of B on A, $\propto_{BA}$.

   3.1 If an estimate of $\propto_{BA}$ has been found in 2.1, double check it with the estimate obtained from the average coordination number. If not, $\propto_{BA}$ has to be estimated from the average coordination number.

   3.2 This case is the same as 3.1.

   3.3 $\propto_{BA}$ can only be estimated from the average coordination number.

4. If the adhesion probability $\propto_{BA}$ is zero or close to zero, the binary system is essentially a random mixture of A and B. In this case the dispersion of A and of B may be investigated separately as in the case of the single component systems, no matter if it is an ideal or nonideal mixture.

   If $\propto_{BA}$ is 100% or close to it, the system is a fully ordered mixture, i.e. essentially all B particles adhere onto A. This situation is often desirable for a functional (composite) material.

   In reality, some B particles will adhere onto A and the rest are dispersed randomly in the matrix without adhering onto A while B particles themselves may form clusters or agglomerates. The average coordination number is proportional to the adhesion probability, which is the result of the kneading or compounding operation and cannot be known a priori. The above procedure enables us to estimate the value of $\propto_{BA}$ from the fractal dimensions of A and of B in certain cases without having to determine also the average coordination number.

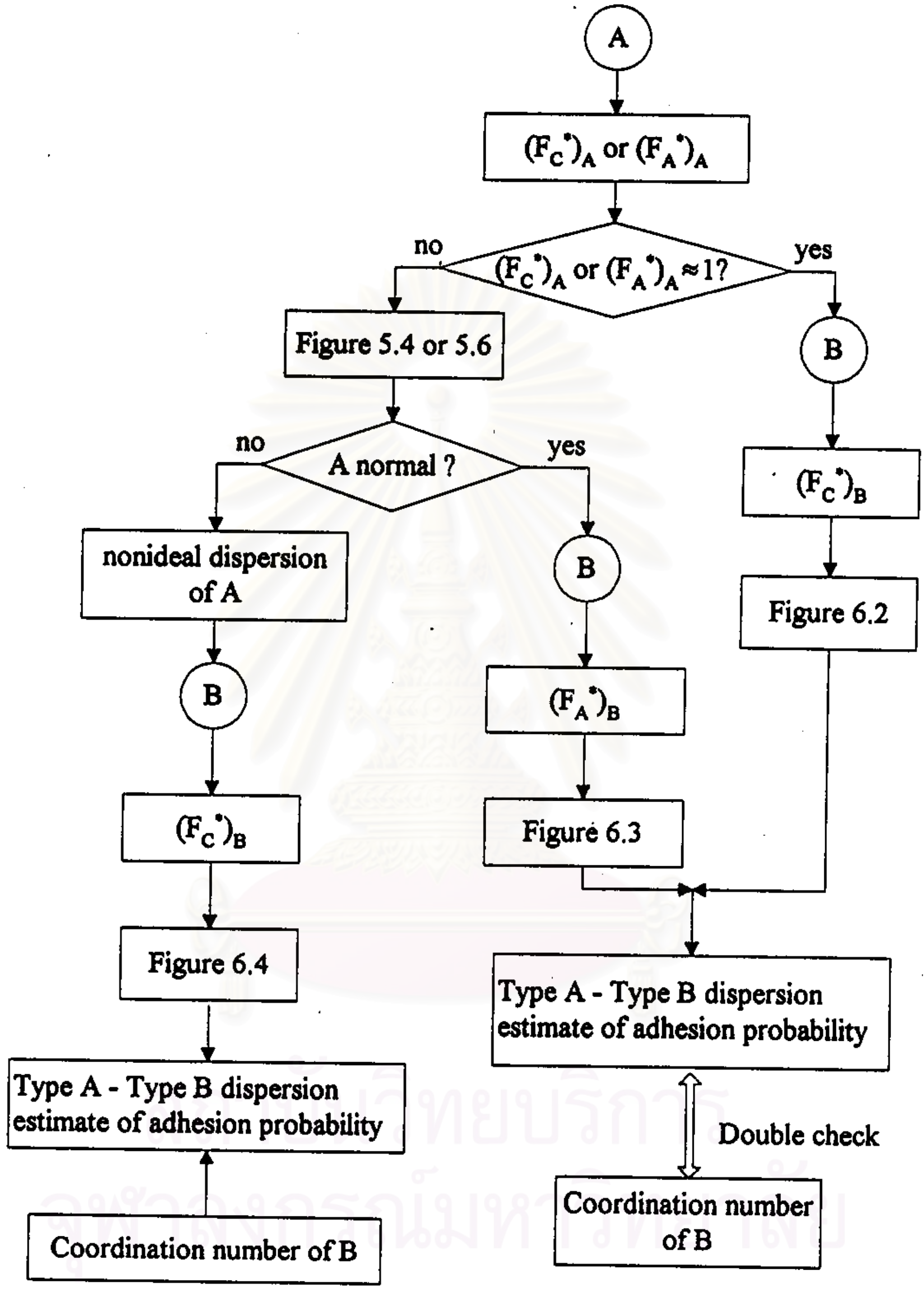

Figure 6.1 Procedure of investigation the dispersion of binary addtive systems.

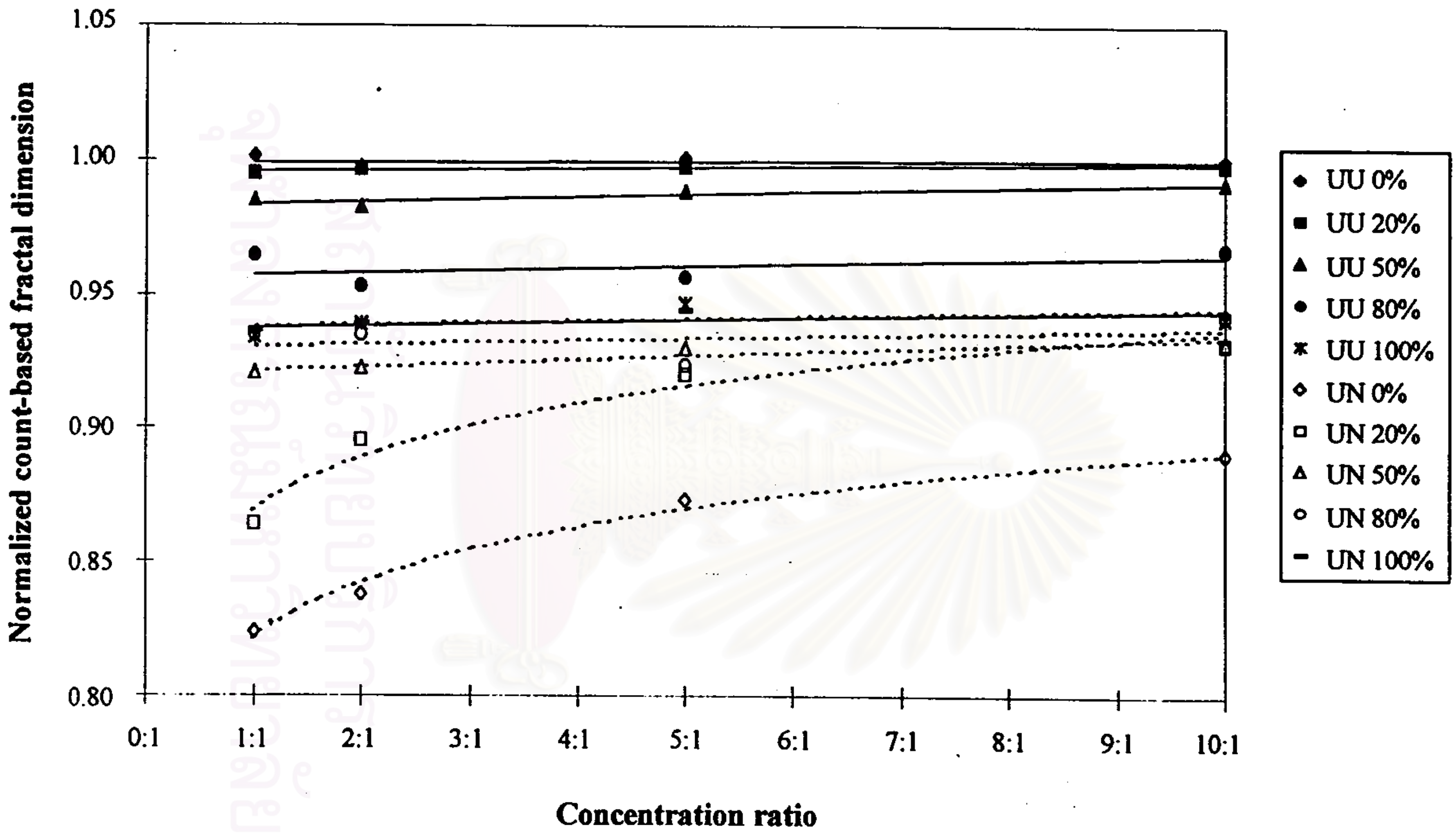

Figure 6.2 Relationship between concentration ratio and normalized count-based fractal dimension of B particles in the case of uniform - uniform dispersion and uniform - normal dispersion .

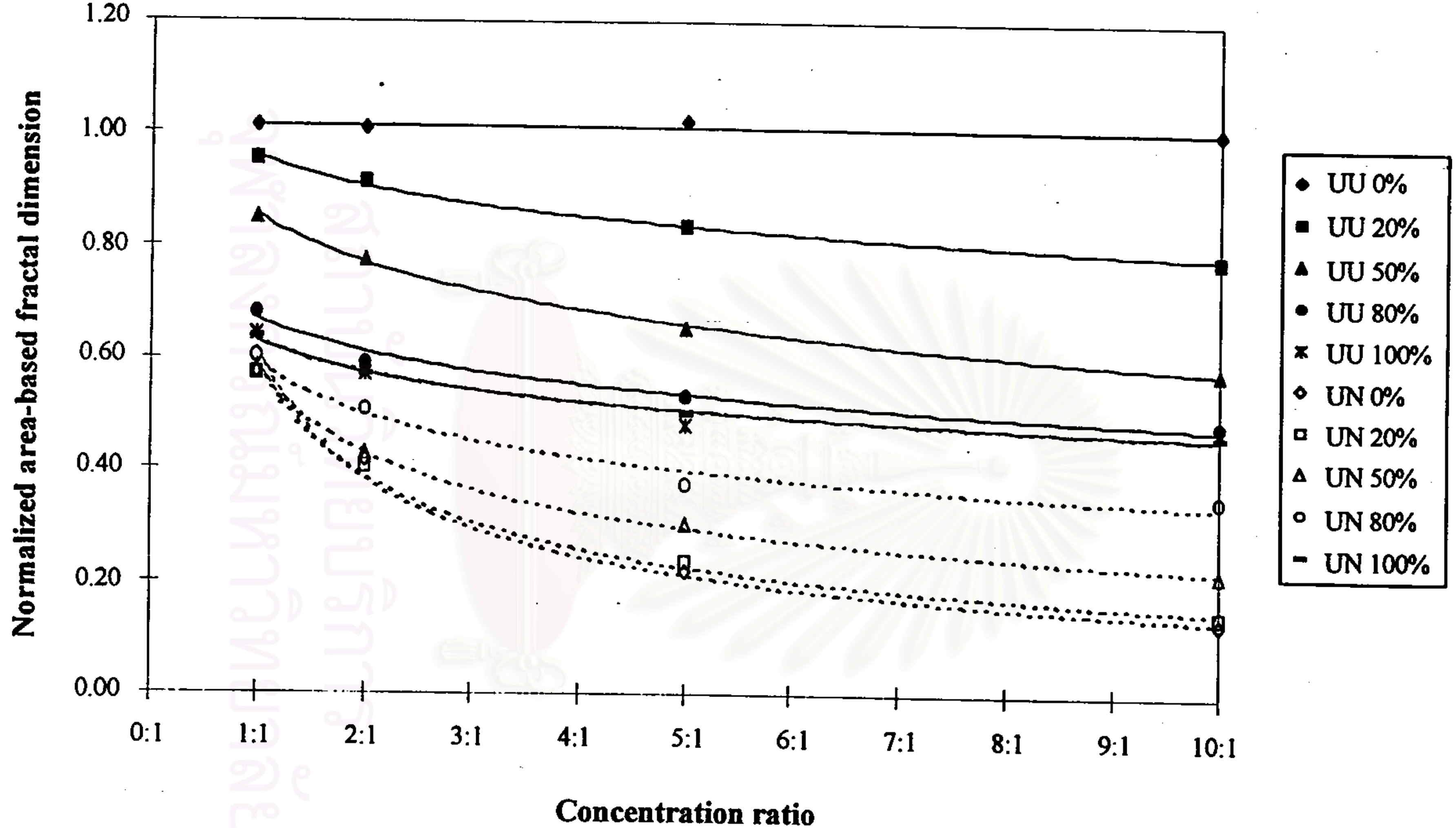

Figure 6.3 Relationship between concentration ratio and normalized area-based fractal dimension of B particles in the case of normal - uniform dispersion and normal - normal dispersion.

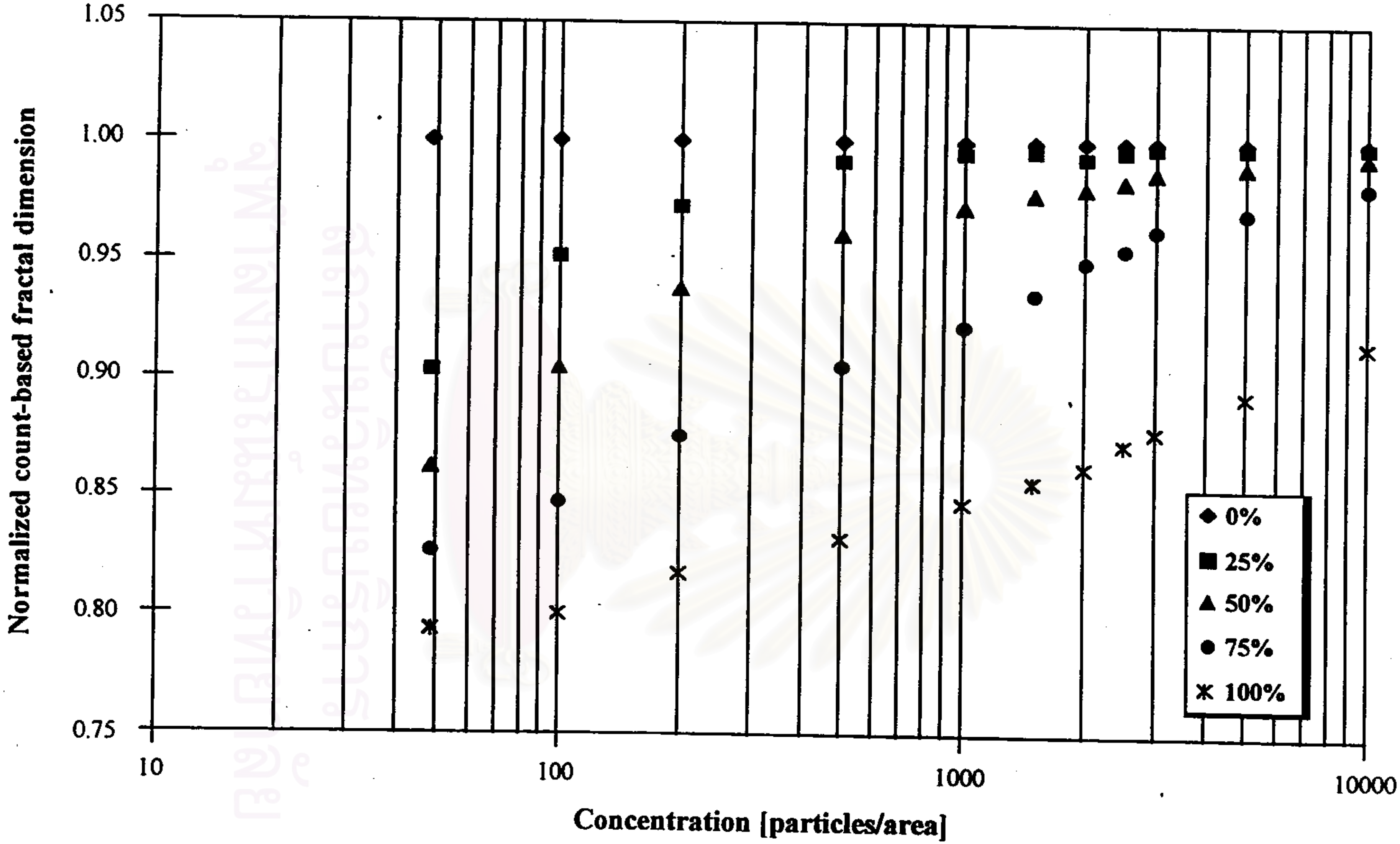

Figure 6.4 Relationship between the total concentration and normalized count-based fractal dimension at each N-U ratio.