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ABE 301, Deliverable 1

Sweat production volume of a professional soccer player

Description:

The model I will construct will output the rate of sweat production volume of a professional soccer player over a 90 minute game. The human body can only operate normally between 36.5°C and 37.5°C and temperatures outside this range impair the body’s regular function. Additionally, the body produces heat as a byproduct of metabolic reactions (Vella & Kravitz). In converting chemical energy into mechanical energy, 75% of the energy is lost as heat through radiation, convection, conduction, and sweat evaporation (Vella & Kravitz). During exercise, heat is generated at a higher rate and the body adjusts to this by increasing blood flow to sweat glands at the skin’s surface, producing sweat so that it evaporates and cools the body (Vella & Kravitz). As sweat is mostly composed of water, sweating causes the body to lose its water content. A loss of more than 5% of the body’s water content causes mild dehydration symptoms, including fatigue, dizziness, and thirst (Dehydration).

Model Inputs:

* Ambient air temperature (°C)
* Relative ambient air humidity (%)
* Player’s mass (kg)
* Player’s height (m)
* Total time played (minutes)
* Player’s position (determines average velocity - m/s)

Model Outputs:

* Sweat volume produced (L) and sweat volume production rate (L/min)
* Time at which the player will begin to display dehydration symptoms (if at all) (minutes)
* Volume of water the player must drink to restore the fluids lost during the game (L)

Relationships:

* Mass balance of aerobic respiration reactants and products, assuming oxygen to be the limiting reactant
* Energy balance of energy produced, used, and lost by the body during play
* Rate of energy use in changes of running speed
* Enthalpy balance to determine heat production of body
* Mass balance of water production through respiration and loss through sweat to determine dehydration point (>5% body water content loss)
* Phase equilibrium/psychrometrics of water and vapor in ambient air determine the evaporation of sweat and thus the cooling of the body temperature

References:

* Dehydration. (2017, November 17). Retrieved January 21, 2018, from https://www.mayoclinic.org/diseases-conditions/dehydration/symptoms-causes/syc-20354086
* Miñano-Espin, J., Casáis, L., Lago-Peñas, C., & Gómez-Ruano, M. Á. (2017). High Speed Running and Sprinting Profiles of Elite Soccer Players. Journal of Human Kinetics, 58, 169–176. http://doi.org/10.1515/hukin-2017-0086
* Vella, C. A., M.S., & Kravitz, L., Ph.D. (n.d.). Staying Cool When Your Body is Hot. Retrieved January 21, 2018, from https://www.unm.edu/~lkravitz/Article%20folder/thermoregulation.html