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Industrial Waste Multi-Metal Ion Exchange

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Abstract : Intel Chandler Site has internally developed its first-of-kind (FOK) facility-scale wastewater treatment system to achieve multi-metal ion exchange. The process was carried out using a serial process train of carbon filtration, pH / ORP adjustment, and cationic exchange purification to treat dilute metal wastewater (DMW) discharged from a substrate packaging factory. Spanning a trial period of 10 months, a total of 3,271 samples were collected and statistically analyzed (average baseline + standard deviation) to evaluate the performance of a 95-gpm, multi-reactor continuous copper ion exchange treatment system that was consequently retrofitted for manganese ion exchange to meet environmental regulations. The system is also equipped with an inline acid and hot caustic regeneration system to rejuvenate exhausted IX resins and occasionally remove surface crud. Data generated from lab-scale studies was transferred to system operating modifications following multiple trial-and-error experiments. Despite the DMW treatment system failing to meet internal performance specifications for manganese output, it was observed to remove the cation notwithstanding the prevalence of copper in the waste stream. Accordingly, the average manganese output declined from 6.5 + 5.6 mg^1L^{-1} at pre-pilot to 1.1 + 1.2 mg^1L^{-1} post-pilot (83% baseline reduction). This milestone was achieved regardless of the average influent manganese to DMW increasing from 1.0 + 13.7 mg^1L^{-1} at pre-pilot to 2.1 + 0.2 mg^1L^{-1} post-pilot (110% baseline uptick). Likewise, the pre-trial and post-trial average influent copper values to DMW were 22.4 + 10.2 mg^1L^{-1} and 32.1 + 39.1 mg^1L^{-1}, respectively (43% baseline increase). As a result, the pre-trial and post-trial average copper output values were 0.1 + 0.5 mg^1L^{-1} and 0.4 + 1.2 mg^1L^{-1}, respectively (300% baseline uptick). Conclusively, the operating pH range upstream of treatment (between 3.5 and 5) was shown to be the largest single point of influence for optimizing manganese uptake during multi-metal ion exchange. However, the high variability of the influent copper-to-manganese ratio was observed to adversely impact the system functionality. The journal herein intends to discuss the operating parameters such as pH and oxidation-reduction potential (ORP) that were shown to influence the functional versatility of the ion exchange system significantly. The literature also proposes to discuss limitations of the treatment system such as influent copper-to-manganese ratio variations, operational configuration, waste by-product management, and system recovery requirements to provide a balanced assessment of the multi-metal ion exchange process. The take-away from this literature is intended to analyze the overall feasibility of ion exchange for metals manufacturing facilities that lack the capability to expand hardware due to real estate restrictions, aggressive schedules, or budgetary constraints.

Keywords : copper, industrial wastewater treatment, multi-metal ion exchange, manganese
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