CHE 205 MASS AND ENERGY BALANCES

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BALANCES ON REACTIVE PROCESSES:

Each time a chemical reaction takes place, chemical bonds are broken and new bonds are formed between the atoms. For the reactions between molecules, some energy is needed to break the chemical bonds of the reactant molecules and energy is released when new bonds are formed in the product. If the nergy requuired in the first process is less than the energy released in the second process, then the reaction is said to be EXOTHERMIC. The net energy released during the chemical reaction is called the HEAT OF REACTION and must be transffered from the reactor to the surrounding to keep the temperature constant.

If the energy released during the formation of new bonds is less than the energy required to break the reactant bonds, then the reaction is said tobe ENDOTHERMIC.

An energy balance on the reactor is needed to know how much heating or cooling is required to operate the system at desired conditions.

HEAT OF REACTION is defined as the change in enthalpy of the system when reactants in stoichiometric quantities react completely to form products at specified temperature and pressure. The value of heat of reaction is a negative value when the reaction is exothermic and a positive value when the reaction is endothermic. The heat of reaction value also depends on the states of the substances that are being reacted or produced. The standart heat of reaction is the defined as the heat of reaction when both reactants and products are at the same specified temperature and pressure, usually 25^{o}C and 1 atm.

Heat of reaction for a certain chemical reaction can be calculated by using heat of formation values for each substance in the reaction. The standart heat of reaction can be formulated as:

$$\Delta H_r^0 = \sum_{products} v_i \, \Delta H_{fi}^0 - \sum_{reactants} v_i \, \Delta H_{fi}^0$$

The standart heats of formation denoted by ΔH_{fi}^0 can be found from *Perry's Chemical Engineering Handbook* as tabulated values. For elemental species, these values should be set to zero.

YOUR TURN:

Calculate the standard heat of reaction for the dehydrogenation of ethane:

$C_2H_6 \rightarrow C_2H_4 + H_2$

The standard heat of formation of a certain chemical reaction can also be calculated from the STANDARD HEAT OF COMBUSTION values for each substance in the reaction.

$$\Delta H_r^0 = \sum_{reactants} v_i \, \Delta H_{ci}^0 - \sum_{products} v_i \, \Delta H_{ci}^0$$

Where ΔH_{ci}^0 is the standard heat of combustion for a substance.

YOUR TURN:

Write the combustion reaction for liquid n-nonane to form CO_2 and liquid water. The standard heat of reaction is given as: -6124 kJ/mol.

Is the reaction exothermic or endothermic?

For isothermal conditions, do you need to heat or cool the reactor?

If the reactor is run adiabatically, what would be the temperature in the reactor?

If 50.0 kmol/s of liquid is consumed and all of the substances are at 25^{o}C, estimate the required rate of heat input or output.

If the water leaving the reactor is in gas state, what would be the heat of reaction?