Supplementary Material

# Supplementary Data

LPTF calculation

An energy balance is used to calculate the theoretical LPTF distance to the inner wall dLPTF, in. Therefore, the sample volume is divided at the LPTF into an inner Vin and outer Vout volume with an equal freezing time tfreezing.

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|  | I |

The heat flow into the sample can be calculated from the heat transfer coefficient k, the heat conducting surface AWall and the temperature difference between the sample and the cooling fluid as described by equation II.

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|  | II |

The total enthalpy H that is removed within tfreezing is calculated by equation III,

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|  | III |

where V is a sub volume, is the mean temperature difference between the mean sample temperature at equilibration and at tfreezing, is the liquid sample density, is the specific latent heat. Equation IV can be calculated by solving I with II and III and calculating the specific areas and volumes with the inner rin and outer rout radii of the freezing device.

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|  | II & III in I |
|  | IV |

was assumed to be linear.