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Application of $FeCl_3$ and $Fe(OH)_3$ compounds for comprehensive silica removal facilitating zero liquid discharge in RO and IC waste water reuse

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Chemical mechanical planarization (CMP), used heavily in integrated circuit (IC) manufacture, generates copious amounts of waste water high in colloidal and reactive silica, which inhibits on-site reuse in cooling operations and ultra-pure water (UPW) production. Silica, when present in cooling water, can reach solubility limits via evaporation and form impervious scale on heat transfer surfaces that decreases efficiency. Silica in reverse osmosis feed-water inhibits aspirations for high rejection and zero liquid discharge (ZLD) due to scale formation. When subjected to RO at high rejection, silica forms difficult-to-remove scale on the membrane concentrate side in the form of glassy patches and communities of aggregate particles. Current methods for silica scale mitigation in industry include dosing with chemical anti scalents or complex operating schemes including ion exchange and large pH swings. This work evaluates the implementation of the common chemical coagulant, FeCl3 and highly insoluble Fe (OH)3 in the removal of silica by coagulation and adsorption mechanisms, respectively. FeCl3 was shown to be optimizable for silica colloid coagulation in CMP waste water via charge neutralization resulting in turbidity <10NTU. Adsorption of reactive silica on Fe (OH)3 using a sequencing batch reactor approach exhibited >90% silica removal for the first adsorption cycle, and increased utilization of adsorbent material for subsequent runs in both CMP waste water and RO concentrate.

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Allium cepa L. as an acid-base indicator

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In this study, a facile and environmentally friendly method was reported for manufacturing of natural acid-base indicator by preparing *Allium cepa* L. juice, which provided the anthocyanins pigment. The anthocyanins pigment was extracted via boiling process. In detailed, the *Allium cepa* L. was cut into small fragments. Then the small fragments of *Allium cepa* L. was boiled in distilled water in order to extract the anthocyanin pigment. This process was followed by the addition of different solutions of acidic solutions; base solution as well as neutral solution was added into separate test tubes filled with extraction of *Allium cepa* L. juice. The obtained *Allium cepa* L. juice was then used as the pigment for the acid-base indicator. The pH of the solution can be determined by observing the color change in the *Allium cepa* L. juice. The light purple color of the *Allium cepa* L. juice turned into red color when added with hydrochloric acid, its purplish color of the juice turned into yellow when added with sodium hydroxide, the original color of *Allium cepa* L. did not undergo any observable color change when distilled water is added into it. The *Allium cepa* L. exhibited excellent color change property with chemical solutions. These color changes make the *Allium cepa* L. be attractive for applications in acid-base indicators.