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# CIRCULAR MANAGEMENT OF RUNOFF WATERS: DESIGN AND PERFORMANCE OF A FULL-SCALE TREATMENT PLANT FOR CLAY HEAP DRAINAGE

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**Abstract**

This study presents the conception, experimental validation, and full-scale implementation of an innovative treatment system for recovering solids from runoff waters generated by clay heaps at the SAPIR terminal in Ravenna (Italy). Runoff from open-air mineral storage areas contains high suspended solid concentrations that, if discharged untreated, can cause serious environmental degradation, increasing turbidity and sediment accumulation in surface waters. The project was developed to achieve two main objectives: (i) reducing the environmental load associated with suspended solids in effluents, and (ii) recovering and reusing the solid fraction within the ceramic industry supply chain, consistent with circular economy principles. Laboratory and pilot-scale studies were first conducted to identify an effective anionic polyelectrolyte, optimize its dosage, and assess the filtration performance of geotextile materials. Based on these investigations, the most efficient configuration, combining coagulation–flocculation with geotextile filtration was scaled up to an industrial plant designed to manage runoff from a 44,000 m² storage area. The system has a treatment capacity of 80 m³/h and operates through automated control of flow, mixing, and filtration stages to ensure stable performance under variable hydrological conditions. The full-scale plant consistently met the regulatory discharge limit of <80 mg/L total suspended solids (TSS), even during peak rainfall events. Moreover, it enabled the recovery of approximately 1,300–1,500 m³ of mineral solids annually, which were successfully reintegrated into the ceramic production chain. This approach provides measurable environmental and economic benefits by preventing solid discharges, reducing sedimentation in water bodies, and lowering the need for virgin raw materials. The Ravenna case study demonstrates how technical innovation, environmental compliance, and industrial feasibility can converge to produce a sustainable runoff treatment model. The system effectively transforms an environmental challenge into an opportunity for circular resource management, offering a replicable strategy for other port terminals and industrial storage sites.

*Key words:* ceramic reuse, environmental impact, geo-textile filtration, polyelectrolyte treatment, suspended solids

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