SNS College of Technology

(An Autonomous Institution)

16AE201/ Aero Engineering Thermodynamics

Unit -5/ IDEAL AND REAL GASES THERMODYNAMIC RELATIONS

Tds Relations

In the previous section, the definition of entropy is given by

$$dS = \left(\frac{\delta Q}{T}\right)_{rev}$$

Rearranging the above equation gives

$$\delta Q_{rev} = Tds \qquad (1)$$

The entropy change during an internally reversible process (1-2) is

$$dS = S_2 - S_1 = \int_1^2 \left(\frac{\delta Q}{T}\right)_{rev}$$

Tds = du +Pdv

The Tds Relations for Closed System

Only when the relation between δQ and T is known, the entropy change can be determined. The relations between δQ and T can be found by considering the energy balance of a closed system.

The differential form of the energy balance for a closed system, which contains a simple substance and undergoes an internally reversible process, is given by

$$dU = \delta Q_{rev} - \delta W_{rev} \qquad (2)$$

The boundary work of a closed system is

$$\delta W_{rev} = PdV \qquad (3)$$

Substituting equations (1) and (3) into equation (2) gives

$$dU = TdS - PdV$$
$$TdS = dU + PdV$$

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or

$$Tds = du + Pdv \qquad (4)$$

where

s = entropy per unit mass

Equation (4) is known as the first relation of Tds, or Gibbs equation.

The definition of enthalpy gives

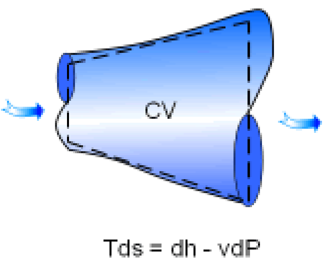
$$h = u + Pv$$

differential the above equation yields

$$dh = du + Pdv + vdP$$

Replacing du + Pdv with Tds yields

$$dh = Tds + vdP$$
$$Tds = dh - vdP \qquad (5)$$



The Tds Relations for Open System

Equation (5) is known as the second relation of Tds.

Although the Tds equations are obtained through an internally reversible process, the results can be used for both reversible or irreversible processes since entropy is a property.

Rewriting equations (4) and (5) in the following form

$$ds = du/T + Pdv/T$$
$$ds = dh/T + vdP/T$$

The entropy change during a process can be determined by integrating the above equations between the initial and the final states.