Title: Sieving and Adsorption in Heterophase Alumina Ceramic Membranes for Applications in Water Treatment

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Abastact: This study presents a ceramic membrane (MIX-CM, denoting a mixed phase) fabricated through die casting and sintering of heterophase YS-Al_2O_3 and α-Al_2O_3 precursors, yielding a hierarchically mesoporous structure with high porosity (60%) and well-balanced mechanical strength (42 MPa). The MIX-CM demonstrates superior chemical stability (<2% mass loss in acidic/alkaline media) and thermal stability up to 1000 °C. Its unique composite microstructure enables dual-function separation via synergistic sieving and adsorption. Under cross-flow filtration (0.5 bar, 25 °C), MIX-CM achieves high rejection of colloids (>98%), humic acid (>96%), and bovine serum albumin (92%), while exhibiting exceptional adsorption of antibioticstetracycline hydrochloride (99.6%) and norfloxacin (95.7%)and selective removal of heavy metals, with Pb^{2+} reduced from 492 to 3.4 μg L^{-1} (below WHO limits). In real surface water treatment, the membrane maintains stable UV_{254} and turbidity removal at 53% and 78%, respectively. NaClO backwashing achieves 96% flux recovery, while a crushing-reconstruction strategy fully restores severely fouled membranes. The MIX-CM is economically viable, with a production cost of ∼113 USD m^{-2}, markedly lower than commercial ceramic membranes (500–3000 USD m^{-2}). These findings position MIX-CM as a scalable, cost-effective, and multifunctional solution for advanced potable water purification.

Keywords: ceramic membrane hierarchically mesoporous structure synergistic sieving-adsorption cost-effective surface water treatment

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