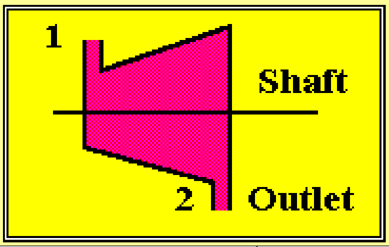
This document shows how Thermo Utilities, MS Excel Add-ins can be used for calculation of expansion process.
Flue gases at 10.5 bar and 700 C enter to a gas turbine. The turbine has a pressure ratio of 10/1. The isentropic efficiency of the expansion is 0.85. The volumetric composition of flue gases is:
N_2 76.4%; O_2 4.0%; CO_2 15.1%; Ar 0.09%; H_2O 4.2%; SO_2 0.21%
Calculate the temperature, specific enthalpy, and specific entropy of the flue gases at the outlet.
If the intake of hot gases is 5 kg/s, what is the output of the turbine?



Inputs		Units	Error ?
Inlet Pressure	10.5	bar	
Inlet Temperature	700.0	C	
N2 Volumetric %	0.7640		
O2 Volumetric %	0.0400		
CO2 Volumetric %	0.1510		
Ar Volumetric %	0.0009		
H2O Volumetric %	0.0420		
SO2 Volumetric %	0.0021		
Isentropic Efficiency	0.850		
Pressure Ratio	10.000		
Mass Flow	5.000	kg/s	

Equations:

$$\gamma = \frac{C_p}{C_p - R}$$

$$\eta_t = \frac{H_1 - H_2}{H_1 - H_{2s}} \quad \text{Isentropic Efficiency}$$

$$\frac{T_1}{T_{2s}} = \left(\frac{P_1}{P_2}\right)^{\frac{\gamma-1}{\gamma}} \quad \text{Isentropic Process}$$

Outputs			
Inlet Enthalpy	833.088	kJ/kg	
Gas Constant	0.275	kJ/(kg.K)	
Inlet Entropy	0.726	kJ/(kg.K)	
Inlet Specific Heat Capacity	1.198	kJ/(kg.K)	
Gamma	1.298		
Kelvin	273.150	C	
Outlet Pressure	1.050	bar	
Ln(P1/P2)	2.303		

(1-1/Gamma)*'Ln(P1/P2)	0.528			
T1/T2s=....	1.696			
T2s	573.923	C		
T2s	300.773	C		
H2s	376.256	kJ/kg		
Outlet Enthalpy	444.781	kJ/kg		
Outlet Temperature	363.341	C		
Outlet Entropy	0.871	kJ/(kg.K)		
Turbine Output	1941.536	kW		

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