Chapter 6 Question #7

Frequently we model compressors as being adiabatic and quasi static and neglect changes in kinetic and potential energy. For such a device operating with air as an ideal gas (R=287 J/kg-K, c_v=716.5 J/kg-K, c_p=1003.5 J/kg-K) which of the following is true?

1) $0 > W_{shaft} > W_{flow} > W$

2) $W_{flow} > 0 > W_{shaft} > W$

3) $W_{flow} > 0 > W > W_{shaft}$

4) $0 > W_{shaft} > W > W_{flow}$

5) I don't know

LO#4

Chapter 6 Question 7 Answer:

(3) $w_f > 0 > w > w_s$

For an adiabatic compressor $w_s = -c_p(\Delta T)$, $w = -c_v(\Delta T)$, and $w_f = R(\Delta T)$. For air, $c_p > c_v > R$. Therefore $w_f > 0 > w > w_s$. This illustrates an important point regarding shaft work and flow work. For a steady flow device, what you would like to design to is the work that must be put into the shaft. If you calculate, the total work (w), you will come up short for a compressor.