UNSTEADY SETTLEMENT TEST AND NUMERICAL CALCULATION OF ACTIVATED CARBON PARTICLES IN STATIC WATER

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INTRODUCTION

In the sewage treatment technology using powdered activated carbon (PAC), the settling velocity of activated carbon in static water is an important parameter. Based on the process and results of the static water settlement test of powdered activated carbon and combining the physical properties of powdered activated carbon, it was found that the powdered activated carbon does not settle in the static water simply as a single particle, but settles in the form of flocs due to effect of flocculation. Activated carbon flocs are accompanied with flocculation and diffusion when settling, and the change of the intensity of flocculation and diffusion results in the change of the equivalent size of flocs with time, thus affecting the settling characteristics of flocs. Therefore, the hypothesis of "flocculation-diffusion" is put forward when activated carbon particles settle, and the fitting formulas of activated carbon flocs equivalent particle size changed with time are given according to experimental data. Based on BBO equation of unsteady particle movement, the settling process of activated carbon particles in static water is numerically simulated. The calculated results are in good agreement with the experimental values.

SETTLEMENT TEST

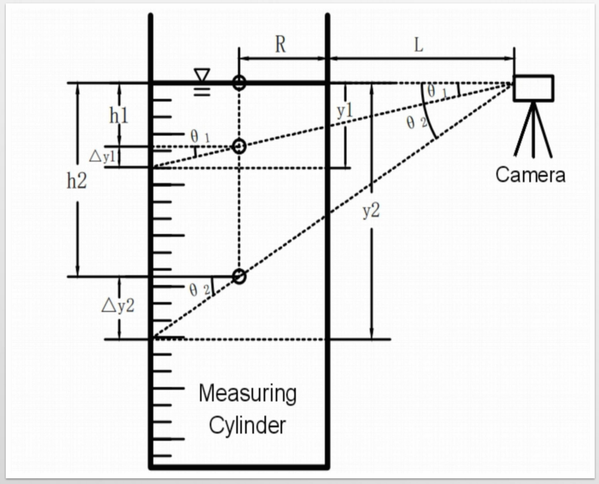


Figure 1. Schematic diagram of experimental device.

MATHEMATICAL MODEL

☛ **BBO Equation of Particle Transient Movement**

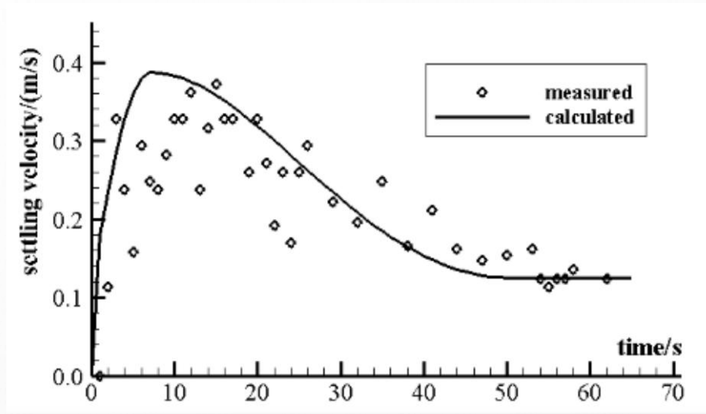
$$\frac{\pi}{6}D^3\rho_s\frac{du_p}{dt}=\frac{\pi}{6}D^3(\rho_s-\rho_f)f+c_1 3\pi\mu D(u-u_p)+\frac{\pi}{6}D^3\rho_f\frac{Du}{Dt}+\Delta_A\frac{\pi}{6}D^3\rho_f\frac{d(u-u_p)}{dt}$$
$$+\Delta_H\left(\frac{D}{2}\right)^2\sqrt{2\pi\rho_f\mu}\int_0^t\frac{d(u-u_p)/d\tau}{\sqrt{t-\tau}}d\tau+C_{LS}k_s\mu D^2\left(\frac{\xi}{\nu}\right)^{0.5}(v-v_p)$$

☛ **Flocculation-diffusion Model of Equivalent Particle Size**

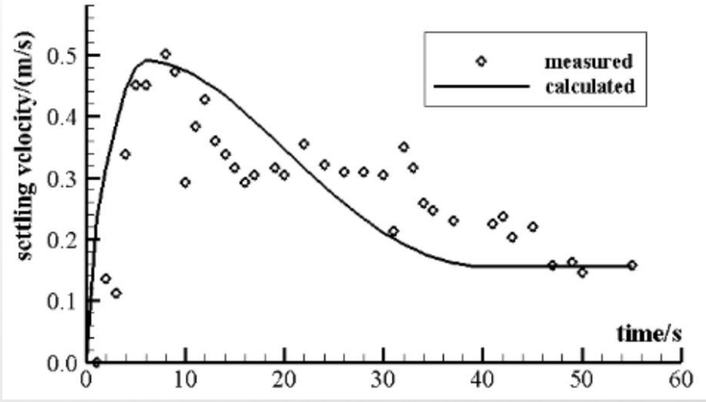
$$D_1(T)=\begin{cases}-(1.34898\times10^{-6})T^2+(1.888572\times10^{-5})T+8.50\times10^{-5}, & 0<T\le7\\ (1.63885\times10^{-9})T^3-(1.40122\times10^{-7})T^2+(1.72079\times10^{-6})T & \\ +1.45358\times10^{-4}, & 7<T\le50\\ 8.595\times10^{-5}, & T>50\end{cases}$$

$$D_2(T)=\begin{cases}-(1.13889\times10^{-6})T^2+(1.36667\times10^{-5})T+5.10\times10^{-5}, & 0<T\le6\\ (2.04305\times10^{-9})T^3-(1.4097\times10^{-7})T^2+(1.471\times10^{-6})T & \\ +8.78077\times10^{-5}, & 6<T\le40\\ 5.185\times10^{-5}, & T>40\end{cases}$$

TEST AND NUMERICAL RESULTS



(a)Activated carbon without adsorbing pollutants



(b)Activated carbon adsorbing pollutants

Figure 2. Curves of settling velocity of two kinds of activated carbon flocs with unsteady particle size

CONCLUSION

☛ The powdered activated carbon is not a simple single particle settling in static water, but settling in the form of flocs due to flocculation. And the particle size of the flocs can change with time due to diffusion.

☛ A flocculation-diffusion model with time-dependent equivalent particle size of activated carbon was proposed in this paper. Based on the experimental data, the empirical formula of the equivalent particle size of activated carbon particle flocs with time evolution is fitted.

☛ The calculated results of the unsteady settlement process of activated carbon particle group in static water based on the BBO equation are in good agreement with the experimental data, indicating that the "flocculation-diffusion" model and numerical calculation method can well simulate the settlement characteristic of activated carbon particle groups in static water.