**VOC Removal by Absorption in Silicone Oil and Biological Regeneration of the Oil in A TPPB: Pilot Scale Trials**

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**Highlights**

* VOC of different hydrophobicities were correctly removed by absorption in PDMS
* PDMS regeneration in a pilot-scale TPPB in a continuous mode was efficient for the studied loads
* After several cycles of PDMS regeneration in the process, absorption performances were preserved

**1. Introduction**

Volatile Organic Compounds (VOC) have harmful effects on both environment, through their global warming contribution, and human health. Several kinds of treatments are possible to remove VOC from air, including adsorption, thermal and catalytic oxidations, absorption and biological processes such as biofilters. Adsorption and oxidation can be very expensive and energy-consuming technologies for large flow rates with low concentrations in VOC, whereas biological processes present low operating costs and are adapted to the treatment of large VOC flow rates at low concentrations; but these latter are mainly suitable for water-soluble compounds removal [1]. For hydrophobic VOC, absorption in a non-aqueous phase (NAP) is possible [2]. Nevertheless, this NAP must be regenerated to reduce the operating cost of the installation. Regeneration methods, such as classic distillation or stripping at high temperature and low pressure can be applied, but they are energy-consuming. Performing a biological regeneration in a Two-Phase Partitioning Bioreactor (TPPB), a multiphasic bioreactor containing microorganisms able to degrade the absorbed VOC [3] would be much cheaper and more eco-friendly. The process studied in this work consists of the combination of VOC absorption in a packed column and biological regeneration of the liquid absorbent (NAP) followed by a separation device insuring a good separation between water, oil and sludge. Th**rough** an industrial partnership, the combined process was tested on a realistic application for the treatment of ~~a~~ complex mixture of different VOC at varying inlet concentrations.

**2. Methods**

The inlet gas consisted of a mixture of molecules of different chemical natures: alkanes, esters, alcohols, ketones and monoaromatic compounds. The NAP used was silicone oil, (Polydimethylsiloxane, PDMS), having a viscosity of 20 mPa.s. The pilot unit included a column (diameter 0.15 m, height 1.3 m) packed with a random packing (IMTP), a bioreactor loaded with waste water plant activated sludge (total volume of 1.25 m3, with 25% v/v of PDMS), a conical settler and a centrifuge (16,000 rpm). The total VOC concentration was measured at the inlet and the outlet of the column owing to a PID (Photo-Ionization Detector, IonScience). The overall pilot unit ran 8 hours a day and 4 days a week.

**3. Results and discussion**

Figure 1 shows the inlet (red squares) and outlet (blue diamonds) total VOC concentrations of the packed column during 160h of operation. Even if the inlet concentration varied between 5 and 450 mg.m-3 in total carbon (TC) with an average of 150 mg.m-3 TC, the outlet concentration stayed most of the time below 50 mg.m-3 TC, showing the performance of the process. After more than 150h of use, given that the total residence time of PDMS (both for absorption and regeneration) is about 15h, PDMS was biologically regenerated 10 times in the process. Looking at steady VOC removal performances, the studied process was efficient for PDMS biological regeneration. Further trials will be investigated in order to know if each VOC is well degraded and operating parameters will be optimized to improve the VOC removal yields.

**Figure 1.** Total VOC concentration at the inlet and the outlet of packed column

**4. Conclusions**

The combination of VOC absorption in a packed column and PDMS regeneration in a TPPB showed that the early results aresatisfactory towards VOC removal. Absorption performances were preserved after several cycles of PDMS regeneration and proved that biological regeneration is suitable to recycle NAP.

**References**

[1] P. Le Cloirec, *Techniques de l’Ingénieur*, vol. G1, no 835, p. 1‑10, 2004.

[2] F. Heymes, P. Manno-Demoustier, F. Charbit, J. L. Fanlo, et P. Moulin, *Chemical Engineering Journal*, vol. 115, no 3, p. 225‑231, janv. 2006.

[3] M. Guillerm, A. Couvert, A. Amrane, E. Norrant, A. Breton, et É. Dumont, *Chinese Journal of Chemical Engineering*, 2017.