

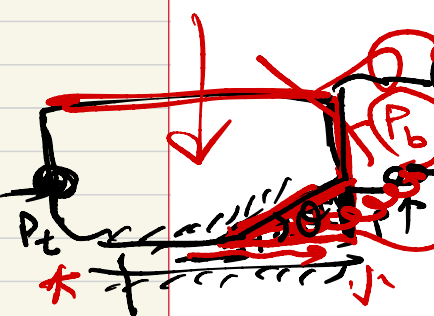
중간고사 (midterm) Ch.7
 (3주2 → 5/17)

5월 10 일 (수)

시간 6:30 - 8:30
 9:00

5/10 수업 할

4/19 수업 - ZOOM



viscous flow

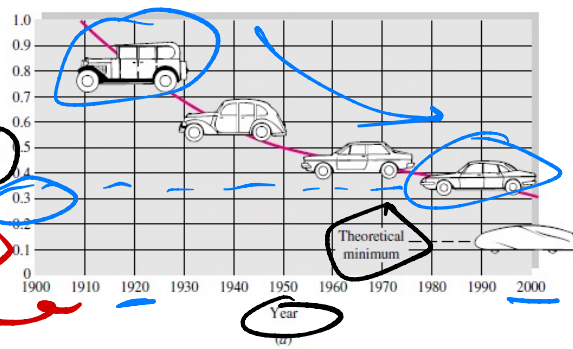
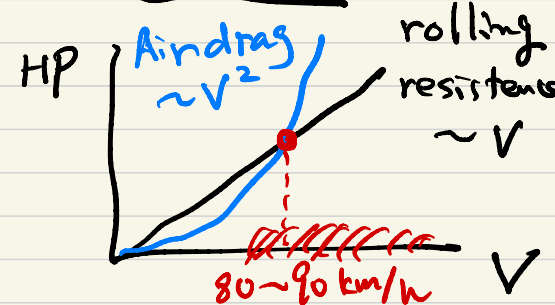


Fig. 7.17 Aerodynamics of automobiles: (a) the historical trend for drag coefficients (from Ref. 21); (b) effect of bottom rear upsweep angle on drag and downward lift force (from Ref. 25).

$$C_D = \frac{D}{\frac{1}{2} \rho U^2 A} \approx \text{const}$$

$$D \sim U^2$$

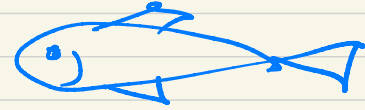


sedan $C_D = 0.25 \sim 0.3$
 SUV $C_D = 0.3 \sim 0.35$



Benz, bionic car
concept car

boxfish

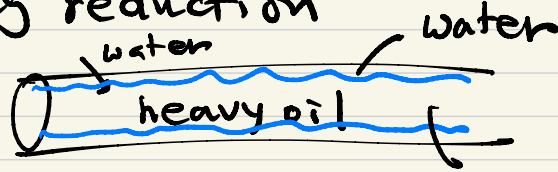


$$C_D = 0.19$$

side mirror $\Delta C_D = 0.01$

• Other methods of drag reduction

① oil + water



drag 60% ↓

② water + polymer (ppm)

drag 80% ↓

$\mu_{\text{water}} \ll \mu_{\text{heavy oil}}$

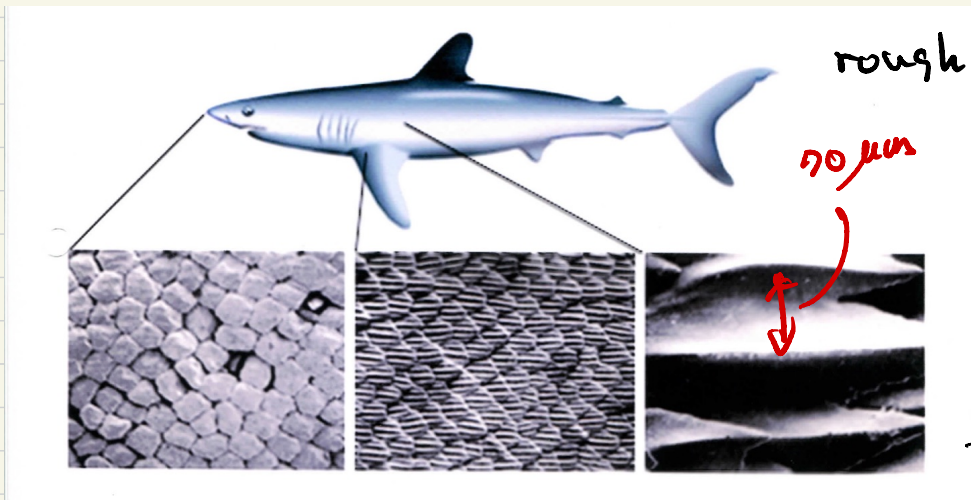
Min et al. (JFM)



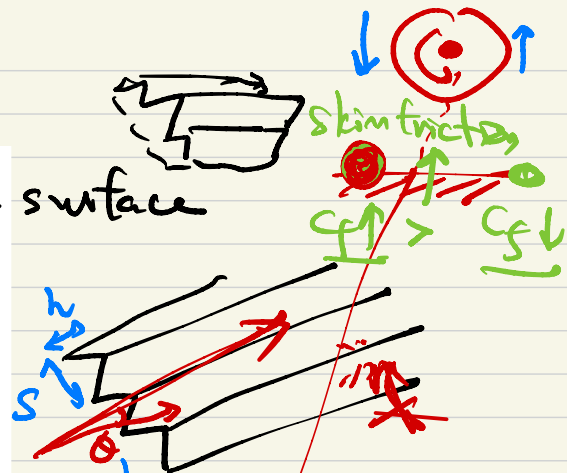
water + polymer

water only

③ riblets (리블릿)

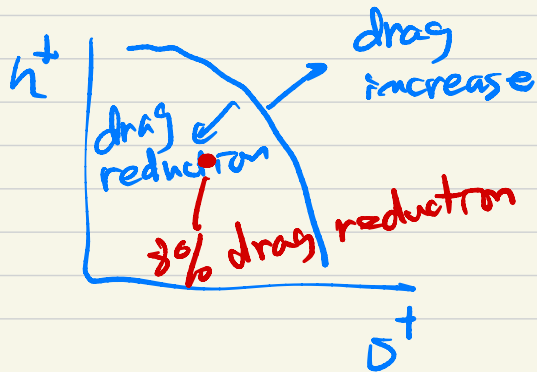


rough surface

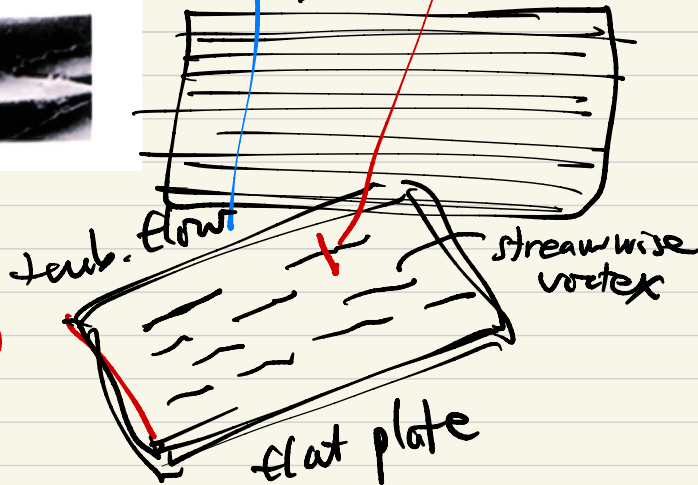


$$\frac{h \cdot \nu}{D}$$

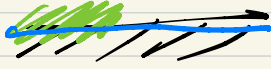
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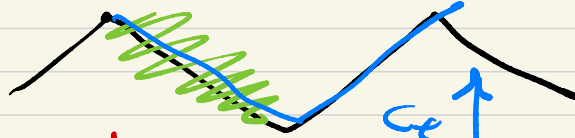
30% drag reduction (1978 ~ 1980)
Walsh



㉔



㉕



Choi et al.
(1993, JFM)

㉖



$C_f \downarrow$

저산속영역, 비행기

① 돛새치

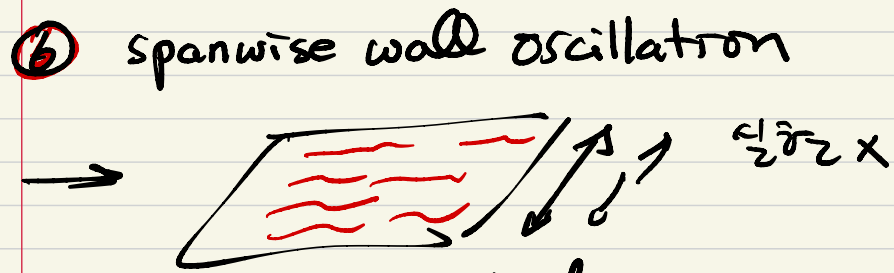
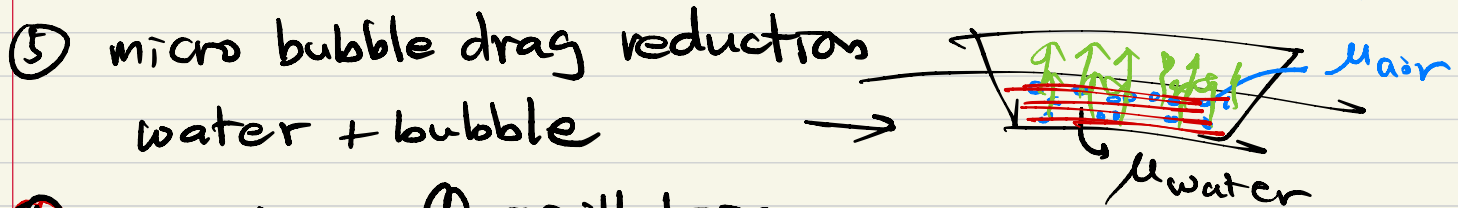
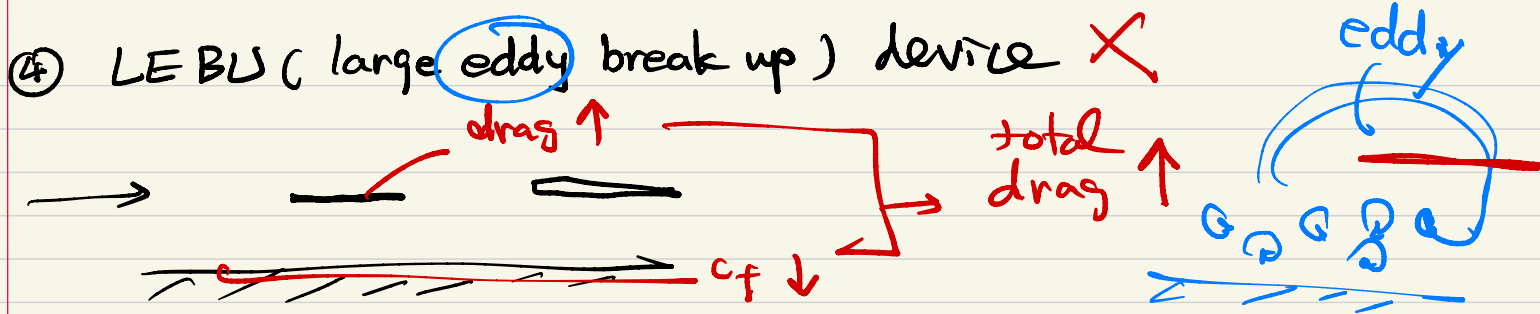


110 km/h

② 청새치

- 오징어
- 돌고래
- 날치

⑩ 상어 50 km/h



⑦ active flow control - opposition control (Choi et al. 1994 JFM)
 20% control of flow over a bluff body
 Choi et al. (2008, Ann. Rev. Fluid Mech.)
 Aerodynamics of heavy vehicles
 Choi et al. (2014, ")

⑧ biological drag reduction - biomimetic flow control

