Air flow

- Ventilation
  - supply of fresh air
  - removal of internal heat
  - heat dissipation from skin

Image by MIT OCW.
Air flow

- Ventilation
  - supply of fresh air
  - removal of internal heat
  - heat dissipation from skin
Air flow

- Ventilation
  - Zion National Park Visitor Center (National Park Service & NREL)

Images courtesy of the U.S. Department of Energy.
Active air flow

Supply of fresh air based on renewal and change rates

Ventilation flow rate $v_r \ (m^3/s) = V \times N \ (nb \ of \ air \ changes \ per \ hour) / 3600$

Ventilation conductance $q_v \ (W/K) = 1200 \ (J/m^3K) \times v_r = 0.33 \times N \times V$

Ventilation heat flow: $Q_v = q_v \times \Delta T$
Active air flow

- Supply of fresh air based on renewal and change rates

Same 60 m³ room as studied for heat flow. Heat losses through façade due to conduction = 190 W

Losses due to air renewal ($N = 0.7 \text{ h}^{-1}$)? What should $N$ be for ventilation and conduction losses to be equal?
Passive air flow

Fluid mechanics: \[ p + \rho gh + \frac{1}{2} \rho v^2 = \text{constant (Bernouilli)} \]

Hydrostatics:
\[ \Delta p = \Delta h \rho g \]

Stack effect:
\[ \Delta p_{i-e}(h) = (h-h_n)g(\rho_e - \rho_i) \]

\[ \rho(T) = \rho_0 \cdot \frac{p}{p_0} \cdot \frac{T_0}{T} \]
Passive air flow

- Fluid mechanics: \( p + \rho gh + \frac{1}{2} \rho v^2 = \text{constant (Bernouilli)} \)

  - hydrostatics: \( \Delta p = -\Delta h \rho g \)
  - stack effect: \( \Delta p_{i-e}(h) = (h-h_n)g(\rho_e - \rho_i) \)
  - \( \rho(T) = \rho_0 \cdot \frac{p}{p_0} \cdot \frac{T_0}{T} \approx 1.29 \text{ (kg/m}^3\text{)} \cdot \frac{273}{T} \)

  hydrodynamics (wind): \( \Delta p = -\frac{1}{2} \rho \Delta v^2 \), Venturi effect: \( S_1v_1 = S_2v_2 \)

Image by MIT OCW.
Passive air flow

- Fluid mechanics
- Pressure ↓ if speed ↑
- Turbulent vs. steady flow
Air flow

Wind

Protected zone

Ascending and descending movements along facades

Influence of relative heights

Image by MIT OCW.
Reading assignment from Textbook:
- “Introduction to Architectural Science” by Szokolay: § 1.1.4 + § 1.4.2

Additional readings relevant to lecture topics:
- "How Buildings Work" by Allen: Chap 11
- “Sun Wind Light“ by Brown & DeKay: § 6 in Chap 1A