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Portable automated osmolality and pH adjusting apparatus for pretreatment of environmental water samples delivered into a cell-based biosensor

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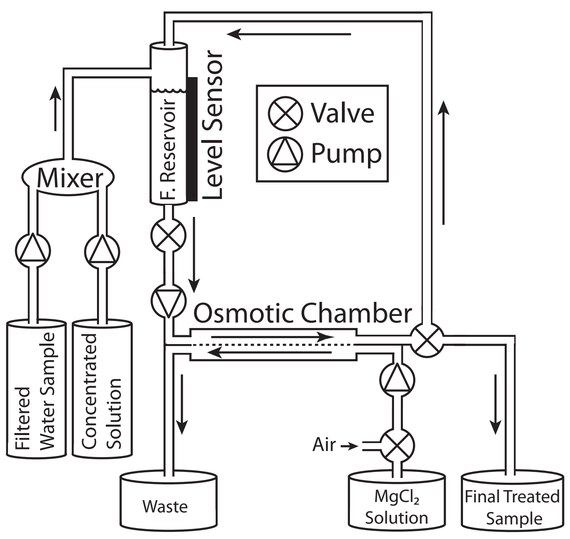
Introduction

Adjusting the osmolality and pH of the environmental samples that are to be introduced to a cell-based biosensor is a critical issue. Conventional methods for such adjustments require complex procedures and expensive devices [1]. These methods mostly affect sample components or cause unwanted sample dilution upon adding dissolved substances like buffers, cell nutrients, etc. To avoid these drawbacks, we developed a fully automated apparatus that works in two steps: firstly, the river sample is mixed with a concentrated cell-culture medium to add all the necessary ions and molecules to the sample; and secondly, the excess water added in the first step is selectively removed using forward osmosis.

Method



Schematic design of the system

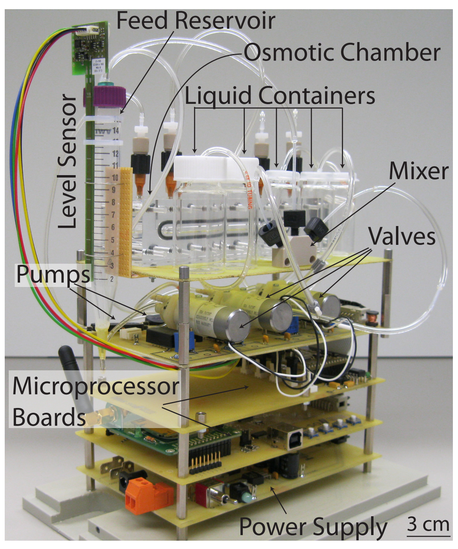
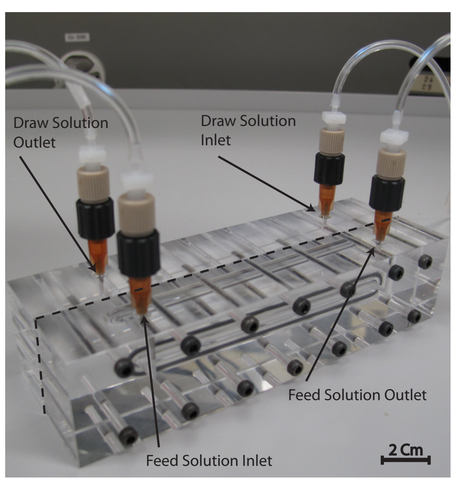
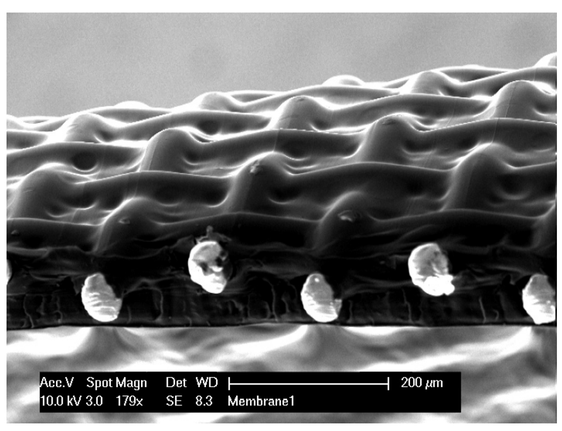


Photo of the apparatus

The heart of the apparatus is the osmotic chamber where forward osmosis takes place. We presented an earlier version of this chamber suitable for submilliliter samples fabricated by rapid prototyping elsewhere [2].



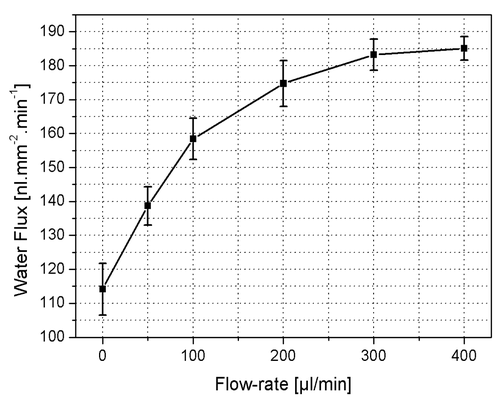
Osmotic chamber



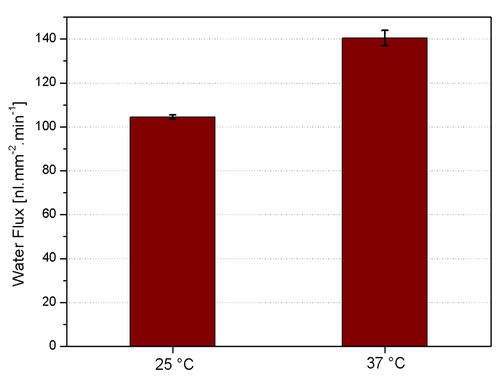
SEM image of the osmotic membrane (provided by Hydration Tech. Inn.)

A microprocessor regulates the pumps and the valves precisely according to the data received from the capacitive liquid level sensor attached to the reservoir. Due to the osmotic pressure water diffuses through the membrane towards the draw solution. When the feed solution volume equals the initial sample volume, the excess water is completely transferred to the draw solution, and the pretreatment is finished.

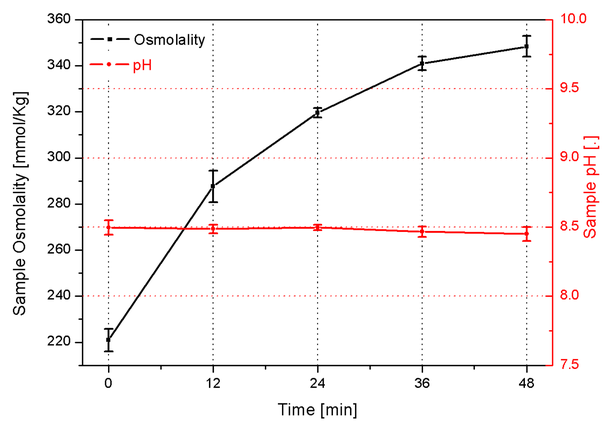
Results



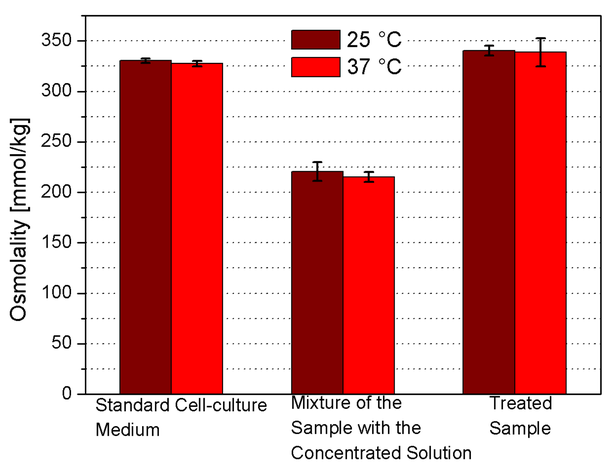
The maximum water flux was obtained when both feed and draw solutions were pumped at 400 µl/min.

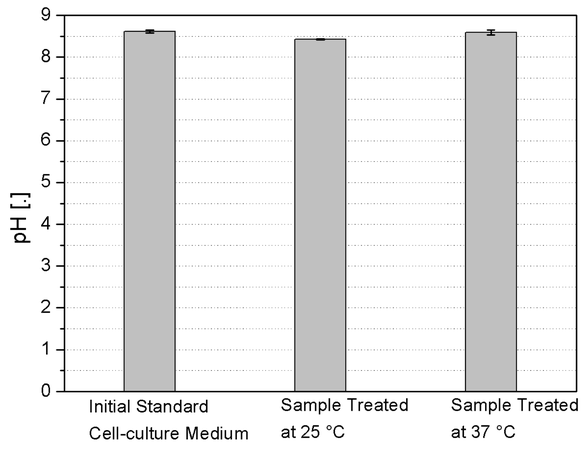


By increasing the temperature from 25 °C to 37 °C, the water flux was increased by 2.9% per degree Celsius.



Osmolality and pH fluctuations of the feed solution over time. This experiment was performed at 25 °C when both solutions were pumped at 400 µl/min.





Osmolality and pH of the final treated samples both at 25 °C and 37 °C.

Conclusions

Using our in-line osmolality and pH adjusting apparatus, we could adjust the osmolality and pH of Swiss river water samples to the standard values of a cell-culture medium (pH: 8.5, Osmolality: 330 ±10 mmol/kg). This pretreatment process neither dilutes the sample components nor affects their chemical structures. By adapting some parameters of the process, the apparatus can be used for pre-concentration of the samples as well. Moreover, the apparatus is fully automated, and can be fabricated at very low price.

References

[1] N. J. Mourlas et al. "An In-line Osmometer for Application to a Cell-based Biosensor System", Sensors Actuators B, 83, pp. 41-47, (2002).
[2] S. Talaei et al. "Sample Preparation Microfluidic Cartridge for On-line Adjustment of Osmolarity in Miniaturized Cell-based Analysis Systems", Proc. Pittcon 2011, Atlanta, USA.

Acknowledgements

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