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CONFERENCE ARTICLE

Synthesis Of Highly Effective Plasticizing Admixtures From Pyrolysis Oil For Improving The Properties Of Cement Composites

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ABSTRACT

This study investigates the hydration and mechanical properties of ordinary Portland cement pastes containing a superplasticizer synthesized from pyrolysis oil. The admixture is a naphthalene sulfonate–formaldehyde (NSF) condensate. Cement pastes were prepared with different superplasticizer dosages and cured for specified periods under controlled conditions. The results show that the synthesized NSF admixture improves the mechanical performance of the cement paste and reduces water demand. The NSF-based admixture also performs better than a sodium lignosulfonate-based superplasticizer in improving the mechanical properties of concrete. The findings suggest that pyrolysis oil can serve as a feedstock for producing water-reducing admixtures for cementitious materials.

Keywords: Pyrolysis oil, naphthalene sulfonate–formaldehyde (NSF), superplasticizer, sulfuric acid, formalin, sodium hydroxide, cement paste, water-reducing admixture.

INTRODUCTION

With the growth of industrial construction, an important objective in the development of chemical admixtures for building materials is to improve the durability and structural integrity of buildings, particularly their resistance to aggressive environments. Another area of interest is the development of organic admixtures from alternative raw materials, including secondary industrial resources. Concrete is one of the most widely used building materials, and its quality is critical because the performance and service life of structures depend on its strength and durability.

High-efficiency plasticizing admixtures play an important role in improving the properties of cement-based materials. Therefore, it is important to develop energy- and resource-efficient technologies for producing plasticizing admixtures from secondary raw materials and to create organic admixtures that improve the workability of fresh concrete and the physical, mechanical, and physicochemical properties of hardened products.

Superplasticizers are chemical admixtures used to modify the rheological and physical-mechanical properties of fresh concrete and hardened cement-based materials.

When added to a concrete mixture, a superplasticizer increases workability and can produce a slump of more than 20 cm. Alternatively, at a given workability, it can reduce the amount of mixing water while maintaining comparable strength. The actual effect depends on the admixture dosage and the composition of the mixture.

Numerous studies have examined the effects of superplasticizers on the physicochemical properties of ordinary Portland cement pastes. In particular, superplasticizers can adsorb onto cement-particle surfaces, promote particle dispersion, reduce water demand, and modify the rheological properties of cementitious systems. The chemical composition, molecular structure, and dosage of an admixture can also affect cement hydration, setting and hardening kinetics, and the microstructure and physical-mechanical properties of the hardened cement matrix. A systematic investigation of the interactions between superplasticizers and cementitious systems is therefore important for developing cement composites with high strength, stable rheological properties, and improved performance.

The experiment used pyrolysis oil, a waste product of the Uz-Kor Gas Chemical enterprise containing up to 85–90% naphthalene, together with 93% sulfuric acid, formalin and a 40% sodium hydroxide solution. A 50 g sample of pyrolysis oil was placed in a 400 mL beaker and heated to 60–70 °C. Then 50 g of concentrated sulfuric acid was added with stirring. The temperature began to rise as the exothermic reaction proceeded. The mixture was heated to 110 °C and then to 130 °C. Formalin solution was added dropwise, which lowered the reaction temperature to approximately 70 °C. The mixture was then heated again to 130 °C, and the addition of formalin was continued. A thick black mixture formed. A 40% sodium hydroxide solution was then added slowly, which caused foaming and a colour change from black to dark brown.



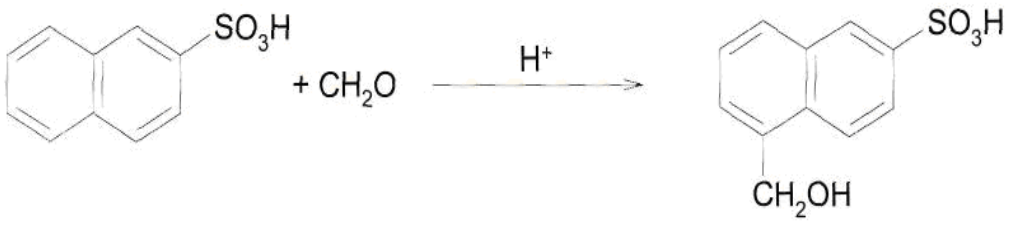


Figure 1. Synthesis of a superplasticizer from pyrolysis oil

Preparation of cement paste. Cement pastes were prepared from ordinary Portland cement (OPC) at a standard water-to-cement ratio. The synthesized NSF admixture was added at dosages of 0.15%, 0.30% and 0.50% by mass of cement. The mixtures were cast into moulds and kept for 24 hours at 100% relative humidity. The specimens were then cured under water for 3, 7, 28, 90 and 180 days. At each age, hydration was stopped, and the samples were dried at 90 °C for three hours and stored until testing.

The synthesized superplasticizer can act as a dispersing agent in mineral-based systems and can be used to adjust the rheological properties of concrete mixtures.

Conclusion

The results show that the synthesized superplasticizer can function as a water-reducing admixture in cementitious systems: it reduces water consumption by 15–20% while maintaining the required workability and consistency of the cement paste. This offers technological and economic benefits through more efficient use of water and raw materials. Further tests with a full report of the experimental conditions and measured properties are needed to confirm its performance and suitability for practical applications.

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