A Study on the Development of Antimicrobial Plasutic Pipes Using Waste PVC

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폐 PVC를 재활용한 항균 플라스틱 파이프 개발에 관한 연구

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Abstract

Polyvinyl chloride (PVC) is a thermoplastic material that is easy to color, hard, corrosion-resistant, inexpensive, and has good durability. It is widely used in various materials such as pipes, materials, artificial leather, or films, sheets, window frames, wire coatings, hoses, cable insulators, and other applications. In 2018, the global demand for PVC was approximately 44.3 million tons, and it is expected to increase significantly to around 60 million tons by 2025. The significant consumption of PVC has led to a sharp increase in PVC waste every year. Due to the chlorine content, adipates, phthalates, etc. in PVC materials, burial and incineration will cause serious environmental problems [1]. In addition, PVC with different uses requires the addition of different additives, such as stabilizers, colorants, or plasticizers, which may bring different environmental and health risks throughout their lifecycle. However, due to increasing restrictions and regulations, hazardous PVC additives used in the past are now appearing in waste streams, complicating waste management [2]. In general, PVC is widely used in the preparation of plastic pipes, because the specific gravity of PVC pipes is 1.43, the weight is 1/5 of iron pipes and 1/8 of lead pipes, the tensile strength is 3 times that of lead pipes, and 2.5 times that of PE pipes. It has strong mechanical strength, is easy to carry, and is not easily damaged. In addition, due to the extremely dense and flat surface inside the pipe, which is free from harmful substances, odors, and the water supply is not turbid, it is the most hygienic and has low friction resistance. The flow rate is about 30% larger than that of steel pipes of the same caliber. The extensive use of PVC pipes results in the production of a large amount of waste PVC pipe materials every year, therefore, the development of waste PVC reuse technology is particularly important. On the other hand, when supplying water through pipelines, if the water cannot frequently exist in a flowing state inside the pipeline, it can lead to the proliferation of various harmful bacteria, which feed on plasticizers, fillers, pills, etc. added during the manufacturing of PVC pipes. This not only pollutes the oil and water, but also seriously damages the pipe body. Recently, the application of antibacterial agents in plastic water pipes has received increasing attention. At present, most antibacterial technologies use coating or plating techniques to deposit metal oxides or nano silver particles on the inner layer of pipelines [3]. The advantage of this technology is that it has good antibacterial effects but high preparation costs and complex processes.

Therefore, in order to solve the above problems, we directly use commercial silver nanoparticles as the main antibacterial agent, mixed with waste PVC and new PVC resin in a certain proportion. We investigated the effects of different mixing ratios of antibiotics on Gram negative (Escherichia coli) and Gram positive (Staphylococcus aureus) bacteria, and analyzed the relevant antibacterial mechanisms.

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