

# CH402 Chemical Engineering Process Design

## Class Notes L16

Plant Cost Scaling and Breakeven

Quiz 1 - paper

In-class problem in Canvas

# L15 lookback: Estimating capital cost for an industrial facility

## Method 1 – scaling against a known price

- Method 1a – scaling equipment
- Method 1b – scaling entire facilities (problems 6-9 and 6-10)

## Method 2 – percentage method

- Method 2a – percentage of FCI – Example 6-1
- Method 2b – percentage of PEC – Colorful worksheet
- Need to differentiate between capital investment and purchased equipment cost.
- Need to understand the different components of capital investment.
- *Key - Each of these components has a well-known percentage of the total FCI.*
- To illustrate, we will look closely at Example 6-1 and problem 6-8 in Lesson 15.
- We also discussed Method 2c – Lang Factors in Lesson 15.

[FE Ref. Manual pages 257](#)

## Objectives for Lesson 16:

1. Estimate capital costs using scaling factors.
2. Estimate capital costs based on turnover ratio.
3. Determine breakeven point given production data.

# Plant Costs - Methods A-G

- A - Detailed item estimate
- B - Unit cost estimate – based on records
- C - Percentage of delivered-equipment cost
- D - Lang factors
- E - Power factors with plant/capacity ratio
- F - Cost per unit capacity
- G - Turnover ratio

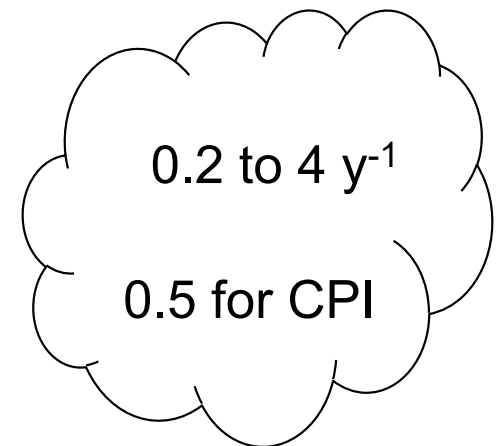
## Method G: Turnover Ratio

Similar to what we have been doing for single pieces of equipment.

$$\text{Turnover Ratio} = \frac{\text{gross annual sales}}{\text{fixed capital investment}}$$

Eq. 6-11, p. 258

± 30 % accuracy.



## Problem 6-9.

Estimate by the turnover ratio method the fixed-capital investment required in 2000 for a proposed sulfuric acid plant (battery-limit) which has an annual capacity of  $1.3 \times 10^8$  kg/yr of 100% sulfuric acid (contact catalytic process), using the data from Table 6-11, when the selling price of sulfuric acid is \$86 per metric ton. The plant will operate 325 days/year. Repeat the calculation, using the cost capacity exponent (scaling) method with data from Table 6-11

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## Method E: Power Factors and Plant Capacity Ratio

Similar to what we have been doing for single pieces of equipment.

$$C_n = C \cdot f_e \cdot R^x$$

cost index ratio

0.6-0.7

Eq. 6-9, p. 254

Table 6-11, p. 255

$$C_n = f \cdot (D \cdot R^x + I)$$

indirect costs

direct costs

Eq. 6-10

± 20 % accuracy.

$$\text{Cost of Plant A} = \text{Cost of Plant B} \cdot \left( \frac{\text{Capacity of Plant A}}{\text{Capacity of Plant B}} \right)^n$$



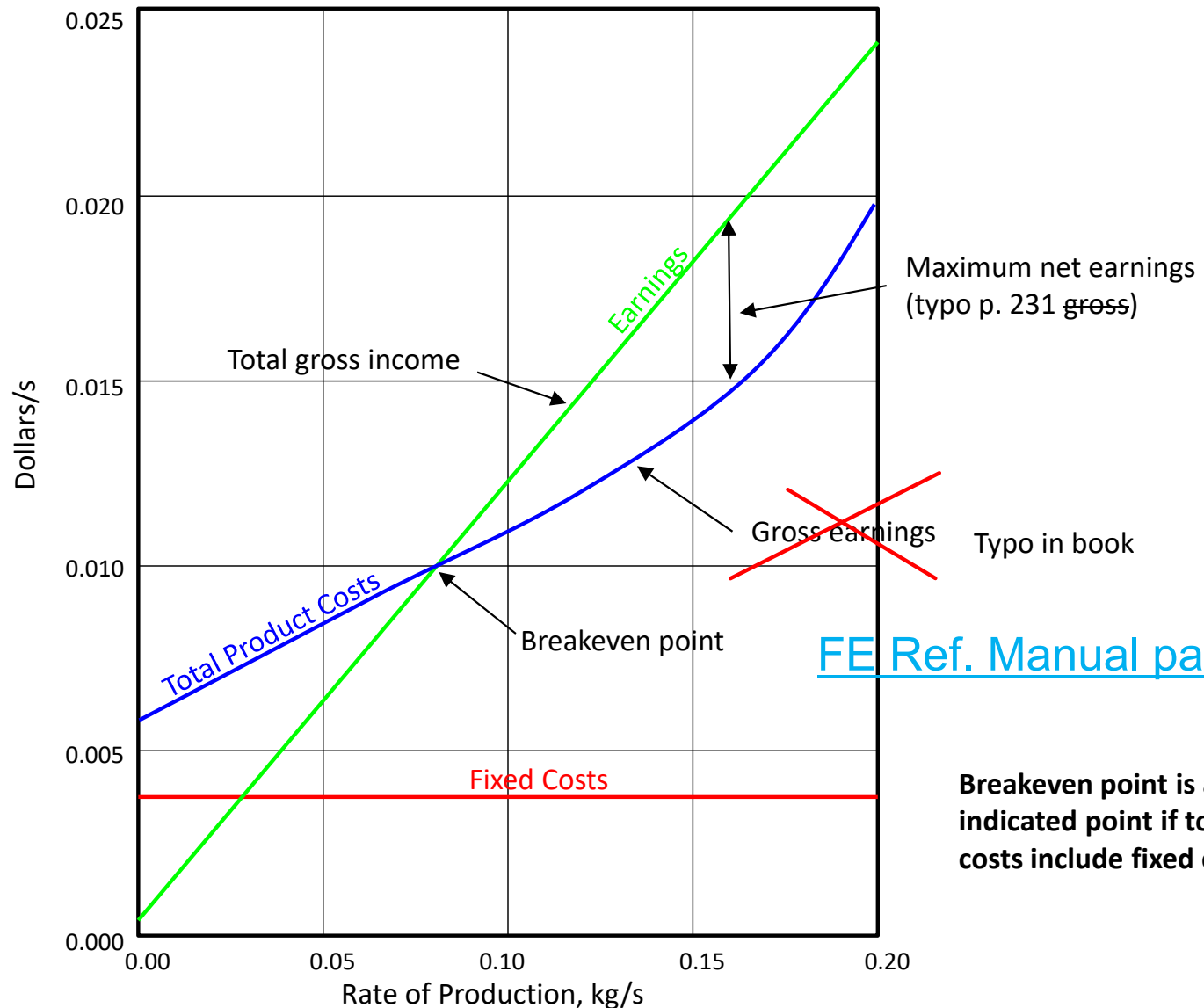
## Problem 6-10.

The total capital investment for a chemical plant is \$1 million, and the working capital is \$100,000. If the plant can produce an average of 8000 kg of final product per day during a 365-day year, what selling price in dollars per kilogram of product would be necessary to give a turnover ratio of 1.0?

# Break-Even Analysis – ICP

Figure 6-3; FEE p. 231; equation:  $\text{gross earnings} - \text{variable costs} - \text{fixed costs}$

apply this equation



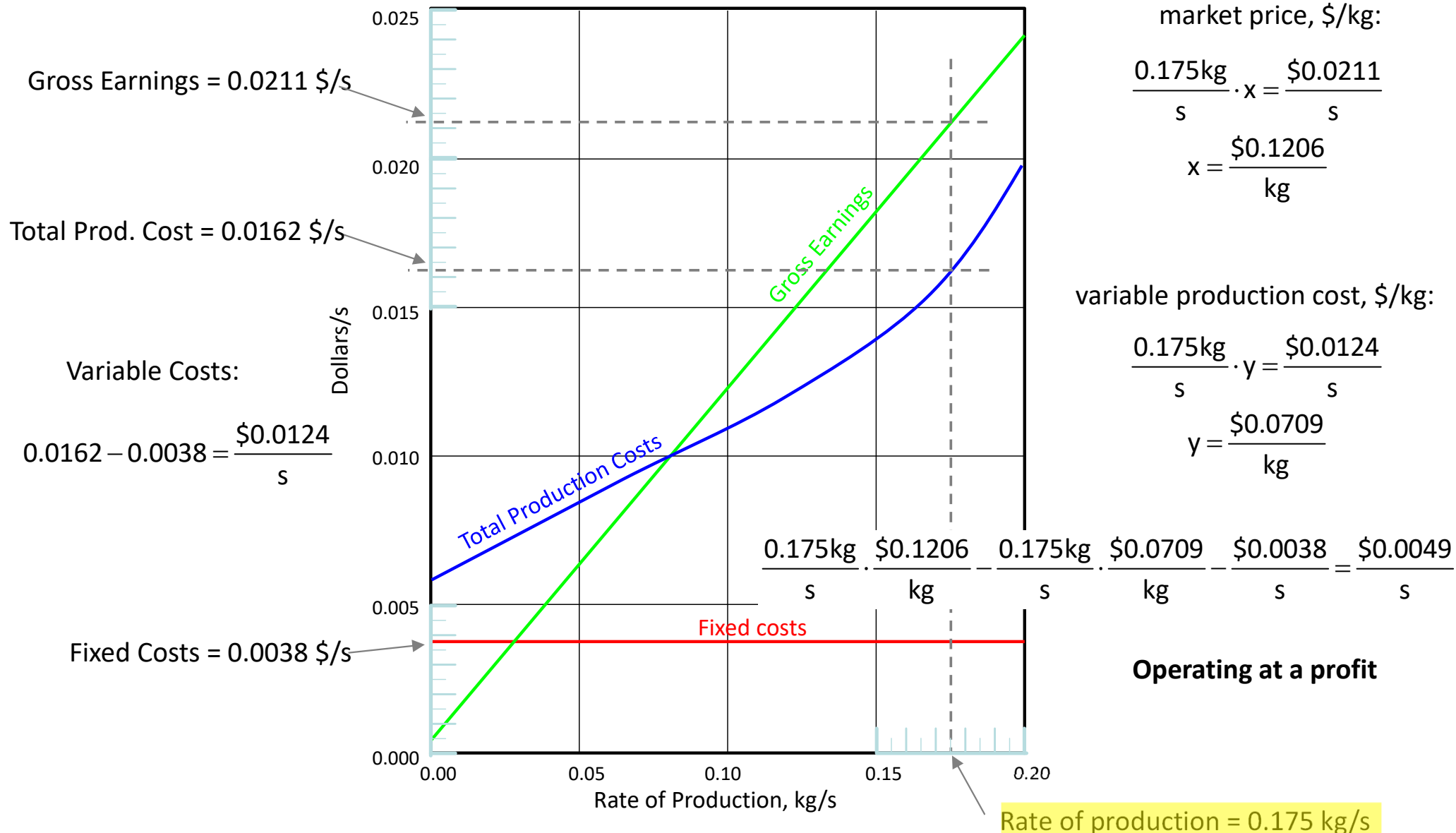
The authors no not state that fixed costs are included in total product costs. Normally they are not (as in ICP).

Breakeven point is at the indicated point if total product costs include fixed costs.

# Break-Even Analysis – Ex1

Figure 6-3; FEE p. 231; equation: gross earnings – variable costs – fixed costs

apply this equation



# Break-Even Analysis – Ex2

Figure 6-3; FEE p. 231; equation:  $\underbrace{\text{gross earnings} - \text{variable costs}}_{\text{apply this equation}} - \text{fixed costs}$

Variable Costs, \$/s:

$$0.0064 - 0.0038 = \frac{\$0.0026}{s}$$

market price, \$/kg:

$$\frac{0.030\text{kg}}{s} \cdot x = \frac{\$0.0039}{s}$$

$$x = \frac{\$0.1300}{\text{kg}}$$

variable production cost, \$/kg:

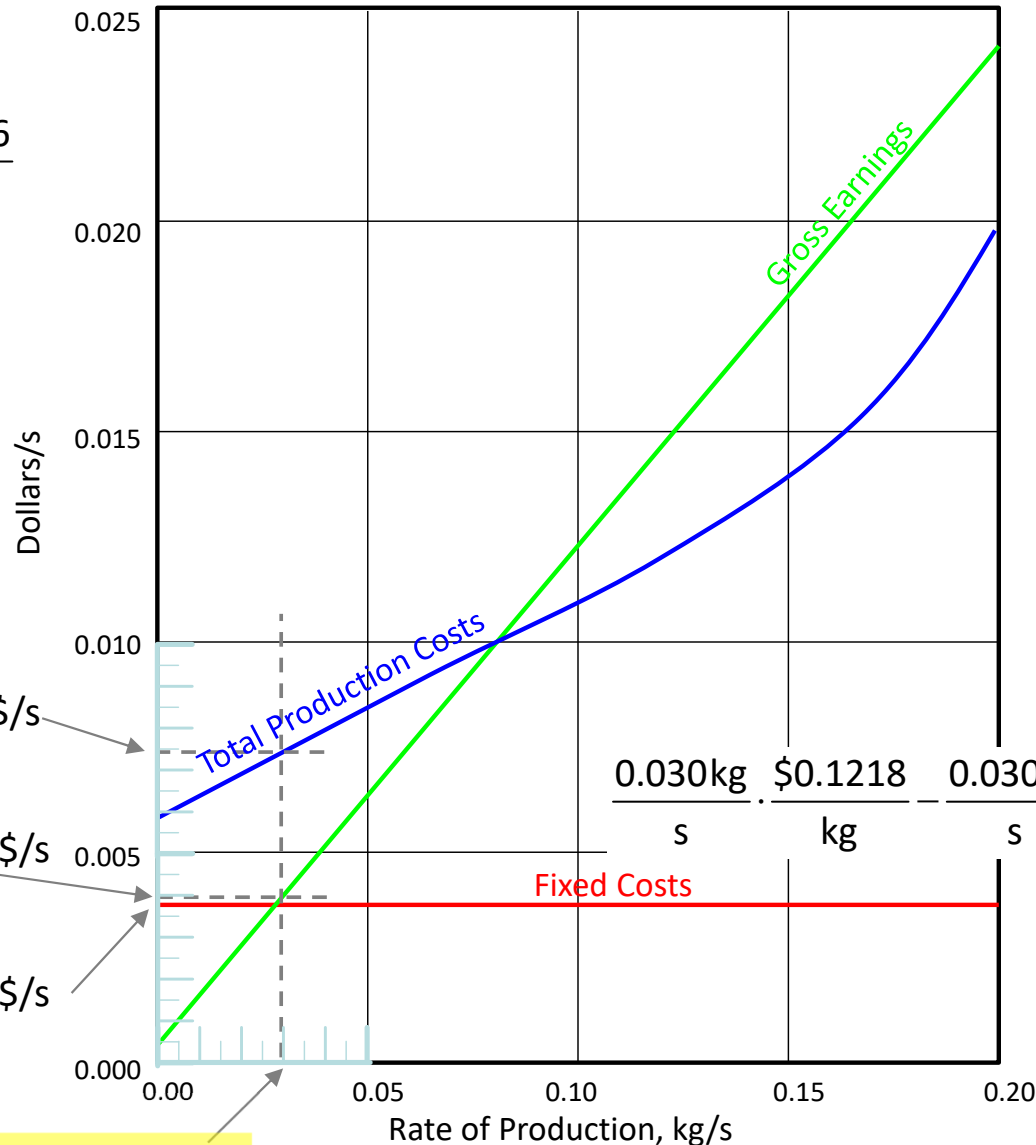
$$\frac{0.030\text{kg}}{s} \cdot y = \frac{\$0.0026}{s}$$

$$y = \frac{\$0.0867}{\text{kg}}$$

Total Prod. Cost = 0.0064 \$/s

Gross Earnings = 0.0039 \$/s

Fixed Costs = 0.0038 \$/s



$$\frac{0.030\text{kg}}{s} \cdot \$0.1218 - \frac{0.030\text{kg}}{s} \cdot \$0.0867 - \$0.0038 = -\$0.0025$$

**Operating at loss**

# Break-Even Analysis – Ex3

Figure 6-3; FEE p. 231; equation: gross earnings – variable costs – fixed costs

apply this equation

Variable Costs, \$/s:

$$0.0100 - 0.0038 = \frac{\$0.0062}{s}$$

market price, \$/kg:

$$\frac{0.080\text{kg}}{s} \cdot x = \frac{\$0.0100}{s}$$

$$x = \frac{\$0.1250}{\text{kg}}$$

variable production cost, \$/kg:

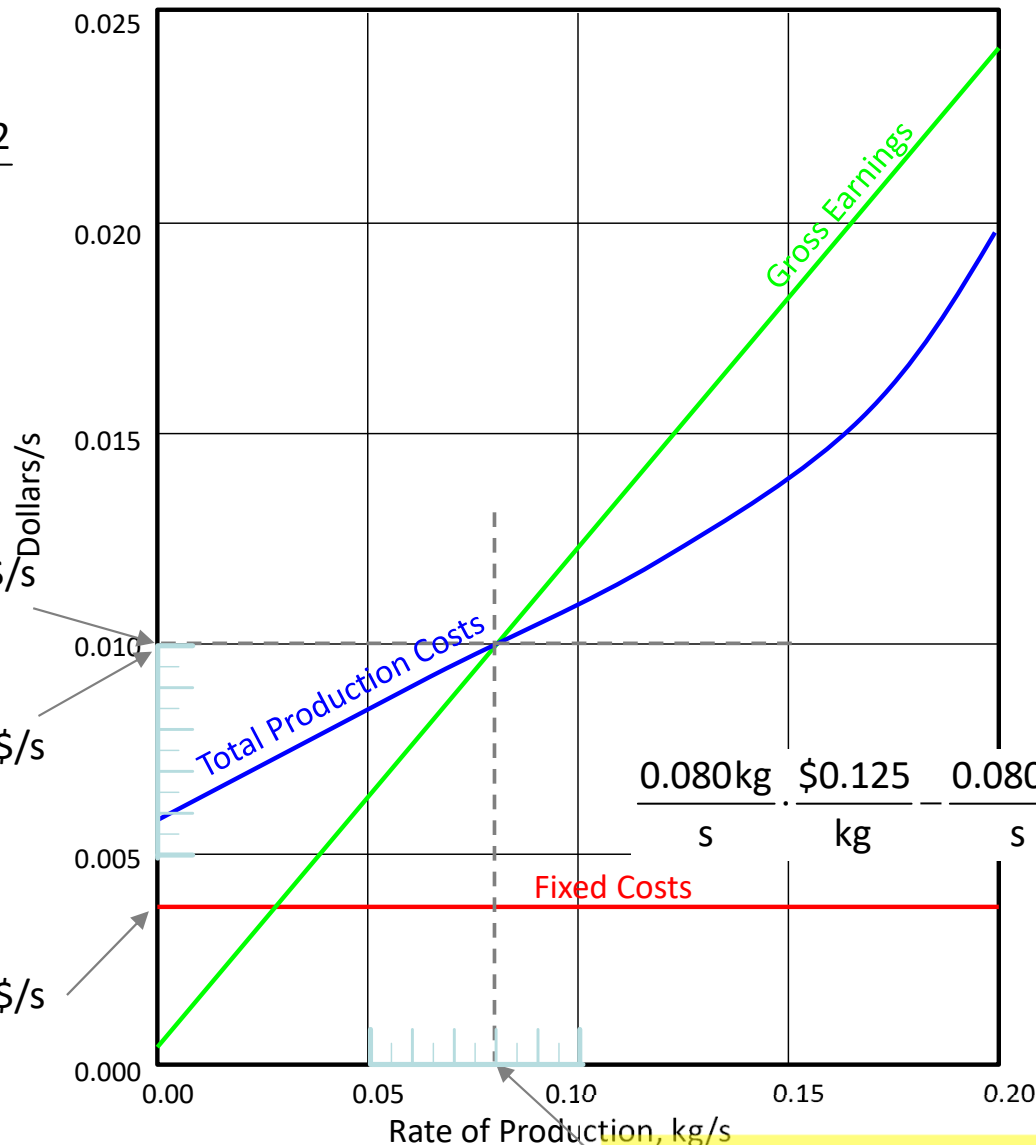
$$\frac{0.080\text{kg}}{s} \cdot y = \frac{\$0.0062}{s}$$

$$y = \frac{\$0.0775}{\text{kg}}$$

Total Prod. Cost = 0.0100 \$/s

Gross Earnings = 0.0100 \$/s

Fixed Costs = 0.0038 \$/s



$$\frac{0.080\text{kg}}{s} \cdot \$0.125 - \frac{0.080\text{kg}}{s} \cdot \$0.0062 - \$0.0038 = \frac{\$0.0000}{s}$$

**"Breakeven"**

Rate of production = 0.080 kg/s

Questions?