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CAUSTICS FREQUENCIES AND COLLISION RATES OF LONG FLEXIBLE FIBERS FOR DIFFERENT STOKES NUMBERS IN TWO-DIMENSIONAL FLOW FIELDS

Manuel Martínez[*,1], Anton Vernet[2] and Jordi Pallares[3]

[1] Department of Mechanical Engineering, Universitat Rovira i Virgili, Av. Països Catalans 26, 43007, Tarragona, Spain, manuel.martinezd@urv.cat
[2] Department of Mechanical Engineering, Universitat Rovira i Virgili, Av. Països Catalans 26, 43007, Tarragona, Spain, anton.vernet@urv.cat
[3] Department of Mechanical Engineering, Universitat Rovira i Virgili, Av. Països Catalans 26, 43007, Tarragona, Spain, jordi.pallares@urv.cat

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Numerical simulations of long flexible fibers are performed in two-dimensional analytical flow fields. The fibers are modelled as a set of rigid segments, with relative motion of segments providing the fiber with flexibility. Forces are applied to the mass center of each segment, and the numerical model ensures fiber continuity and conservation of overall length. No interaction among fibers is considered, neither the two-way coupling accounting for the fibers effect on the flow [1, 2, 3]. Several cases are simulated for Stokes numbers, which relate the characteristic time of the particle to the characteristic time of the flow, ranging from 0.05 to 10 and for fiber aspect ratios between 10^3 and $7{\cdot}10^4$. A total of 10,000 fibers are released in each simulation, which is run the sufficient time in order to retrieve all the needed statistical parameters. In addition, cases are run for two different analytical flow fields. At the end, results for 33 different cases are obtained.

The results show that the collision rates between fibers correlate with the frequency of caustics (singularities in the particle dynamics field). The correlation coefficient varies from 0.737 to 0.966, depending on the package of cases. These collision rates also correlate strongly with the formation of regions of preferential concentration for fibers with the same aspect ratio, with correlation coefficients larger than 0.965. In addition, the dimensionless frequency of caustics is observed to be dependent on the Stokes number. For low Stokes numbers, this dependence is found to be linear, while for larger Stokes numbers it fits well with a power expression.

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