Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Effect of phase delay on the pumping efficiency of a multi-plate gill array[1] MARY LARSON, KEN KIGER, Univ. of Maryland — In nature, pumping by oscillating appendage arrays (used for respiration, feeding or locomotion) have been noted to exhibit distinct patterns of movement depending on their intended function and Reynolds number. One thing that is typically in common, however, is that a phase lag of 60 to 90 degrees between adjacent appendages is used for many low to intermediate Reynolds number conditions (10 to 10000). To understand why this trait is commonly exhibited, a robotic oscillating plate array modeled after a nymphal mayfly was constructed that permitted stroke, pitch and phase lag variation between adjacent plates. Stereoscopic PIV was used to obtain three-dimensional velocity data, allowing computation of the net pumping rate and flow induced dissipation for five cases, focusing on the role of the gill plate interactions and their dependence on the phase lag between adjacent gills. The results indicate that mayfly gills most likely use a phase lag of 90° because it produces the highest net mass flow rate while consuming the least amount of energy. Measurements indicate that this occurs as a balance between excessive dissipation during close-approach events while optimizing favorable hydrodynamic interactions between adjacent plates.

[1]Work supported by NSF under grant CBET0730907.

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Date submitted: 11 Aug 2011 Electronic form version 1.4