ABE 4171 Power and Machinery

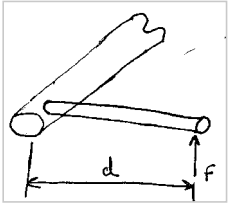
- Review

Review

- Work = force * distance = lbs * ft
  - English: ft*lbs
  - SI: N*m (Joule)
- Power = (force * distance) / time
  - English: (lbs * ft) / sec
  - SI: (N*m) / s = Watt
- Ex: F = 100 N, v = 4 m/s, P = ?
  - 100 N * 4m / 1s * 1W / 1Nm/s = 400 W

Mechanical Power

- 2 forms
  - Linear power – uses linear velocity
  - Rotary power – uses radial velocity
- Torque
  - T = f*d (ft*lbs) or (N*m)
- Rotary speed
  - Eng: Rev per min →RPM
  - SI: Rev per sec → RPS



Rotary Power

- P = (F * D) / τ (Linear)
- C = distance/revolution = 2πr
- W (Angular Speed) = Rev/Min
- Power = F * C * W * (1 HP/33,000 ft*lb/min)

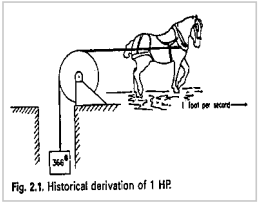


Fig. 2.1. Historical derivation of 1 HP.

Example

- F = 100 N, R = 0.254 m, w = 2.5 rev/s
- Power =

100 N * (2π * 0.254m)/rev * 2.5 rev/s * 1W/(N*m/s) * 1kW / 1000W

= 0.4 kW

Rotary Power Example

- Rev = 2πr = 6.280 ft

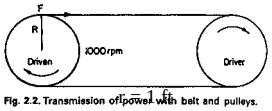
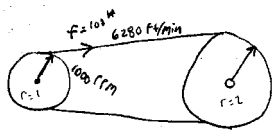


Fig. 2.2. Transmission of power with belt and pulleys.

- d/τ = 6.28 ft/rev * 1000 rev/min = 6280 ft/min
- P = (100 lb * 6280 ft/min)/ (33000 ft*lb/min) = 19 HP

Example



w_1 = 1000 rpm
w_2 = 500 rpm
$V_1 = 2\pi*1$ ft/rev * 1000 rpm
= 6,280 ft/min
$V_2 = 2\pi*2$ ft/rev * 500 rpm
= 6,280 ft/min

- P_1 = (100 lbs * 6.280 * 1000 RPM) / 33,000 = 19 HP
- P_2 = (100 lbs * 12.56 * 500 RPM) / 33,000 = 19 HP
- T_1 = 100 lbs * 1 ft = 100 ft*lbs
- T_2 = 100 lbs * 2 ft = 200 ft*lbs

Off-Road Vehicle Power

- Pulling power: pulled or towed implements receive power through traction of drive wheels and the draft of the drawbar.
- Rotary power: from power take off shaft (PTO) or belt pulley
- Hydraulic power: can produce linear and rotary power; steering, brakes, implement, and transmission
- Electric power: Battery and alternator; ignition, CD, AC, lights

Drawbar Power

- DBP = FS/C
  - Where DBP = hp
  - F = lbs
  - S = mph (ground speed)
  - C = 375 (constant)

PTO Power

- PTOP = $(2\pi FRN) / C = (2\pi TN) / C$
  - Where PTOP = hp
  - F = lbs - tangential force
  - R = ft - radius of force rotation
  - N = RPM
  - T = lb*ft
  - C = 33,000 for English and 60 for SI Units

Hydraulic Power

- HyP = P*Q / C

  Where
  - HyP = hydraulic power in hp
  - P = Gauge Pressure in psi
  - Q = Flow rate in gal/min
  - C = 1714

Electric Power

- Power = Voltage * Current
  - P = E*I
  - P = Watts
  - E = Volts
  - I = Amps