Chemical Reactivity

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Learning Outcomes

- Use Gibbs free energy and other thermodynamic properties to estimate the stability and potential energy release of chemicals.
- Understand chemical compatibility and the risks of accidental mixing of incompatible substances.
- Interpret data from thermal stability tests (e.g., DSC, ARC) to determine safe processing limits.

Reading

- Foundations of Spiritual and Physical Safety: with Chemical Processes; Chapter 6, Sec. 2

Download pdf of lecture freeform here: physical/supportfiles/311Reactivity.pdf

See also a pdf of mass and energy balances: physical/supportfiles/MassAndEnergyBalances.pdf

Action Items

1. Calculate the heat of reaction at standard conditions for the production of formaldehyde from methane and oxygen (CH_4+O_2+H_2O). Is this an exothermic or endothermic reaction? Why?
2. Download the appropriate portion of the Bretherick's Handbook of Reactive Chemical Hazards(Urben, 2017) and outline the hazards stated on using butanol with aluminum. Also list what happened to the aluminum distillation column with a reason why.
3. What are estimates of enthalpy and Gibbs energy of reaction for methane pyrolysis at 1000 C? The text(Guymon, 2025) on Page 116 can help you make an estimate.
4. Reproduce the plot in Figure VI.1(Guymon, 2025). Also plot the enthalpy of reaction for the same temperature and pressures. Describe differences in the Gibbs free energy and enthalpy at a pressure of 200 atm and temperatures of 450 C and 600 C and what those values mean.

5. What percentage increase to the reaction rate in Eq. VI.3(Guymon, 2025) occurs with a 90% temperature increase from 175 to 333C (given a typical activation energy of 50kJ/mol)?

6. Generate a compatibility matrix for the chemicals in your house. Include at least four (4) chemicals.

References

C. Guymon. *Foundations of Spiritual and Physical Safety: with Chemical Processes*. 2025.

P. Urben. *Bretherick's Handbook of Reactive Chemical Hazards*. Elsevier, 2017.