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Flow and filtration imaging of single use sterile membrane filters

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Abstract

Sterile filters incorporating endotoxin adsorption function emerged recently to pretreat dialysate liquids fed to a hemodialysis filtration process. Their application significantly enhances the survival rate during dialysis treatment as they function as sterilesteril filters as well as an endotoxin adsorber. Little is known about the fluid flow distribution in such single use membrane modules. We report a detailed analysis of the local 3D flow field distribution in such membrane modules using magnetic resonance flow imaging. Next to pure water filtration representing the application case of endotoxin adsorption from an already pure liquid, we also used the module as a filtration device rejecting for instance colloidal silica. Such experiments performed in-situ allow the quantification of cake layer development and its concomitant redistribution of the flow field. Particularly novel is the quantification of the time evolution of local permeate flux distribution. These detailed insights of this study encourage the use of flow-MRI when designing and applying new membrane module configurations.

Keywords: MRI, local flux, active membrane area, cake layer visualization

1. Introduction

The prevalence of hollow fiber based hemodialysis reached 2067 per million population in 2014 [1] with an increasing tendency. This trend underlines the issue of a global public health problem [2, 3] and the necessity for continuous improvements in medical devices enabling the lifesaving treatment. Recently, single-use microfiltration membrane based devices act as sterile filters as well as endotoxin adsorbers for dialysate pre-treatment. They (a) eliminate any bacterial contamination and (b) reduce the level of endotoxins in the dialysate to a minimum and thus

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