

$$CV = \frac{\bar{L}_{80\%} - \bar{L}_{20\%}}{2\bar{L}_{50\%}} \times 100 \quad (8.33)$$

Experimental CV values measured in membrane crystallization tests carried out on NaCl range within 15–35%,^{57,58} as a comparison, the coefficient of variation for ideal MSMPR is 50% for size-independent growth.

From an industrial point of view, advantages of membrane processes are generally related to their unique properties of modularity for an easy scale-up and a large operational flexibility, compatibility between different membrane operations in pre-treatment and downstream processes, robustness and stability under operating conditions, low environmental impact and low energy consumption. In membrane crystallization technology, the interfacial membrane area for solvent removal or antisolvent addition per unit volume is very high if compared to conventional forced circulation or draft tube baffled crystallizers, especially in the case of hollow fibers membrane modules (packing density > 20.000 m² m⁻³). Moreover, the gentle flow of the mother solution through membrane modules in laminar regime guarantees a high mixing degree and reduces the risk of attrition and breakage of crystals with moving parts of the equipment.⁵⁹

Flux decline with increased feed concentration, in conjunction with concentration and temperature polarization phenomena, is an inherent characteristic of membrane crystallization. Due to occurrence of heterogeneous nucleation, attention should be paid to the hydrodynamics of the system in order to assure that the shear stress generated by flow recirculation is sufficient to remove crystals deposited on the membrane surface, so preserving the stability of the process.

The main concerns about a membrane relates to the long-term maintenance of its hydrophobic behavior. In case of membrane wetting determined by the loss of hydrophobicity, the crystallization process collapses as a result of the dispersion of liquid phases. This potential problem can be circumvented by operating with moderate transmembrane fluxes (1–5 L m⁻² h⁻¹) and by using hydrophobic polymeric materials, whose non-wettability is eventually enhanced by physical or chemical modification of the membrane surface.

8.8 Operational Stability

The operational stability of membrane crystallization imposes that the liquid phase cannot penetrate through the microporous hydrophobic membrane; in case of wetting, since membrane is not intrinsically selective, all solution components would be transferred from feed to the permeate side, thus leading to process failure. From an operative point of view, a fluid will not pass through a porous medium if its pressure is kept below a critical threshold, known as “breakthrough pressure” (ΔP_{entry}) and estimated for cylindrical pores by the Young–Laplace equation: