

# University of Nottingham

## Department of Mechanical, Materials and Manufacturing Engineering

### Thermofluids 3

#### Self Assessment Exercise Sheet - Non-Steady Flow Energy Equation

1. A rigid tank, volume = 100 litres, contains air at 1 bar, 20°C. The tank is filled from a supply of air at 7 bar 20°C until the pressure in the tank is 7 bar. Assuming no heat losses from the tank during filling, calculate the final temperature of the air in the vessel, and the mass of air which enters the vessel.  
[115°C, 0.0.51 kg]

The air in the tank then cools to 20°C, calculate the final pressure in the tank.  
[5.29 bar]

Calculate the exergy in the air fed into the tank from the supply, the initial exergy of the air in the tank immediately after filling and the final exergy in the air in the tank after it has cooled to room temperature.  
[83.5 kJ, 50.9 kJ, 45.2 kJ]

The environmental temperature is 20°C and pressure 1 bar. (All pressures are absolute pressure.)

*This second question is more difficult and you won't be asked an exam question on this.*

2. A compressed air bottle containing air at 34 bar (absolute) and 15°C, is to be used to drive a small turbine as an emergency starter for an engine. The turbine is required to produce an average output of 4 kW for 30 seconds. The pressure in the bottle is allowed to fall to 3.4 bar during the process, and that the turbine exhausts to atmosphere at 1.01 bar and the air exhausting from the turbine is at a constant temperature of -150°C, determine the necessary capacity of the bottle.

Assume that the air in the bottle expands isentropically and adiabatically (ie.  $p v^\gamma = \text{constant}$ ).

*(The air is very cold at outlet from the turbine as it has done work on the turbine.)*

[33.8 litres]

*Hint: draw a control volume around bottle and turbine and apply NSFEE.*