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# **Cell Disruption Mechanics**

by

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# Summary

High-pressure homogenization is a key unit operation used to break cells containing intracellular bioproducts. Modeling and optimisation of this process has been restrained by a lack of understanding of the fundamental processes that occur to effect cell breakage during homogenization.

This thesis examines the cell-fluid interactions that occur during homogenization, and combines them with an investigation of the mechanical properties of the cell. This results in a truly predictive model for cell-disruption efficiency during high-pressure homogenization.

An experimental investigation confirmed previous assertions that cell disruption occurs in the valve-inlet and impinging-jet regions of a homogenizer valve. However, experimental disruption data alone does not elucidate the physical processes that cause cell breakage.

To determine how cells and fluid within the homogenizer interact, an investigation of homogenizer fluid mechanics was conducted. The calculated fluid velocities and strain rates within the valve assembly were then used to model the passage of a cell through the valve. The dependence of maximum cell-wall tensions on cell diameter and homogenizer pressure were then calculated. This then provided a homogenizer tension distribution function.

The mechanical properties of individual cells were characterised using a micromanipulation technique. The ultimate cell-wall tension was found to be Gaussian within a population of cells and independent of cell diameter.

Combination of the calculated homogenizer tension distribution function with the measured ultimate cell-wall tension distribution was used to predict cell-disruption efficiency, and homogenate cell-size distributions, for two cultures of yeast cells, after one pass through the valve-inlet region of an APV-Gaulin 15M high-pressure homogenizer.

**This result is highly significant, as it is the first time that true *a priori* predictions of cell disruption efficiency (that do not rely in any way on the regression of previous disruption data) have been obtained. Further work is required to extend the approach used in this thesis to different microorganism and homogenizer systems.**

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