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Cement & Concrete Composites 28 (2006) 90–96

Cement & Concrete Composites

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Methodology for flocculant selection in fibre–cement manufacture

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Received 10 May 2005; accepted 12 July 2005
Available online 16 September 2005

Abstract

In the Hatschek process used to produce fibre–cement products, it is necessary to use a suitable flocculant when asbestos is substituted by pulp fibres. The right selection of flocculant is crucial in the industrial process due to its effects on mineral fines retention, dewatering and formation and, as a consequence, on the overall efficiency of the machine. This paper presents a two-step methodology for flocculant selection in the fibre–cement manufacture. The first step is based on the study of the flocculation processes and the flock properties, using a focused beam reflectance measurement (FBRM). This technique allows the study of flock size, flock stability and flock resistance to shear forces, reflocculation tendency and reversibility of the flocks, as well as the optimal flocculant dosage for each particular fibre–cement suspension. The second step uses a drainage vacuum tester to study retention and dewatering. The two techniques give important and complementary informations that allow a proper selection of the best flocculant for the fibre–cement manufacture.

Keywords: Hatschek process; Flocculation; Fibre–cement; Retention; Dewatering; Delamination; Construction; Building materials; FBRM

1. Introduction

Over the last few years, many research studies related to the substitution of asbestos for others raw materials have been published [1,2]. These mainly focus on natural cellulose fibres (from wood or non-wood raw materials) [3–12] and synthetic fibres [1,2,13,14], alone or as a mixture. Out of all these sources the softwood unbleached Kraft fibres are the most widely used due to their strength characteristics, the high availability and the price.

Asbestos is a naturally occurring fibrous silicate and the fibre's size together with its chemical structure, make asbestos very compatible with cement. However, the different chemical composition and hygroscopic character of pulp fibres make the compatibility between cellulose fibres and cement much more complex and, therefore, new aspects are needed to be considered. In the Hatschek process, the behaviour of these fibres is different and therefore, a suitable flocculant is needed when using pulp fibres. The right selection of flocculant is crucial in the industrial process due to its effect on mineral fines retention, dewatering and formation and, as a consequence, on the overall efficiency of the machine. Most work in this field has been carried out at mill sites and no public information is available in the literature. This paper addresses this issue, providing a methodology for optimal flocculant selection.

In the literature, the main methods to monitor the flocculation process of the fibre suspension are described. These methods are mainly based on electrokinetic properties like colloidal titration, cationic demand and zeta potential [15]. All these methods are difficult to apply to fibre–cement suspensions because of the high abrasion power of the solids, the colour of the suspensions and the high solid concentration in the

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0958-9465/$ - see front matter © 2005 Published by Elsevier Ltd.
doi:10.1016/j.cemconcomp.2005.07.003

suspensions. An indirect method for studying flocculation is based upon sedimentation tests after flocculant dosage has been added to the suspension. However, this method gives limited information about the flocculation process in the fibre–cement suspensions.

A different approach is based on monitoring the size distribution of the particles in the suspensions before and after adding the flocculant dosage. The change in both the average size and the size distribution of the particles in the suspension represents the flocculation process independently of the mechanism that takes place. The authors were pioneers in proposing this technique for the paper industry in 1996 [16–19]. This method allows to follow the flocculation process in real time, giving detailed important information such as type of flock, flock strength, the kinetics of the flocculation process, reversibility of flocks, influences of process conditions on flocculation like shear forces and temperature. Therefore, this method is appropriate to monitor the flocculation processes of a fibre–cement suspension, and this is the methodology developed in this paper.

On the other hand, in the literature several laboratory test procedures are described to predict the performance of chemicals for enhancing retention or dewatering for the manufacturing process [20]. For the fibre–cement suspensions, the most suitable method is the vacuum drainage tester (VDT). This allows to dewater the suspensions using a machine botting cloth, in order to simulate the retention on the vat, or a machine felt, in order to simulate the dewatering process once the different layers have been formed into the final sheet on the Hatschek machine. Consequently, it is also possible to determine the final water content of the sheet [21–23].

2. Materials and method

The methodology is a two-step process based on measuring flocculation, retention and drainage. First a FBRM probe is used to monitor the flocculation process and then, a vacuum drainage tester is used to study the retention and the dewatering processes.

The methodology to monitor flocculation is based on using a focused beam reflectance measurement system FBRM M500LF manufactured by Lasentec. The focused beam reflectance measurement offers the possibility of particle characterization in a wide concentration range. The FBRM instrument operates by scanning a highly focused laser beam, at a fixed speed, across the particles in the suspension and measuring the time duration of the reflected light from these particles (Fig. 1). The temporal duration of the reflection from each particle or flock multiplied by the velocity of the scanning laser, which is known, results in a characteristic measurement of the particle known as the chord length (Fig. 2). Thousands of chord length measurements are collected per second, producing a histogram in which the number of the observed counts is sorted in several chord length bins over the range of 0.2–2000 μm. From the data, total counts, counts in specific size regions (population), mean chord length, and other statistical parameters can be easily calculated. The evolution of these various statistics under varying process conditions allows us to interpret the evolution of the flocculation process [24].

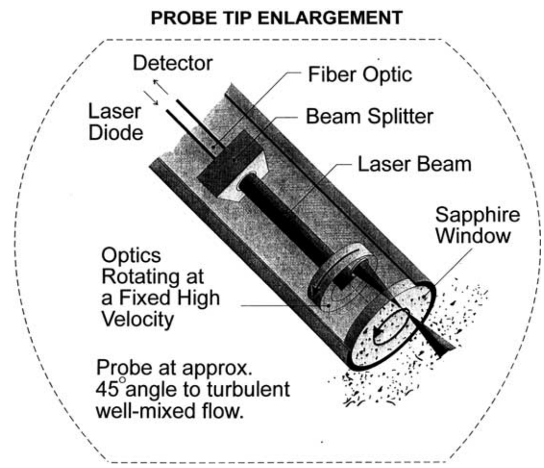

Fig. 1. FBRM probe.

The second step in the methodology consists in retention and drainage studies. The equipment used for measuring retention and drainage was a vacuum drainage tester (VDT) supplied by Nalco. Fig. 3 shows a scheme of the lab device, it has two jars separated by a barrier: the upper jar is used to keep the fibre–cement suspensions stirred until the addition of the flocculant dosage. After the necessary contact time the barrier is removed and the suspension is drained to the second jar in which a filter is located. In this case two types of filters were used: a botting cloth (18 mesh) and a machine felt (mixed felt with a permeability to the air of 120 c.f.s.) in order to simulate the dewatering in the vat and in the upper part of the Hatschek machine. In this device

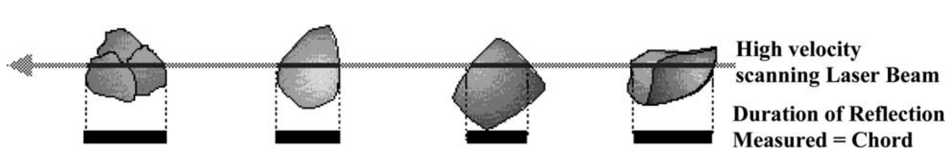

Fig. 2. Examples of particle chord length measurements.