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TECHNOLOGY

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Contents

News

Features

Regulars

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Journal info

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21

H Index

Subject Area and Category

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- Food Science

Chemistry
- Chemistry (miscellaneous)

Energy
- Energy Engineering and Power Technology

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- Electrical and Electronic Engineering
- Industrial and Manufacturing Engineering

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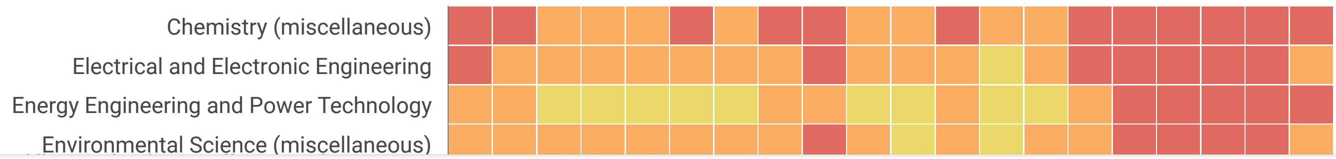

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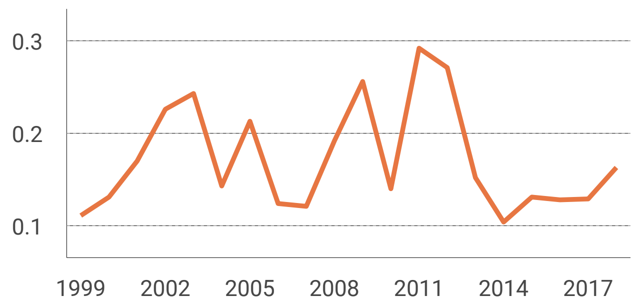

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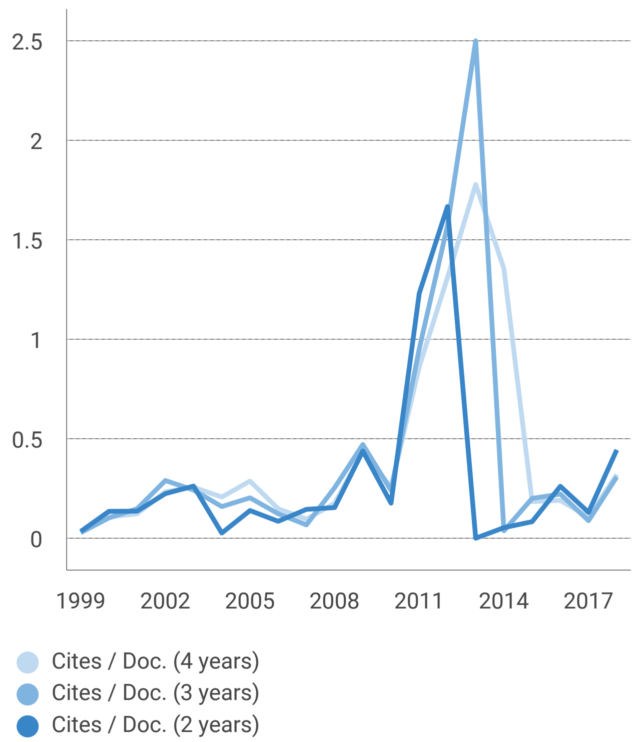

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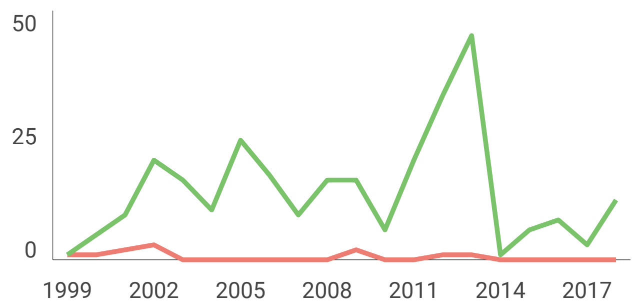

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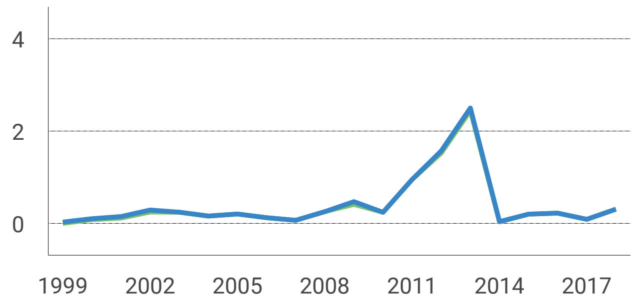

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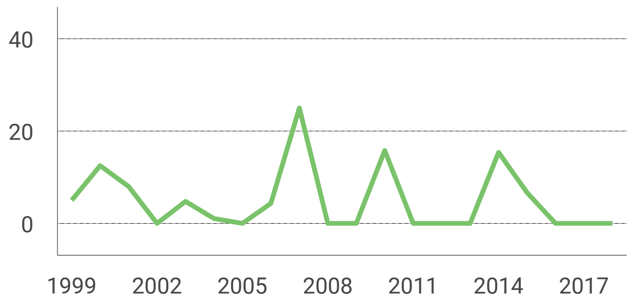

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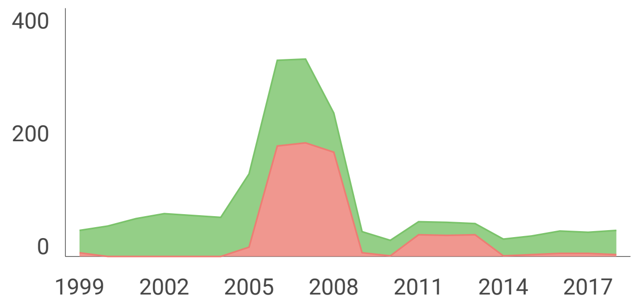

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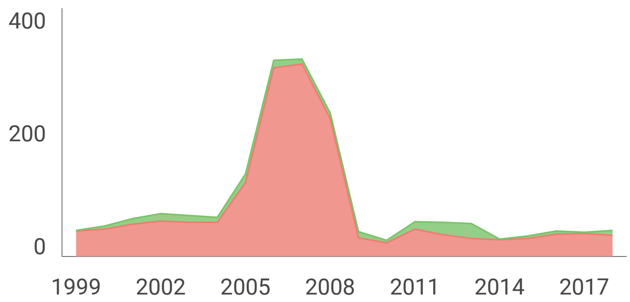

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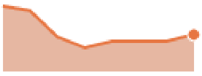

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Feature

Performance of interlayer-free pectin template silica membranes for brackish water desalination

Aulia Rahma, Muthia Elma, Amalia E. Pratiwi, Erdina L.A. Rampun

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This article provides details of a study that fabricated interlayer-free pectin template silica membranes and then employed them in a series of experiments for the desalination of brackish water using pervaporation. The main objective of this research is to investigate the performance of the membranes in the desalination application and to look at ways of improving their mechanical stability.

Previous article in issue Next article in issue

Performance of interlayer-free pectin template silica membranes for brackish water desalination

Aulia Rahma, Muthia Elma, Amalia E. Pratiwi and Erdina L.A. Rampun, Chemical Engineering Department, Engineering Faculty – and Materials and Membranes Research Group (M^{2}ReG) – University of Lambung Mangkurat, Banjarbaru, South Kalimantan, Indonesia; Mahmud, Environmental Engineering Department, University of Lambung Mangkurat, Banjarbaru, South Kalimantan, Indonesia; and Rahmi Fauzia, Psychology Study Program, Medical Faculty, Lambung Mangkurat University, Banjarbaru, South Kalimantan, Indonesia

This article provides details of a study that fabricated interlayer-free pectin template silica membranes and then employed them in a series of experiments for the desalination of brackish water using pervaporation. The main objective of this research is to investigate the performance of the membranes in the desalination application and to look at ways of improving their mechanical stability.

In this study interlayer-free pectin template silica membranes were successfully fabricated using the sol-gel method, and dip-coating and calcination processes, with tetraethyl orthosilicate (TEOS) as the precursor. These membranes were carbonised using pectin templated into silica matrices and calcined in air using the rapid thermal processing (RTP) technique at temperatures of 300°C and 400°C.

This research aims to improve the mechanical stability of silica-based membranes by templating carbon groups extracted from pectin (0 wt%; 0.1 wt%; 0.5 wt% and 2.5 wt%) into silica matrices. The resulting membranes were then employed in experiments that involved the desalination of artificial brackish water (0.3 wt% NaCl) using pervaporation.

The results show that the water flux of pure silica membranes, calcined at 300°C and 400°C, is low (1.11 kgm^{-2} h^{-1} and 1.27 kg m^{-2} h^{-1}). In addition, 0.5 wt% pectin template membranes have the highest water flux (9.92 kg m^{-2} h^{-1} and 13.21 kg m^{-2} h^{-1}) amongst other pectin concentrations (0.1 wt% and 2.5 wt%) for membranes calcined at 300°C and 400°C, respectively.

However, the water flux drops sharply (49%) when the concentration of pectin template is increased (2.5 wt%). It can be concluded that the concentration of 0.5 wt% pectin templated into silica membranes is more robust compared with a concentration of pectin template of 0.1 wt% and 2.5 wt%.

Global water crisis

The global water crisis is an issue that needs to be resolved urgently. The increasing demand for water continues to deplete fresh water resources.

The desalination of brackish water is one potential way of expanding conventional water supplies to mitigate water shortages. However, membrane technologies such as reverse osmosis (RO) are not environment-friendly. RO, for example, produces a concentrate, or brine, during the desalination of water.[1]

Pervaporation is an alternative desalination technology. Compared with RO, it promises to produce fresh water whilst consuming less energy.[1–3] This process can operate at high temperatures and offers a high water flux.[4, 5]

An inorganic membrane, based on silica, has attracted researchers' attention because of the advantages it offers. It is capable of serving as a good molecular sieve, and is stable and robust compared with zeolite and organic membranes.[6–8]

Silica membrane

A silica membrane is produced using the sol–gel method.[9] The sol–gel process forms the siloxane group (Si–O–Si) and silanol group (Si–OH) which play a critical role in the production of the silica matrix.[10]

However, the silanol number may affect the hydro-stability of the silica matrix, causing it to collapse when it is brought into contact water molecules.[11]

Researchers Duke *et al.*[12] have reported studies that aim to increase the hydro-stability of silica membranes. This has been achieved by carbon templated into silica matrix, which causes the silica matrix to become more stable in water.

In addition, the carbon material is capable of building a more robust silica matrix by connecting the carbon chains in silica matrices. This results in an increase in the performance of the membrane.[13]

Pectin

Pectin is a complex polysaccharide compound containing sugar neutral chains that have carbon content.[14]

Using pectin as carbon source has many advantages. For instance, it is relatively inexpensive, and easy to obtain as it is available from fruit peel or the waste industries.[15]

The content of pectin in apple pomace ranges from 3.5 wt% to14.3 wt%, and serves as means of creating a material with a high active surface area and pore distribution.[16, 17] Therefore, pectin has great potential as carbon material for use in the fabrication of silica membranes.

In practical terms, membranes are coated on a microporous alumina substrate using a process with a slow calcination rate called conventional thermal processing (CTP).[18] However, during fabrication it requires a longer processing period because of the longer ramping rate and dwelling time.

In order to reduce costs and production time, membranes have been fabricated without an interlayer Elma *et al.*[19] These are referred to as interlayer-free membranes.

Materials can be directly calcined by using RTP, which is faster than fabrication methods that use CTP. The RTP technique does not

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