Sustainable technology for recovery of cleaning agents from bottle washers

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Introduction

Bottle washing is a major water and chemical consuming process in beverage industry. Due to significant savings in cleaning chemicals and energy consumption of the cleaning process as well as a possible reduction of discharged waste water to centralized WWTPs, recovery of spent lye from bottle washers in breweries becomes more important. Polluted caustic solutions, characterized by remaining contaminants which have been washed out of returned bottles, usually contain suspended and diluted matter. In this investigation additionally a high load of aluminum is solubilized in the caustic bath because of applied bottle aluminum sleeves. This work allows a comparison among treatment options for caustic recovery: settling and decanting as typical clarification method, process-integrated membrane filtration within the cleaning process and - as a novel option - precipitation of aluminum at high pH. Process performance and product quality are compared. The two last methods were investigated on technical scale with spent lye from a Vietnamese brewery.

Methodology

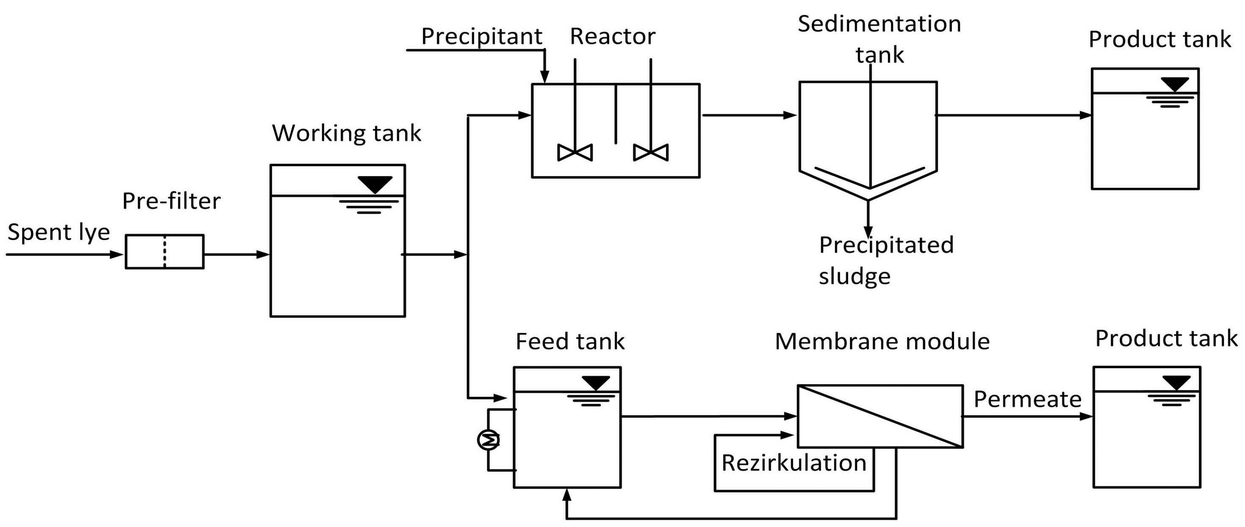

Figure 1.1: Layout of investigated treatment processes in technical scale

The filtration and precipitation process was tested in a pilot plant (figure 1.1) constructed by EnviroChemie GmbH, Rossdorf, Germany, installed next to the bottle washer building of the local brewery in Vietnam.

Precipitation trials were conducted in a stirred reactor with two reaction tanks (V = 200 L) by dosing sodium silicate solution (Thanh Phuong Co., Vietnam). Specific dosages were varied depending on current aluminum concentration and volumetric flow of the influent which ranged from 100 L/h to 120 L/h. Precipitated sludge separated in a settling tank was partly pumped back to the reactor for seeding or collected for further experiments.

Filtration trials were conducted at 70°C with tubular ceramic membranes (pore size 0.1 micron (Atech GmbH) and 0.9 nm (Inopor GmbH)) with a membrane area of 1.68 m^2 and 1.75 m^2 respectively. The transmembrane pressure was set to 2 bars for microfiltration and 5 bars for nanofiltration. Crossflow velocities of 3.85 m/s (MF) and 3.70 m/s (NF) were applied.

Results & Discussion

With regard to process performance and retention of aluminum, membrane filtration and precipitation process were compared on technical scale (figure 1.2). Cleaned caustic solutions after filtration are free of particular matters. More than 80 % of additives – measured as surfactants - remain in permeate. The filtration tests have proven a steady filtration capacity of J_P = 54 L/(m^2·h) for microfiltration and J_P = 37 L/(m^2·h) for nanofiltration at an achievable permeate recovery rate of 90 % and 85 % respectively. It could be concluded that membrane technology suits the requirements for recovery of caustic solutions which are not heavily contaminated by dissolved metals. An advantage of continuous refreshing cleaning solutions could avoid chemical alteration during the washing procedure.

Significant reduction of soluble aluminium (nearly 90 %) was achieved by alkaline precipitation process without changing pH value or causing a bad influence on the solution's strength. The precipitating reaction additionally reduces colloidal (80 %) and organic matter (50 %) but also leads to unexpected adsorption of 50 % surfactants within the solution. Like filtration, the experiments were operated continuously at high temperature. Compared to other treatment processes, precipitation offers a sustainable solution to current situation at the local brewery.

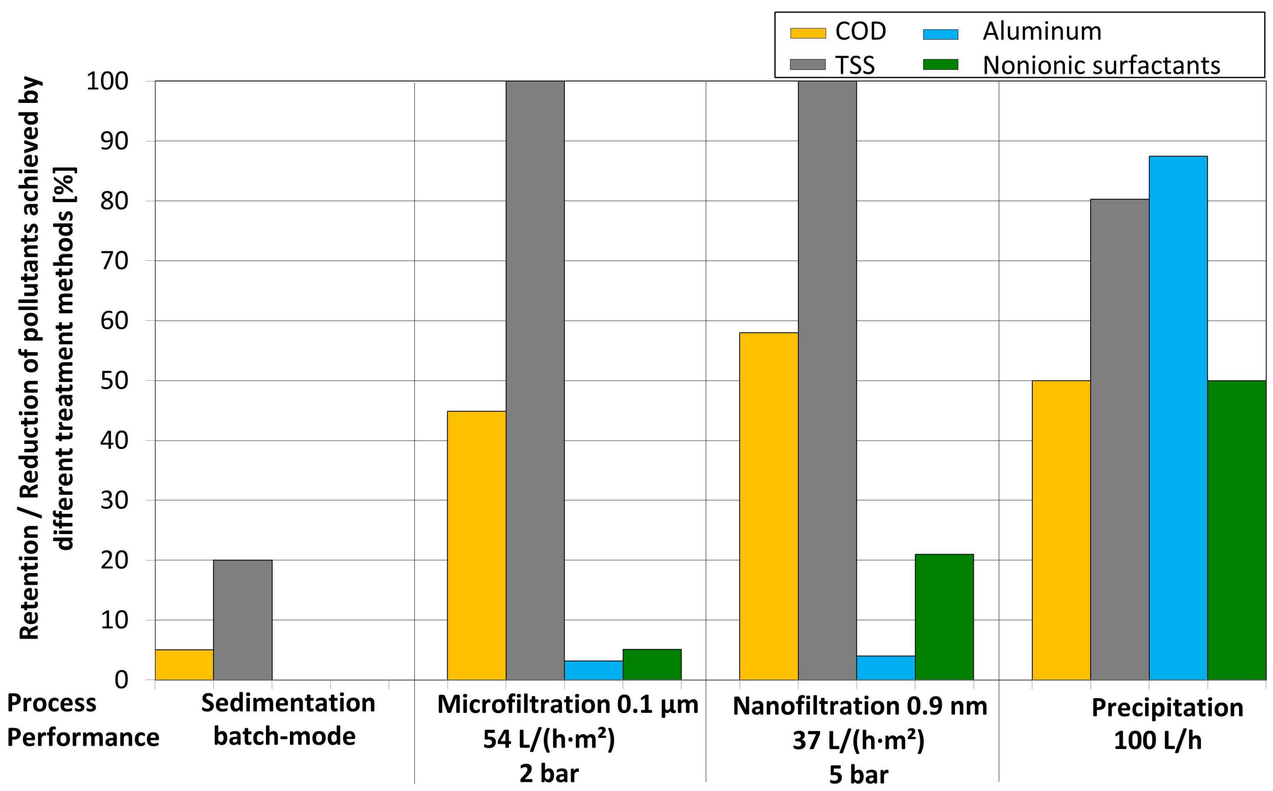

Figure 1.2: Comparison of optional treatment processes

Conclusions

Decreasing the consumption of chemicals, water and energy is an important need in the industry. Recovery of cleaning agents requires suitable treatment options in accordance with specific properties of discharged solutions. Conventional separation methods such as sedimentation and centrifugation are not sufficient to meet reuse quality. Filtration and precipitation are suitable for keeping constant efficiency of caustic solution during the cleaning process as well as extending its service life due to permanent retention of organic and suspended matters. In case of aluminum contaminated caustic solution at the Vietnamese brewery, precipitation process was shown to be the most sustainable technology with best performance and retention required. A patent for this process was submitted.

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