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Instability of thin liquid films in strongly confined channels[1] GIANLUCA LAVALLE, LIMSI, CNRS, Univ. Paris-Sud, Univ. Paris-Saclay, YIQIN LI, SOPHIE MERGUI, FAST, CNRS, Univ. Paris-Sud, Univ. Paris-Saclay, NICOLAS GRENIER, LIMSI, CNRS, Univ. Paris-Sud, Univ. Paris-Saclay, GEORG DIETZE, FAST, CNRS, Univ. Paris-Sud, Univ. Paris-Saclay — The flow of a falling liquid film in contact with a gas within a very narrow inclined channel may occur in several chemical engineering devices, e.g. within structured packings in distillation columns. Surface waves on the liquid film are known to greatly intensify inter-phase heat/mass transfer. It is also known that a counter-current gas flow may destabilize the non-linear surface waves, possibly leading to the flooding of the channel. Conversely, we show in our current study that the confinement can strongly stabilize the film when the gas velocity is quite low. In particular, we find that the critical Reynolds number can be increased by up to 30% at moderate relative confinement. This effect depends on the inclination angle of the channel due to a competition between lubrication- versus acceleration-induced pressure variations in the gas. We show this by way of linear stability analysis based on the Orr-Sommerfeld equation as well as experimental comparisons. In addition, simulations with an integral boundary layer model and direct numerical simulations show that the opposing bounding wall causes a flattening of the crests of large-amplitude non-linear surface waves. This effect may be important in understanding the onset of flooding in strongly-confined geometries.

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Gianluca Lavalle
LIMSI, CNRS, Univ. Paris-Sud, Univ. Paris-Saclay

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