**Nanofiber Based Dual Functional Enzymatic and Thermo-Responsive Membranes for Protein Self-Cleaning**

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**Introduction**

One of the most versatile methods to reduce fouling and self-clean the membranes is to incorporate self-cleaning materials such as proteolytic enzymes that can lyse and detach the protein foulants from the membrane surface (Shi *et al*. 2011, Cordeiro *et al*. 2011) and thermo-responsive polymers that offer facile temperature based cleaning for membranes (Tripathi *et al*. 2014). However, the combined self-cleaning effect of PNIPAAm and biocatalytic enzymes has not been explored so far.

**Method & Approach**

In this research, a new nanofiber based dual functional biocatalytic thermo-responsive poly(vinylidene fluoride)(PVDF)/nylon-6,6/poly(N-isopropylacrylamide)(PNIPAAm) ultrafiltration membrane was fabricated by integrating a hydrophobic PVDF cast layer and hydrophilic nylon-6,6/PNIPAAm nanofiber layer where trypsin enzymes were covalently immobilized. The structural and functional properties of the as-prepared membranes were investigated and correlated to the membrane performance. Also, the impact of thermo-switchable volume-phase transition on the stability of immobilized enzymes was studied. Figure 1 shows the schematic of enzymatic and thermo-responsive self-cleaning of membranes. 

**Fig. 1.** Schematic of enzymatic and thermo-responsive self-cleaning of membranes

**Results & Discussion**

The immobilization density of enzymes on the membrane surface decreased with increasing PNIPAAm concentration, due to the decreased number of amine functional sites. Through an UF study using a model solution containing BSA/NaCl/CaCl2, the membrane without PNIPAAm revealed superior fouling resistance and self-cleaning with an RPD of 22%, compared to membranes with 2 and 4 wt% PNIPAAm with 26% and 33% RPD, respectively, after an intermediate temperature cleaning at 50°C, indicating that higher enzyme density offers more efficient self-cleaning than the combined effect of enzyme and PNIPAAm at low concentration.

**Conclusion**

Overall, the thermo-switchable conformational volume phase transition of the as-prepared membranes did not affect the stability of surface immobilized enzymes. Hence, the approach of enzyme immobilization onto nanofibrous surface has greater potential including fouling mitigation and surface self-cleaning beyond membrane separation.

**References**

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