E7 Biocompatible Polymer for Self-Humidification

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This investigation focuses on humidifying inhaled air to prevent the iatrogenic dryness caused by Continuous Positive Airway Pressure (CPAP) therapy, through a self-humidification approach that recovers moisture from exhaled airflow using smart polymers.

Obstructive Sleep Apnoea (OSA) can be explained as repeated breathing pauses due to upper airway blockage. As the leading non-invasive treatment for OSA, CPAP therapy supplies a continuous airflow to open the upper airway using pressurised airflow (Al-Jumaily et al., 2003). However, the elevated pressure increases turbulence during inhalation and leads to temporary damage to the respiratory tissues, resulting in nasal dryness and mucosal trauma. Conventional solutions involve external water containers, which are bulky, expensive, and inconvenient for users. In contrast, human exhaled airflow contains 100% relative humidity at body temperature, which carries sufficient water molecules that could be recovered to humidify the inhaled air (Grau-Bartual & Al-Jumaily, 2018).

The research aims to produce a compact, biocompatible, energy-efficient moisture recovery method using a state-of-the-art hydrophilic/hydrophobic smart polymer capable of capturing and releasing water vapour molecules. The ideal characteristics of this polymer would include facilitating optimal water vapour exchange (approximately 44 mg H_2O/L) and operating effectively within the typical human breath cycle, which lasts 4 to 6 seconds (Grau -Bartual & Al-Jumaily, 2020). Smart polymers capable of moisture recovery, both with and without external energy input, were investigated under different compositions, configurations (shapes, sizes), and CPAP pressure conditions to identify the most promising polymer for further analysis. These findings emphasise the potential of smart polymeric materials as a promising candidate for biomedical applications, specially with self-humidification.

This presentation outlines nasal dryness caused by CPAP and highlights smart polymer-based non-invasive solutions.

Keywords
Smart Polymer, Humidification, CPAP therapy

References

Al-Jumaily, A., Mithrarathne, P., Gradon, L., & White, D. (2003, November 15-21). *Modelling and simulation of a breathing system* [Paper presentation]. ASME International Mechanical Engineering Congress and Exposition, Washington, DC, USA. https://doi.org/10.1115/IMECE2003-41853

Grau-Bartual, S., & Al-Jumaily, A. M. (2018). An Approach to Capture Humidity From Exhaled Air [Paper presentation]. ASME International Mechanical Engineering Congress and Exposition, Pittsburgh, Pennsylvania, USA. https://doi.org/10.1115/IMECE2018-86507

Grau-Bartual, S., & Al-Jumaily, A. M. (2020). Prediction of upper airway dryness and optimal continuous positive airway pressure conditions. *Journal of Biomechanics, 112*, 110037.