Ceramic nanofiltration: Creating a resilient future for drinking water supply

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WATER INFRASTRUCTURE AND RESILIENCE WIRe

EPSRC Centre for Doctoral Training

BENEFITS OF CERAMICS

Can ceramic nanofiltration membranes be a viable alternative to current technologies for natural organic matter (NOM) removal in drinking water treatment?

GOAL 1: IMPROVE RESILIENCE

- Upgrade existing 'tight ultrafiltration' to ceramic nanofiltration in decentralised Scottish upland regions
- Remove need for chemical pre-treatment and any associated supply chain disruption risks
- Minimise risk to drinking water distribution networks by using more robust ceramic membranes

GOAL 2: ENHANCE NOM REMOVAL

- Reduce water quality complaints with more selective removal of dissolved organics
- Exceed current and future water quality standards including disinfection by-products
- Lower disinfection by-products formation through increased removal of natural organic matter (NOM) precursors

*Reference operating flux for polymeric (2000Da) comparable to ceramic (450Da) with 4x smaller MWCO

KEY RESEARCH QUESTIONS

- ❑ *Do tighter molecular weight cut offs (MWCO) for ceramics equate to better selectivity?*
- ❑ *Can selectivity be decoupled from permeability by using ceramics instead of polymerics?*
- ❑ *Do ceramics offer improved removal of natural organic matter (NOM) with reduced fouling?*
- ❑ *How can operating conditions, especially pressure, impact the selectivity of ceramic?*
- ❑ *What is the membrane area trade-off as MWCO decreases for ceramic membranes?*

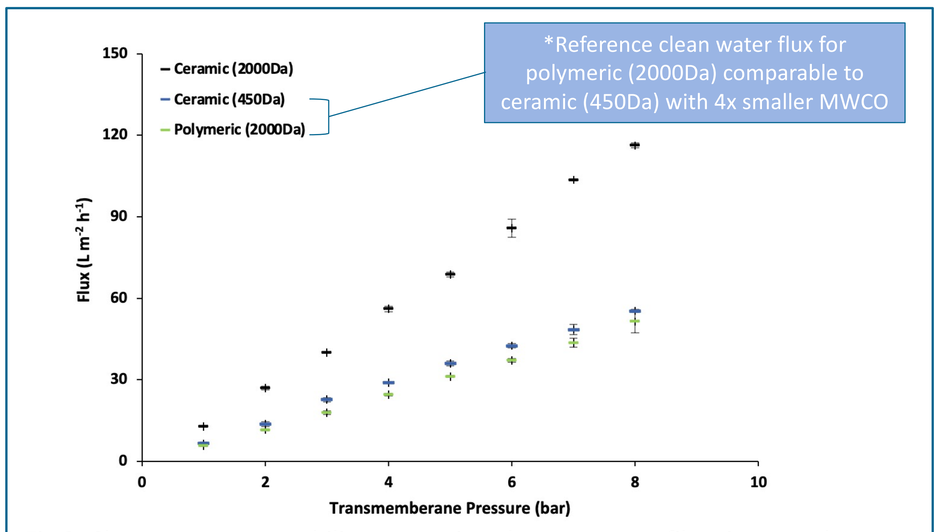

Fig 2: Clean water permeability comparison between nanofiltration membranes

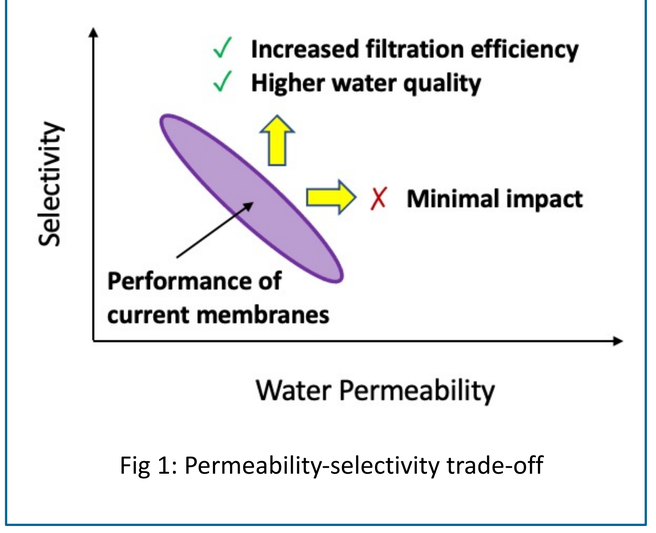

Fig 1: Permeability-selectivity trade-off

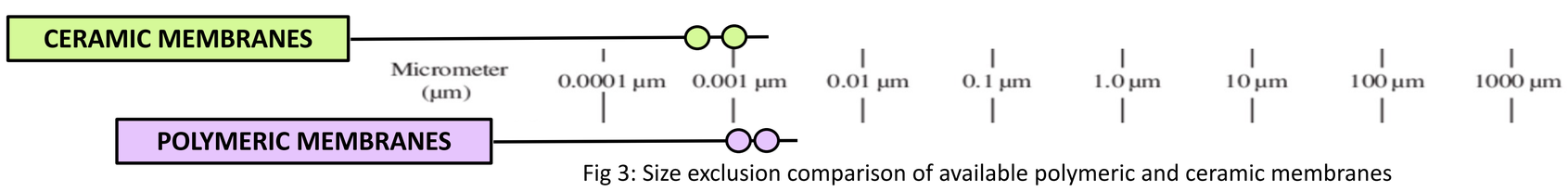

Fig 3: Size exclusion comparison of available polymeric and ceramic membranes

- ❑ **Ceramic nanofiltration membranes pore sizes are true nanofiltration at <0.001 µm or <1000 daltons (Da) molecular weight.**
- ❑ **Polymeric nanofiltration membranes pore sizes >0.001µm or 1000-2000 daltons (Da) molecular weight.**

OUTCOMES

1. **Improve resilience for existing upland nanofiltration water treatment works**
2. **Meet current and future water quality consents through improved selectivity**
3. **Reduce whole life costs with more robust ceramic nanofiltration technology**
4. **Lower carbon footprint through higher durability of ceramics versus polymerics**

📌 **If we can solve ceramic nanofiltration for upland waters, the technology can be translated to lowland water treatment works.**

📌 **Ceramic nanofiltration could become a key treatment stage in flowsheets of the future for chemical free drinking water treatment.**

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