CENTRE OF BIOLOGICAL ENGINEERING
UNIVERSIDADE DO MINHO

INSTITUTE FOR BIOTECHNOLOGY AND BIOENGINEERING

Characterization of the Wave bioreactor: Residence time distribution

Rodrigues M.E., Costa A.R., Henriques M., Azeredo J., Oliveira R.

IBB-Institute for Biotechnology and Bioengineering, Centre of Biological Engineering, Universidade do Minho, Campus de Gualtar, 4710-057 Braga, Portugal

The high dose requirements of biopharmaceutics have led to the development of mammalian cell culture technologies to increase biomanufacturing capacity. Among them, disposable bioreactors are attracting attention, particularly the Wave bioreactor. This system induces an undulation movement to the culture, ensuring good mixing and oxygen transfer without shear damage, and requires no cleaning/sterilization, providing simpler operation and no cross-contamination. However, this new reactor still needs further characterization. In this sense, the residence time distribution (RTD) was evaluated, allowing the characterization of the mixing/flow and the comparison with ideal models and a commercial stirred tank reactor (STR). RTD was determined using methylene blue with a pulse input methodology, at three mammalian culture flow rates: low (L: $3.3x10^{-5}$ m^3/h), intermediate (I: $7.9x10^{-5}$ m^3/h), and high (H: $1.25x10^{-4}$ m^3/h). Samples were taken and absorbance read at 660 nm. Results show that Wave behaviour approximates the ideal and experimental STR at flow L, but deviates from ideal models at flows I and H. The comparison of average residence time (tr) with time of passage (τ) provides a possible explanation for this non-ideality. For STR at all flows and Wave at flow H, tr was lower than τ, indicating dead zones inside the reactor. For Wave at flows L and I, tr was higher than τ, indicating short-circuiting.

In conclusion, the choice of flow rate will strongly influence the behaviour of the Wave bioreactor. The use of a low flow seems to be a choice that provides behaviour closer to the ideal continuous STR model.