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Effects of explosive explosion shockwave pretreatment on sludge dewaterability

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HIGHLIGHTS

- ▶ Explosive explosion shockwave can improve sludge dewaterability.
- ▶ The viscosity and particle size have an important role on sludge dewaterability.
- ▶ Increasing explosive dosages will increase sludge turbidity.
- ▶ High explosive dosage is less effective for the reduction of particle size.

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ABSTRACT

The potential benefits and mechanism of explosive explosion shockwave pretreatment on sludge dewatering treatments were investigated in this study. Water content of sludge cake after centrifugation was used to evaluate sludge dewaterability. Particle size, viscosity, turbidity, and micrograph were determined to explain the observed changes in the pretreatment process. The results indicated that the optimal pretreatment condition, generating the lowest water content of sludge cake, was 25 g explosive and 96.7% original sludge water content. This condition resulted in the reduced particle size and viscosity as well as increased turbidity. Particle size and viscosity significantly contributed to enhance sludge dewaterability. Micrograph investigation indicated that explosive explosion shockwave pretreatment could rupture sludge flocs, release physically bound water, and extracellular substances into the solution, consequently enhancing sludge dewaterability.

1. Introduction

Activated sludge technology is a widely used biological method for wastewater (especially municipal wastewater) treatment, but large quantities of waste-activated sludge are produced in the process (Zhang et al., 2010). A common characteristic of different types of sludge is the very high water content, the colloidal and compressible nature of the sludge (Mahmoud et al., 2011). This excessive water increases the volume and the cost to transport the sludge to the final disposal site. These problems can be remedied by sludge dewatering because this process reduces the sludge volume. Dewatered sludge is also generally much easier to handle. However, sludge dewatering remains the most expensive and most poorly understood wastewater treatment process (Bruus et al., 1992).

Dewatering is generally performed by physical means with mechanical methods, such as vacuum filtration, belt filter presses, drying beds, and centrifugation. The addition of polyelectrolyte to sludge is presently the most widely used pretreatment in wastewater treatment plants (WWTP) to improve mechanical dewatering (Feng et al., 2009). The sludge, regardless of the conditioning, maintains a gel-like structure and extremely high compressibility, rendering dewatering a quite challenging process (Citeau et al., 2011). The use, especially the over dosage, of polymers may cause various environmental problems in the supernatant of water generated during the sludge dewatering process. The residual polymers in dewatered sludge cakes may pose long-term risk to the surrounding environment, especially when the sludge cakes are subject to landfill as the final disposal, which is very expensive (Van der Roest et al., 1999).

Thus, various alternative methods have been proposed to improve the sludge dewatering characteristics, including the addition of Fenton's reagent pretreatment (Tony et al., 2008), ultrasonication (Na et al., 2007; Li et al., 2009; Feng et al., 2009), ultra-rapid freezing (Parker and Collins, 1999), electrolysis-pretreatment (Yuan et al., 2011), hydrogen peroxide (Neyens et al., 2004), and fry-drying (Ohm et al., 2009), as well as applications of dry ice (Jean et al., 2001), seawater and brine (Liu et al., 2011), acid (Delin et al., 2011) and fungi (Ahmadun and Abul, 2007). Explosions result from the almost instantaneous conversion of a solid or liquid into gas after detonation of an explosive material. Detonation gas

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