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Huliienko S.V., Ph.D., associate professor
Muzyka S.M.
National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute",
sergiiguliienko@gmail.com

MATHEMATICAL SIMULATION OF THE REVERSE OSMOSIS: CURRENT STATE AND PERSPECTIVE OF DEVELOPMENT

The reverse osmosis process is widely used in water treatment systems, chemical, food, biotechnological industry and other fields. The important direction in the investigations of this process is the mathematical simulation which allows to increase effectiveness of design and exploitation of membrane equipment with lower number of experiments. In work [1] the critical analysis of the publication about this topic from 2000 to 2010 was carried out. The follow-up of this work is the analysis of publication in the next period of time: from 2011 to 2020. For this purposes the publications in leading journals in main systems of scientific information including *ScienceDirect* [2], *Springer* [3], and *DOAJ* [4] ware analyzed.

The distribution of the publication by the years is represented on the Fig. 1. These results show that the reverse osmosis simulation is still actual direction of investigation of the membrane processes and the interest for such researches increased.

In work [1] it was pointed out, that the conventional models include such groups of modes as models based on irreversible thermodynamics, diffusion based models and pore flow based models. Some investigations involving computational fluid dynamics, artificial neuron networks, optimization and economical analysis were identified as individual groups. The analysis of published works in this field has shown that it is reasonable except identified in previous work [2] to consider individually the methods of molecular dynamics and energy analysis. According to this into account, the distribution of the approach in publication chosen for review is shown on Fig. 2.

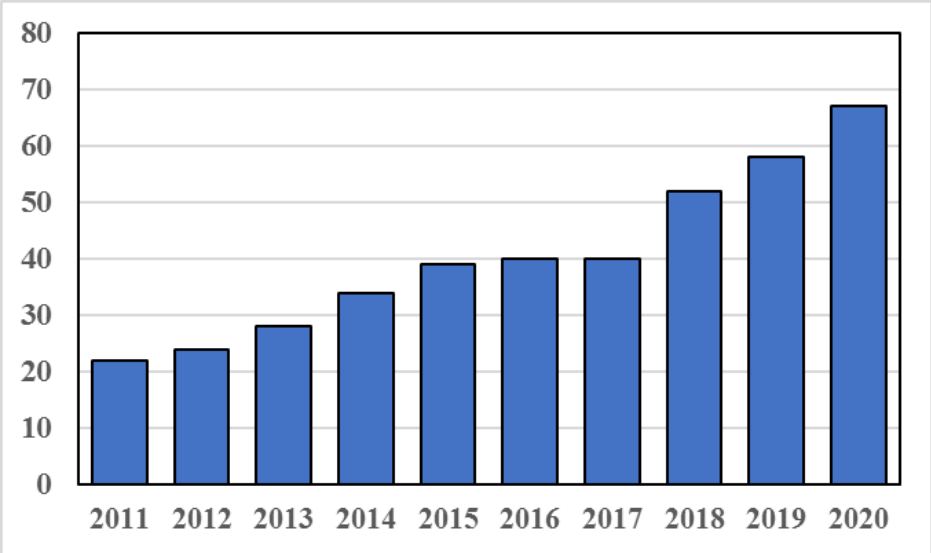

Fig. 1 – The distribution of the publication about reverse osmosis simulation chosen for analysis by years

As in previous period, the biggest number of works is dedicated to simulation with using of computational fluid dynamics and optimization methods, whereas the number of model with using concept of irreversible thermodynamics and pore flow is still relatively low. The main difference is unexpected high number of diffusion based models, which is probably related to the fact that

this models are relatively simple and take into account the membrane properties in contrast with irreversible thermodynamics based models.

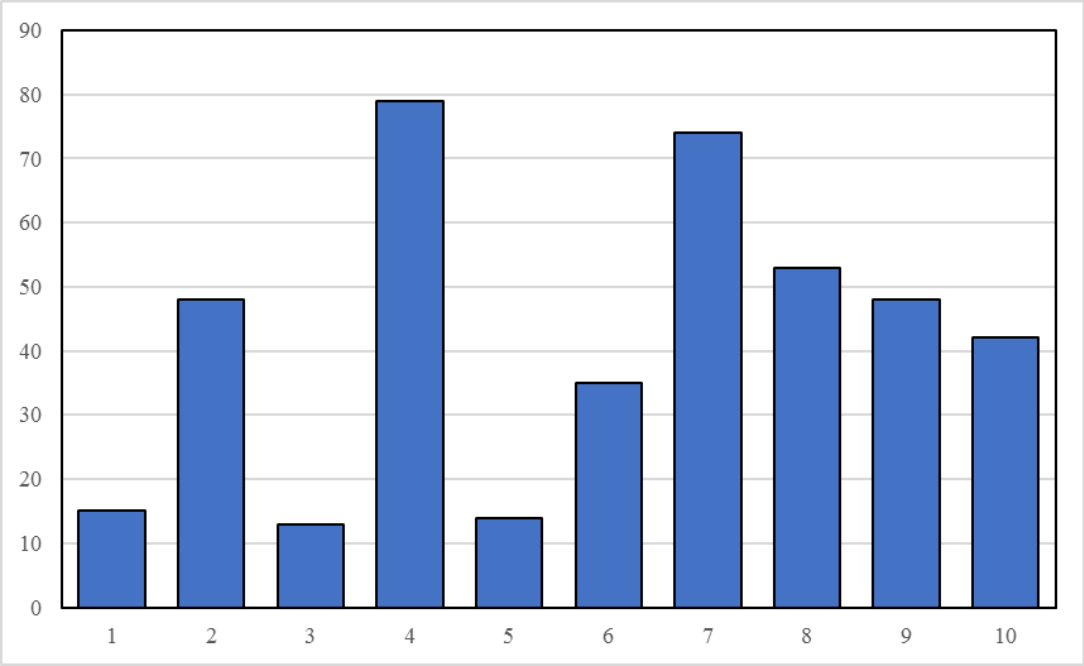

Fig. 2 – The distribution of the reverse osmosis models by groups in chosen publication: 1 – irreversible thermodynamics; 2 – diffusion; 3 – pore flow; 4 – computational fluid dynamics; 5 – artificial neuron network; 6 – molecular dynamics; 7 – optimization; 8 – energy analysis; 9 – economical analysis; 10 – other approaches.

The relatively low number of publication about the simulation of the reverse osmosis with using of the artificial neuron networks also attract attention. Despite the dynamical development of this method of simulation in practically all kinds of humane activity, the number of investigation of the reverse osmosis with this approach is still at the same level with irreversible thermodynamics and pore flow based models. At the same time, the number publication about reverse osmosis modeling using the molecular dynamics method has become quite high which allow to suggest the perceptivity of this approach.

In general, taking into account intensive development of the computer technologies and software (including presence of free open software such as OpenFOAM), the most perspective ways in the reverse osmosis simulation in coming years will be the computational fluid dynamics and molecular dynamics and also optimization methods.

References

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