Introduction

- **What is Industrial Chemistry?**

The development, optimization and monitoring of fundamental chemical processes used in industry.

It Deals with transforming raw materials and precursors into useful commercial products for society

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- Industrial Chemists study and apply the physical and chemical properties of substances to determine their composition. They use this information to develop new substances, processes and products and to increase scientific knowledge.

Characteristics of the Chemical Industry

1) *Basic objective* - make a profit
2) *Very competitive*
3) *Highly dependent on science and technology*
4) *Spends large amounts of its money on R&D*
5) *Large capital requirements* - to construct, expand and maintain production facilities
6) *Low labor requirements* - BUT needs highly qualified personnel
7) *Industry Growth* - generally through integration rather than diversification

The Chemical Sector at a Glance

Chemicals and chemical products:

- account for ~10% of total world trade in all commodities
- are the 2nd largest single item of global trade (road vehicles being the 1st).

<u>World Chemicals Output (2002): $1.6 Trillion USD</u>

- Europe 31% USA 28% Asia/Pacific 27% Other*14%.

<u>North American Chemicals Output (2002): $505 Billion USD</u>

- USA 92% ($467 Billion USD)
- Canada 5% ($23 Billion USD)
- Mexico 3% ($15 Billion USD)

Laboratory Chemistry *vs.* Industrial Chemistry

There are fundamental differences between the design of a chemical synthesis for industry and that for a research laboratory.

Students should be able to

1) explain how industrial synthetic approaches differ from laboratory synthesis methods.

2) evaluate possible reaction schemes based on thermodynamic, economic, and other considerations.

.g., formation of ethyl alcohol by hydration of ethylene

$$CH_2{=}CH_2 + H_2O \xrightarrow{H^+} CH_3CH_2OH$$

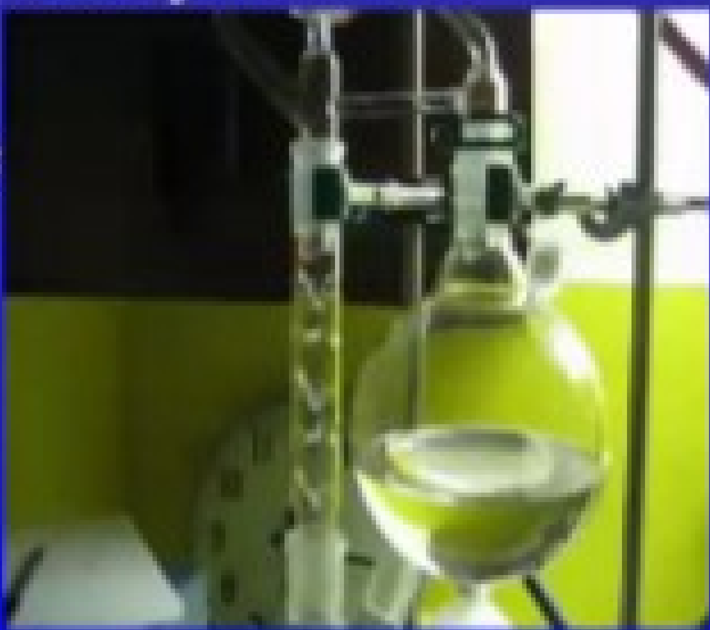
Laboratory Scale

- bubble ethylene into 98% H_2SO_4
- dilute and warm the reaction mixture to hydrolyze the resultant sulfate ester

Laboratory Objectives

- synthesize the product in the most convenient manner considering:

1) chemist's time
2) equipment available (usually must use glassware)
3) conditions achievable



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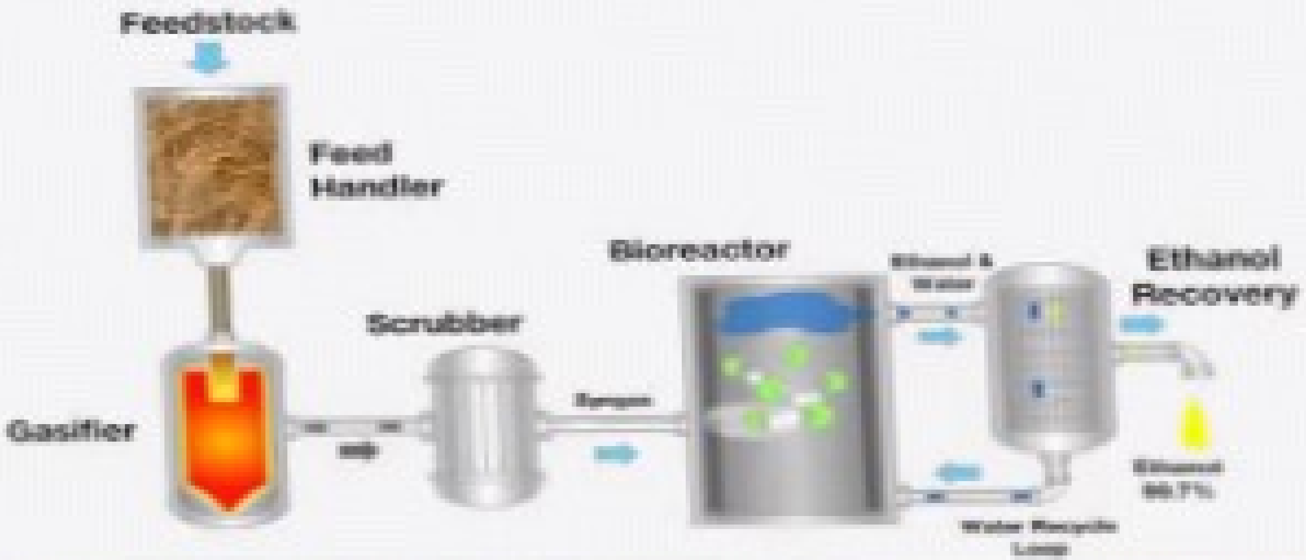
Industrial Scale

- A stream of ethylene is mixed with steam at 325°C and 1000 psi and passed over a solid catalyst consisting of phosphoric acid Unreacted ethylene is recovered and recycled to the feed stream.



Industrial Objectives

- produce the product at **minimum total cost** on a scale that will generate the maximum economic return.

may use:

1) large range of temperatures and pressures
2) batch process or continuous operation
3) reactants in vapor phase or liquid phase

Evaluation of a Reaction (process)

1) Evaluation of the reaction

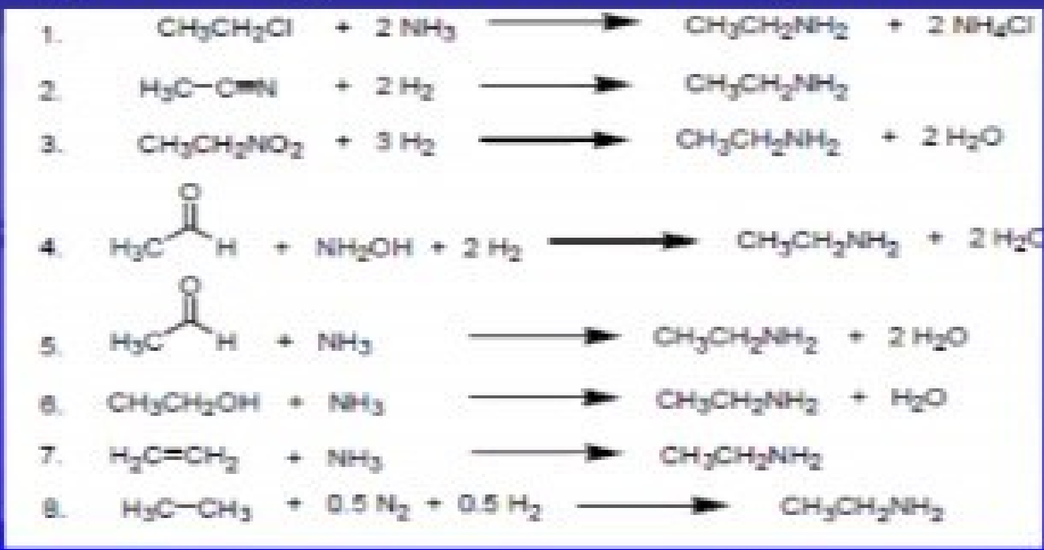
2) Economic feasibility

3) Technical feasibility

4)Other considerations: environmental issues,

Evaluation of a Reaction

The chemist must consider not only the well-known, obvious approaches, but also unknown or untested approaches. *e.g.*, the manufacture of ethylamine



Economic Feasibility

Estimate the difference between the market value of the products and the reactants.

First approximation, assume:

1) 100% yield
2) no costs of solvents or catalysts
3) no value for co-products

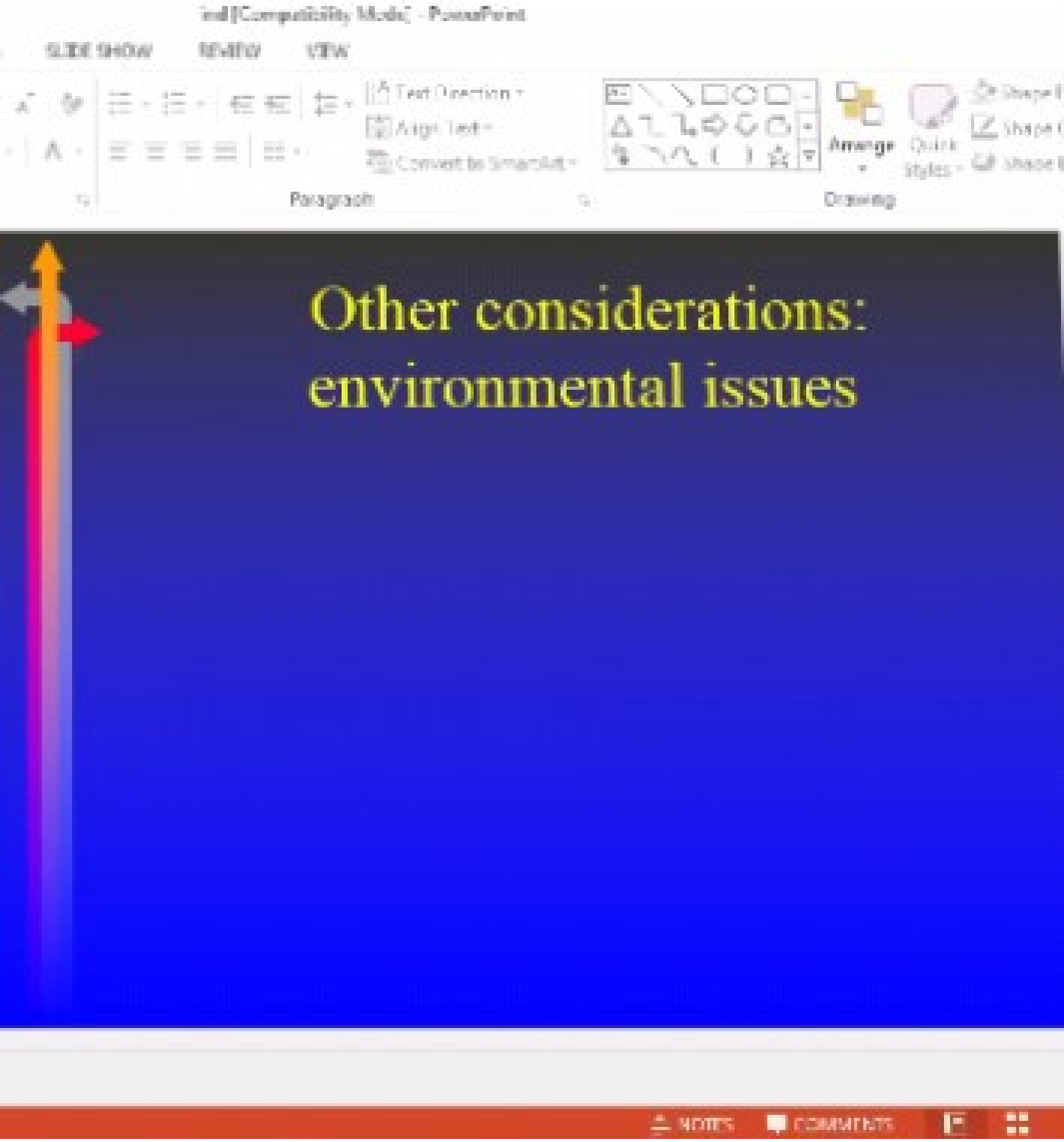
These assumptions must be reassessed further on in the development stage.

Technical feasibility

There are two basic questions that a chemist or chemical engineer must ask concerning a given chemical reaction:

(1) How *far* does it go, if it is allowed to proceed to equilibrium? (Does it go in the direction of interest at all?)

(2) How *fast* does it progress?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Other considerations:
environmental issues
NOTES
COMMENTS

Unit operation

In transforming matter from inexpensive raw materials to highly desired products, chemical engineers became very familiar with the physical and chemical operations necessary in this transformation. Examples of this include:

Filtration,

Drying

distillation,

Crystallization

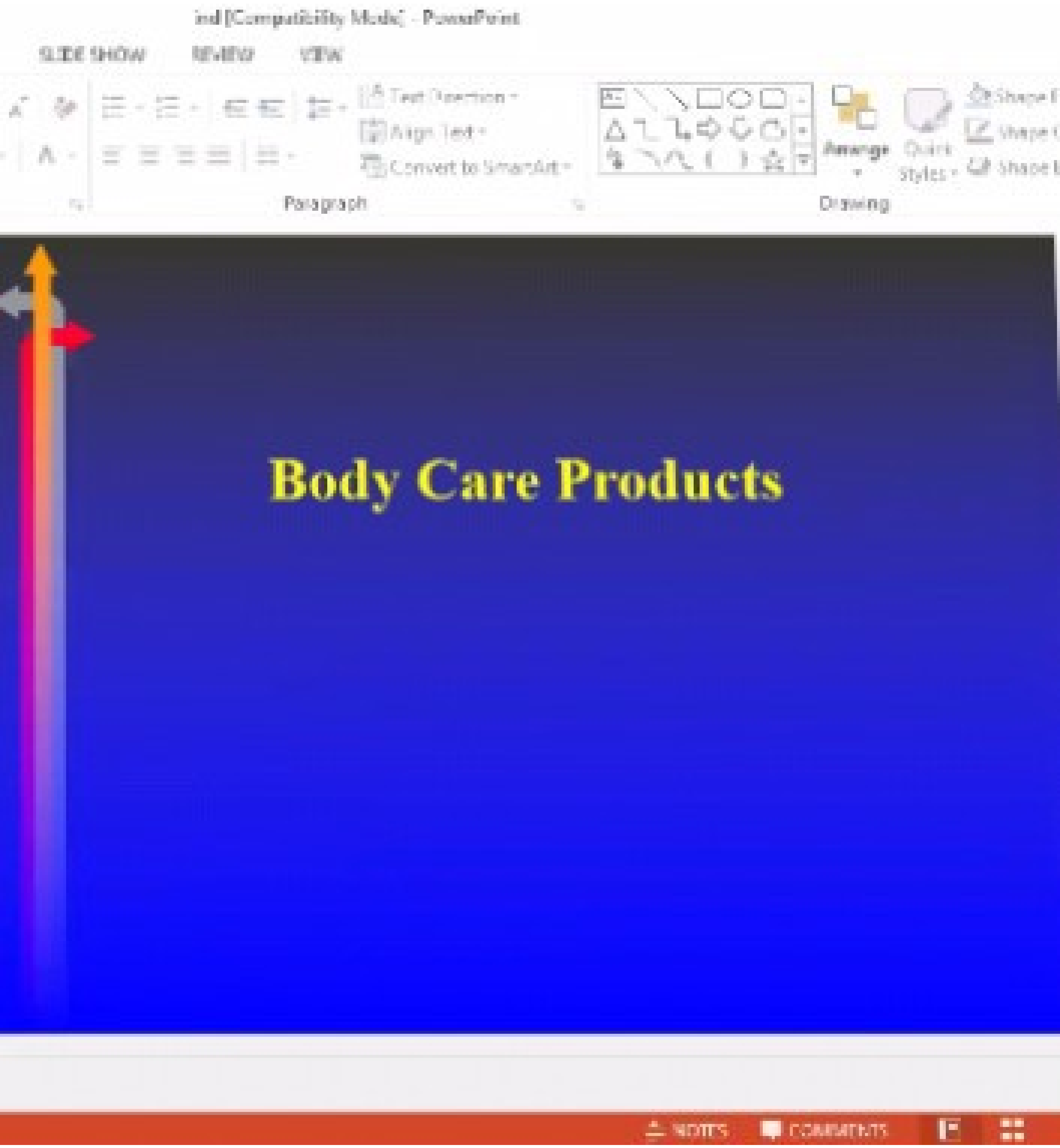
Grinding,

Sedimentation

Combustion,

Catalysis, heat exchange,

Coating, and so on.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