Inquiry-Based Activity 1: Hair Dryer (Simulation)

Student Name _____

In this simulation, a hairdryer will be used to simulate air flowing through a compressor. You will measure the temperature before and after compression as well as the flow rates to calculate an energy closure for the system.

***Materials**:*

Something with internet access that can run javascript (most browsers should work)
This link: http://www.facstaff.bucknell.edu/mvigeant/Thermo_JS/Tempestv2.0/tempest.html

***Directions**:*

10. You will be flowing air through the hair dryer on the cool setting, where the heating element is not on – the dryer in this case operates very much like a fan. Predict if the temperature of the air will change as it passes through the dryer. Will the temperature increase, decrease or remain the same relative to the entering air? Explain your reasoning.

11. Open the simulation.
12. Set the middle switch on the hair dryer to COOL.
13. The exit diameter of .the hair dryer is 4.5cm, you will need this value in the analysis questions.
14. Switch the virtual hair dryer on.
15. Once it is running, take a velocity measurement with the anemometer right at the exit of the hair dryer. Assume the entering air is quiescent (i.e. zero net velocity). You may need to move the hair dryer to get an accurate reading from the anemometer..

    Exit Velocity = _____

16. While the hair dryer is running, record the value for the power in watts that is being measured by the wattmeter.

    Power = _____ W

17. While the hair dryer is running measure the temperature at the outlet. As with the velocity, you may have to move it to get the most accurate value which should be at the center line of the hair dryer exit. You may measure the surroundings temperature by moving the thermocouple to the right hand side of the screen. .

Room Temperature (entrance temperature) = _____°C Exit Temperature = _____°C

18. You can try again with other settings if desired (be sure to record which settings you use. Note, all data were originally captured from the original experimental setup).

Analysis *– to do after class/lab and hand in:*

9. What did you observe in this experiment? How did these results compare with your predictions? If it was different from your prediction explain why. Feel free to discuss this with your group.
10. Symbolically (no numerical values at this point), write an energy balance for the air as it moves through the hair dryer.
11. Calculate the cross sectional area for the exit of the hair dryer.
12. Assuming ideal gas law, determine the mass flow rate of air in and out of the hair dryer.
13. Determine what change in kinetic energy the air undergoes as it moves through the hair dryer. How does the magnitude of this value compare to the magnitude of the electrical work entering the system?
14. Calculate the values for the change in internal energy and enthalpy for the air as it moves through the hair dryer. You may assume that the Cp and Cv for air are independent of temperature and are 1.008 and 0.720 J/g*°C (**ref in faculty version)**, respectively.
15. From your calculations determine the closure on the energy balance using the internal energy. Now repeat the calculation using enthalpy instead. How do the energy closures compare? Conceptually, what is the difference between the two?
16. The heating elemental was off and there was no heat being added so what led to an increase in the temperature of the air? Note there are <u>two</u> sources for the observed change. Even a (impossible) perfectly efficient compressor would alter the air's temperature.