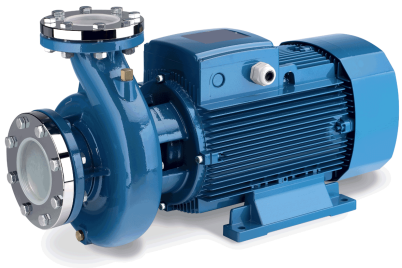
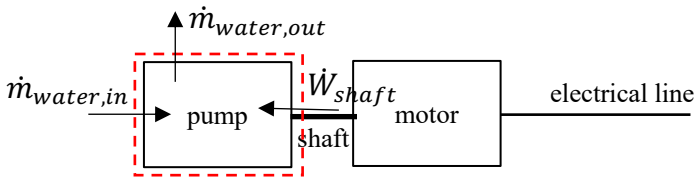
a. Draw an EFD for a water pump, not including the electric motor. Assume the pump is well insulated, but the motor is not. Note that the pump is connected to the motor via a rotating shaft.

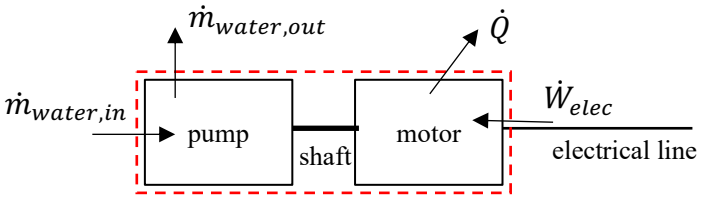


b. Now draw an EFD that includes the electric motor.
c. How will your EFD change for part (b) if the motor is well insulated?

Solution:
For simplicity and clarity, make a schematic of the pump and motor. For part (a), the control volume (CV) surrounds just the pump. There is water mass entering and leaving the CV. Since the pump, i.e., the CV, is well-insulated, there is no heat transfer into or out of the CV, i.e., the CV is adiabatic. Because the pump/CV is connected via a rotating shaft to the motor, there is shaft work that is done on the CV.



For part (b), the CV now includes the pump, motor, and shaft. We still have water mass entering and leaving the CV. Since the motor within the CV volume, there is now some heat that is leaving the CV. In addition, there is now electrical work done on the CV; however, there is no longer any shaft work since the rotating shaft is entirely within the CV. The shaft does not cross the control surface.



For part (c), the CV is the same as part (b) and the mass flow rates and electrical power are the same. The only difference now is that the motor is well-insulated (like the pump) so that there is no longer any heat transfer across the control surface. Thus, the CV is once again adiabatic.