## Practice Problem

**27-1** A turbojet engine propels an aircraft at a speed of 535 miles per hour through still air at 6.5 psia, 9°F. The inlet diameter of the diffuser of the engine is 5.25 ft. The pressure ratio of the engine is 13 and the temperature at the turbine inlet is 1035°F. Air leaves the nozzle of the engine at 6.5 psia. Analyze the Ideal engine performance with (assume isentropic efficiency of 100% for the diffuser, compressor, turbine, and nozzle). Analyze this engine using the real-fluid properties of air (fluid name = ‘air\_ha’). Calculate the following:

1. The velocity at the exit of the nozzle (mph)
2. The propulsive force (thrust) of the engine (lbf)
3. The heat transfer rate required at the combustion chamber (Btu/hr)
4. The propulsive power of the engine (hp)
5. The propulsive efficiency of the engine

**27-2** Repeat the above problem , except use an isentropic efficiency of 85% for the compressor and turbine. The diffuser and nozzle can stay at 100% isentropic efficiency.

1. Compare your answers to the ideal case above.
2. Does the propulsive efficiency make sense, and why/why not?

## Preparatory Reading Questions

1. Sketch the operation of an air standard Carnot engine on Ts and Pv diagrams. Using thermodynamic vocabulary, rigorously describe each process in the Carnot gas engine cycle.
2. What device is used in a Stirling engine to approach Carnot cycle efficiency?
3. Sketch the operation of an air standard Brayton cycle on Ts and Pv diagrams. Use a SOLID LINE to express ideal operation. Use a DASHED LINE to express real operation that includes compressor inefficiency, turbine inefficiency, and combustion chamber pressure drop.
4. In a Brayton cycle, what is meant by pressure ratio? Express the thermal efficiency of a cold air standard Brayton cycle in terms of the pressure ratio. Define all parameters in this expression.

## Answers

For the Ideal cycle

1. ~1300 (mph)
2. ~22,000 (lbf)
3. ~2.5 x 108 (Btu/hr)
4. ~30,000 (hp)
5. ~60 (%)

For the Real cycle

1. ~760 (mph)
2. ~6,500 (lbf)
3. ~1.9 x 108 (Btu/hr)
4. ~9,000 (hp)
5. ~80 (%)