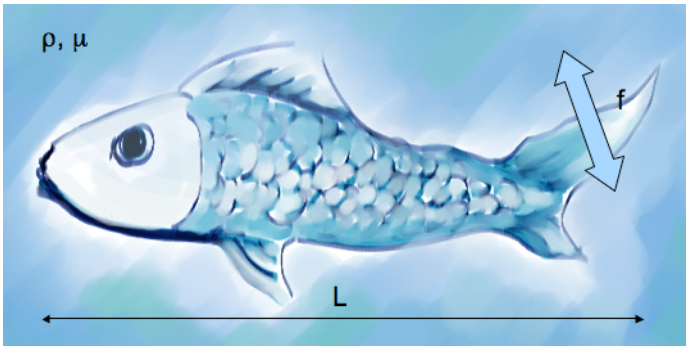
MIT Department of Mechanical Engineering
2.25 Advanced Fluid Mechanics

Problem 7.18
This problem is from "Advanced Fluid Mechanics Problems" by A.H. Shapiro and A.A. Sonin



A researcher is concerned with the mechanics of fish propulsion. To determine how the thrust force generated by a fish of a given geometry depends on fish size (L = fish length) and on the frequency of oscillation of the tail (f, in cycles/sec), she builds a mechanical model, having this geometry, of length $L = 1\,\text{m}$. She then mounts this model in a fixed position deep within a large tank containing stagnant water at room temperature, and measures the thrust force F, over a large range of frequency of tail oscillation. She finds that her data can be described by the empirical equation

$$F = \frac{0.49 \times 10^4 f^3}{1 + 0.74 \times 10^3 f} \text{ Newtons} \tag{7.18a}$$

where f is in cycles/sec.

(a) Suppose we want to infer, from these results, the thrust generated by fish of other sizes held in still water having different temperature (*i.e.* different density, viscosity). What relation must be satisfied between the frequency, size, and fluid condition of the real fish and of the model experiments

(b) From the empirical equation given above for the thrust of a 1 m model in room temperature water, develop a formula for the thrust of a fish of any given size and tail frequency, held in water at any given density and viscosity.

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