
CHEMICAL REACTIVITY

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Keywords Spiritual Safety, Process Safety, Chemical Engineering, Risk Assessment

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 to Sec. 2.1

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

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

Action Items

1. Calculate the heat of reaction at standard conditions for the production of formaldehyde from methane and oxygen ($\text{CH}_4 + \text{O}_2 \rightarrow \text{H}_2\text{O}$). Is this an exothermic or endothermic reaction? Why?
2. Download the appropriate portion of the Bretherick's Handbook of Reactive Chemical Hazards([Urban, 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.