Control System Objective

Control System Objectives

The objectives of a control system may be grouped into the following areas:

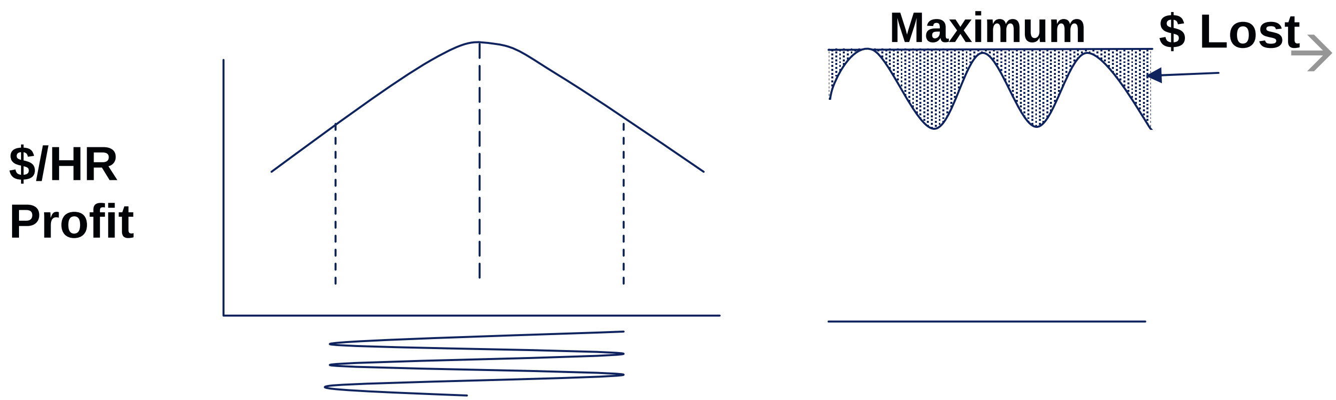
- Economic Incentive
- Safety
- Equipment Protection

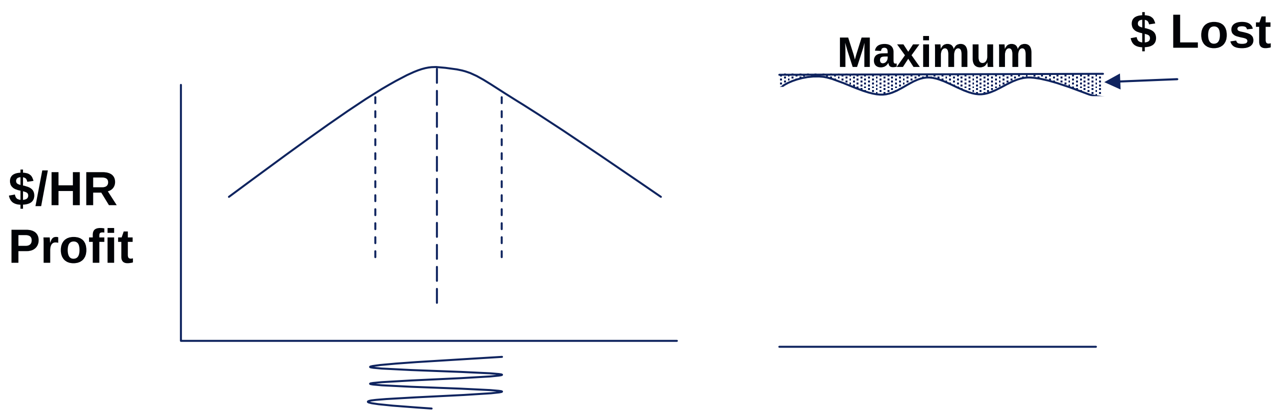
Economic Incentive

A process parameter's effect on product depends greatly on the plant's limitations and operating condition. Production variations fall into two categories

1. Global production maximum for a given operating condition
2. Production maximum occurs at an upper or lower bound on a parameter for a given operating condition.

Global Production Maximum

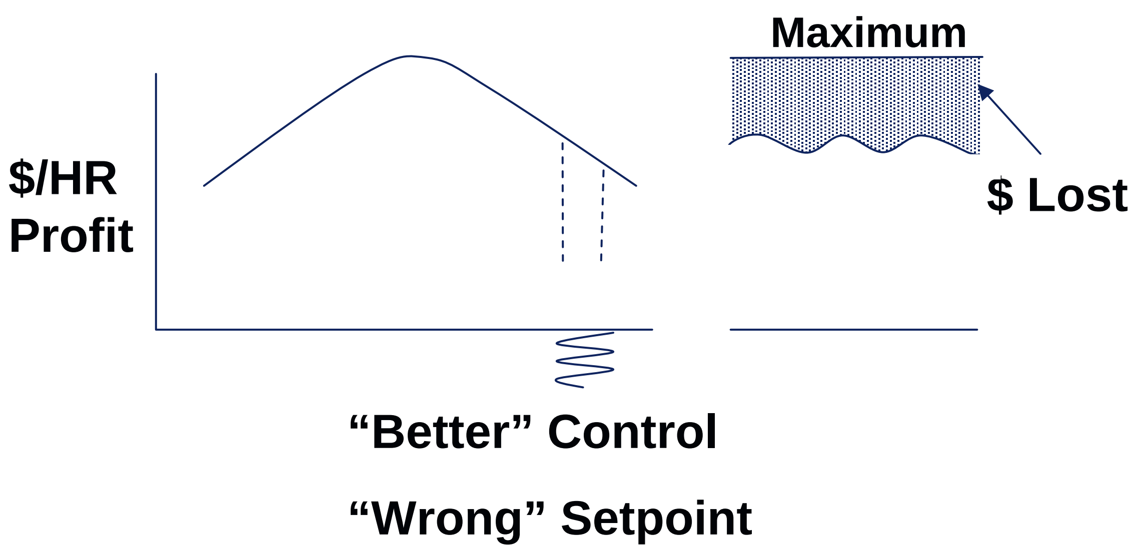




"Better" Control

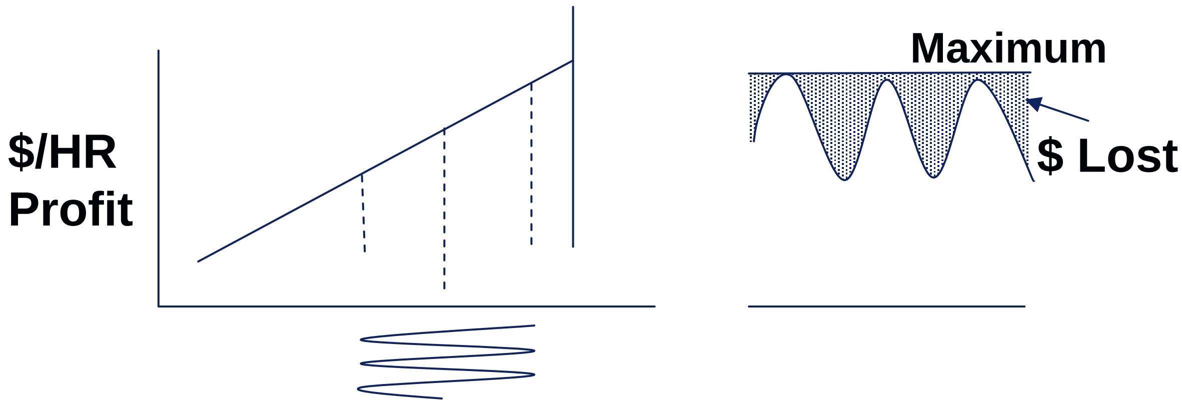
For this case, production is greatest when the band of variation is reduced to zero and the process parameter is maintained at the value corresponding to maximum production

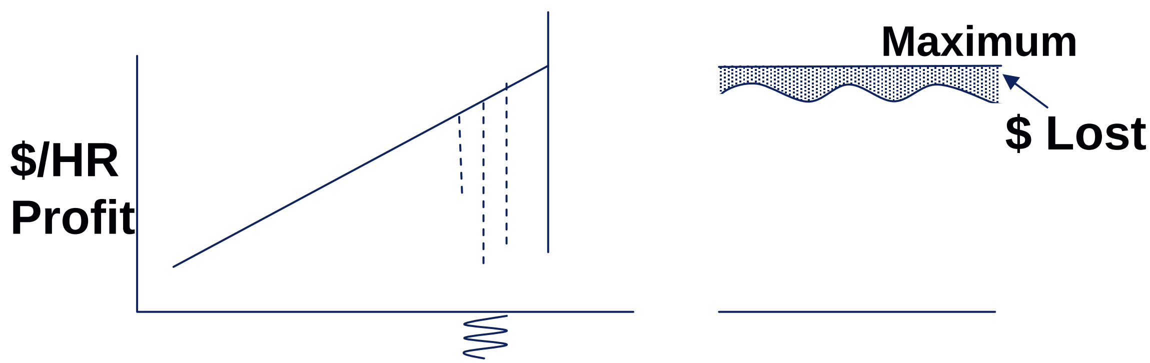
Global Production Maximum (Cont)



- To benefit from improvement in control, the loop must operate at the target that provides maximum production.
- The plant design conditions may be used as a guide in establishing setpoints for best operation

Production Maximum at Limit





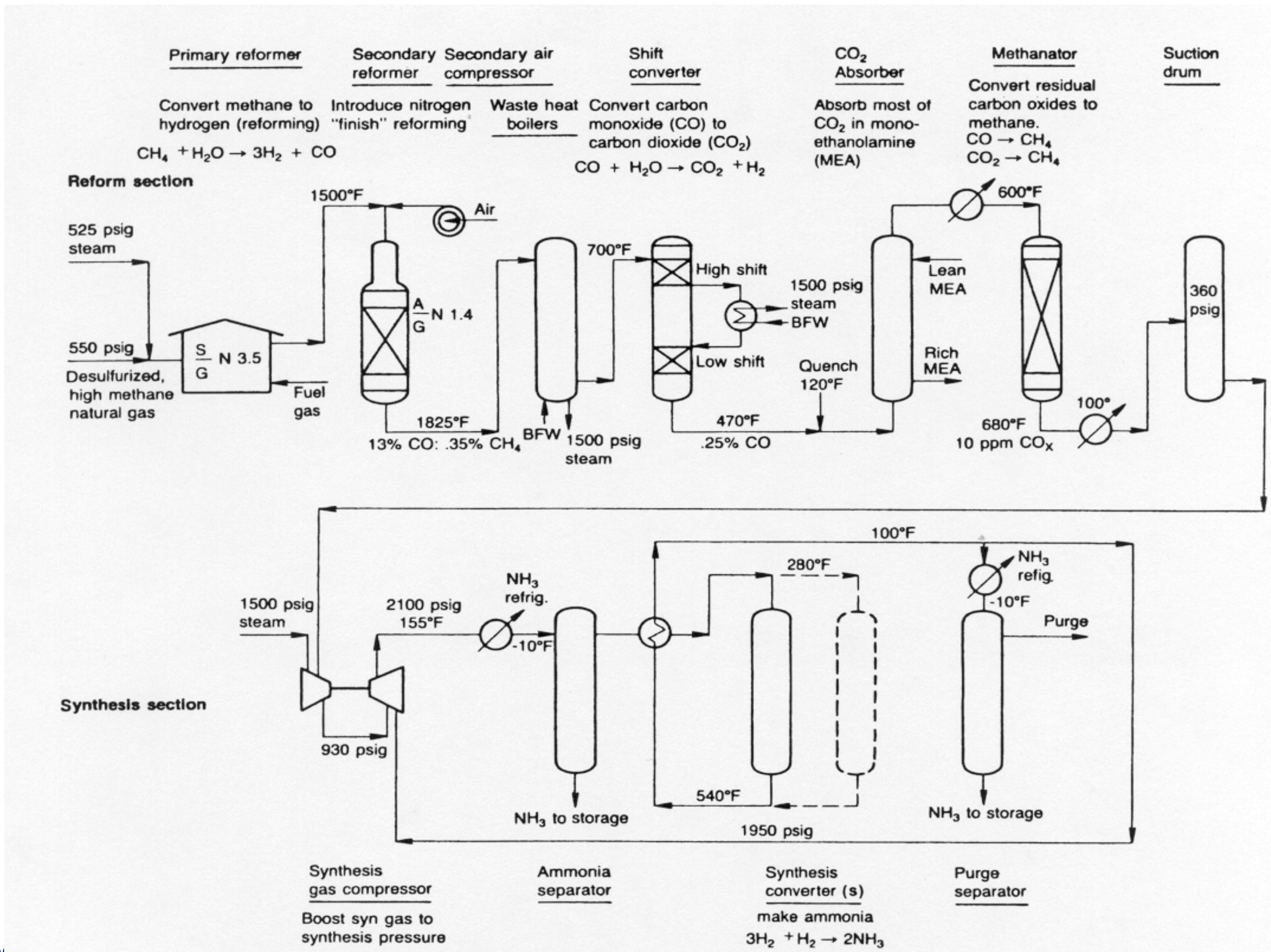
"Better" Control

- For this case, maximum production is obtained by maintaining the process parameter at a limit determined by some plant limitation.
- How close to the limit you can operate is determined by the quality of the control

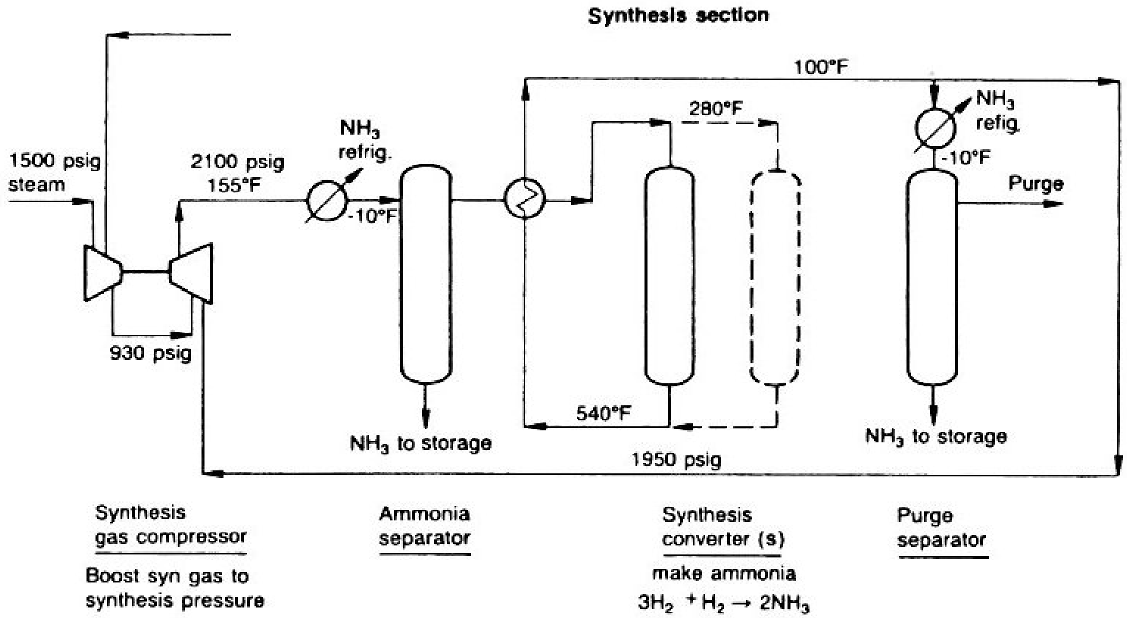
Production Maximum at Limit

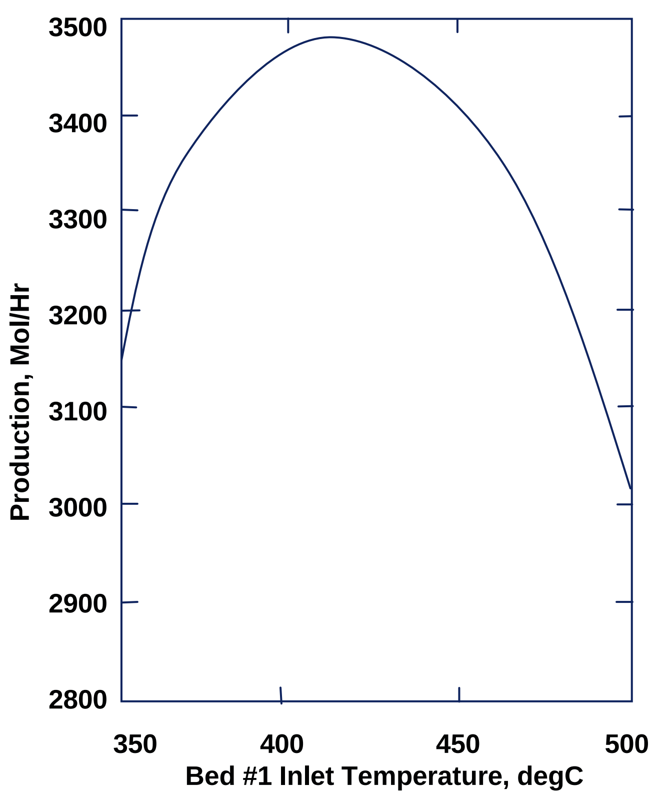
Production improvement is obtained by operating closer to product specification or operating limit.

Ammonia Process Example



Synthesis Converter





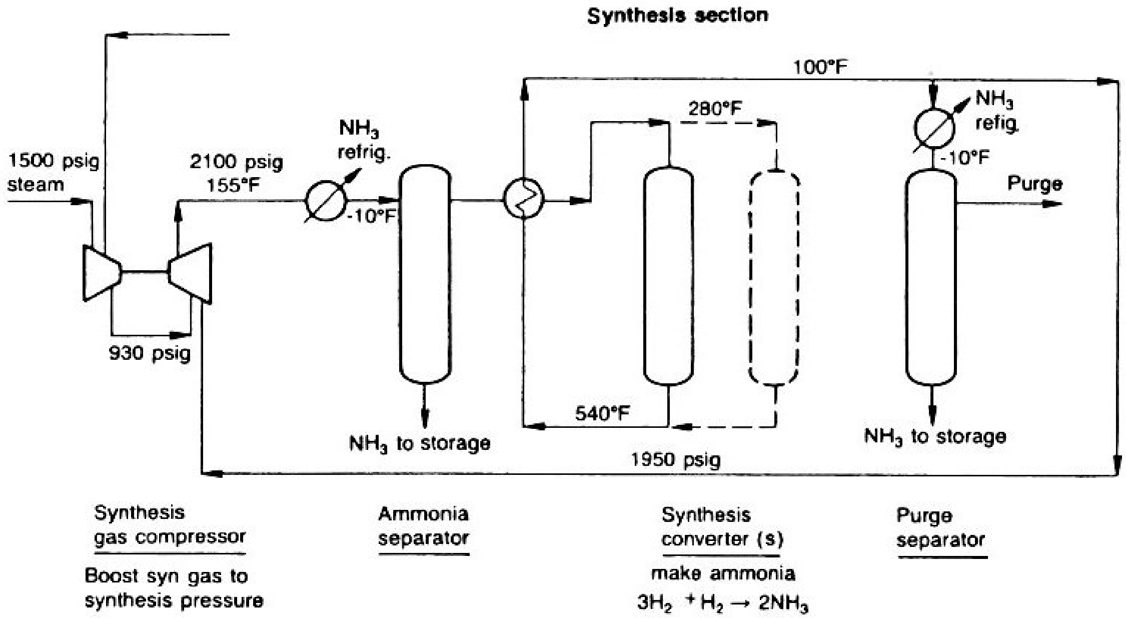
Cost of Synthesis Temperature Variation

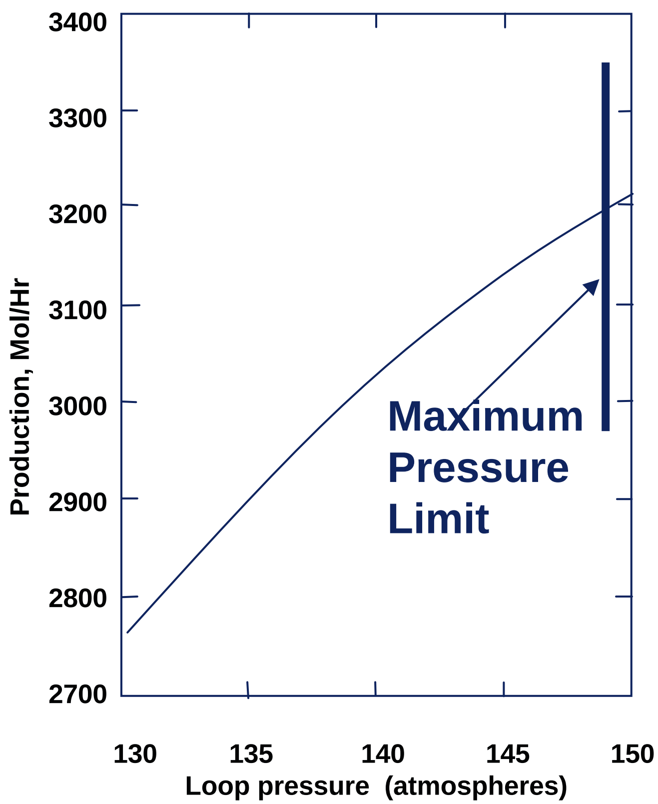
@410 degC

$$\frac{\text{\% production change}}{\text{Change in bed \#1 inlet temp}}$$

$$\frac{\left[\dfrac{3441 - 3413}{3441}\right]}{\left[430\text{-}410\right]} * 100 = 0.4$$

Ammonia Plant - Synthesis Loop Pressure



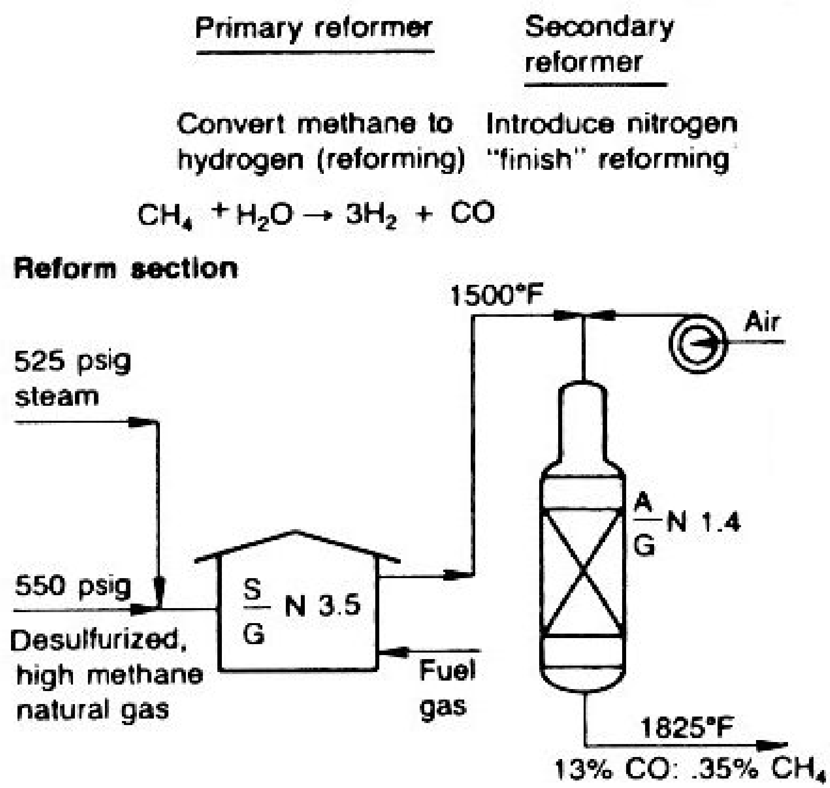


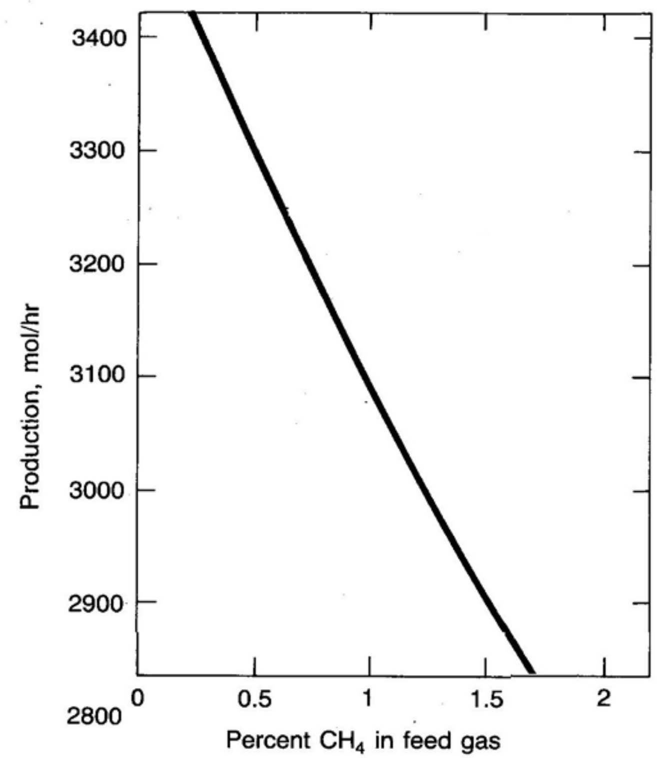
Cost of Synthesis Pressure Variation

@148 Atm

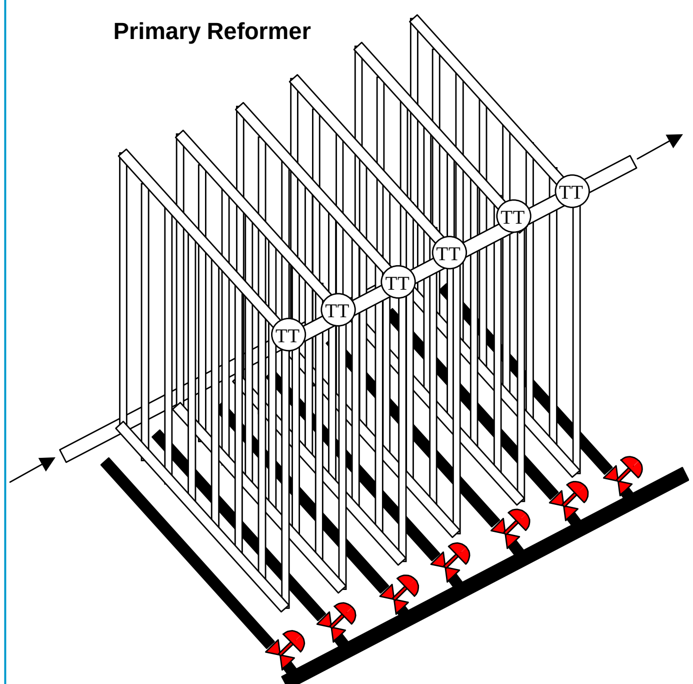
$$\frac{\%\ \text{production change}}{\text{change in pressure (Atm)}} = \frac{\left(\dfrac{3205.6-3142.26}{3175.24}\right)100}{(150-146)} = .05$$

Primary Reformer Methane Leakage





Primary Reformer Temperature Control



- Maximum operating temperature limit is determined by the material of construction
- Exceeding maximum temperature can result in tube rupture and shutdown of the process

Cost of Variation from Minimum Leakage

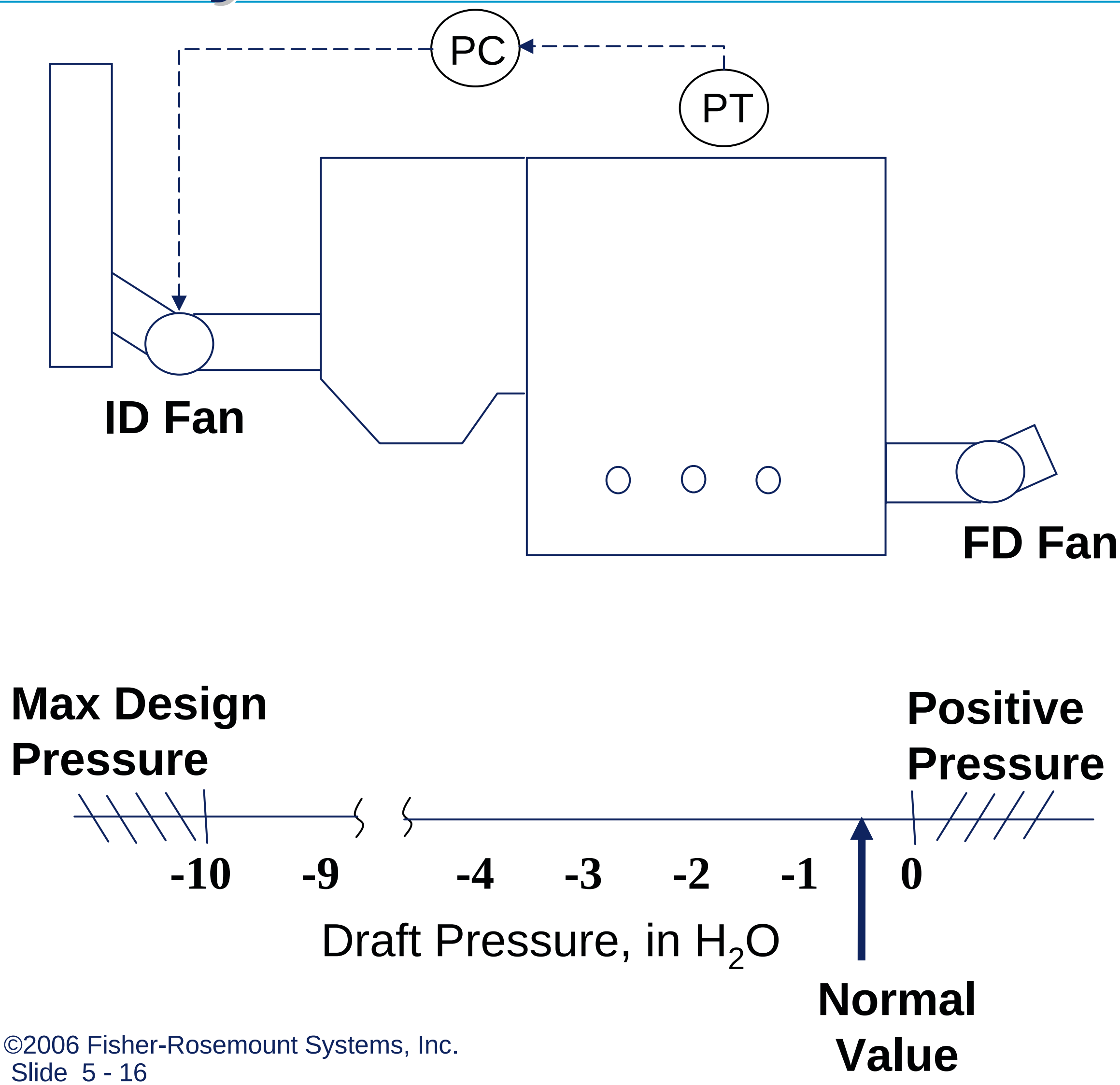
at 1% CH_4

$$\frac{\%\ \text{production change}}{\text{change in } CH_4}$$

$$\frac{\left(\frac{3303.9-2909.1}{3087}\right)100}{(0.5-1.5)}$$

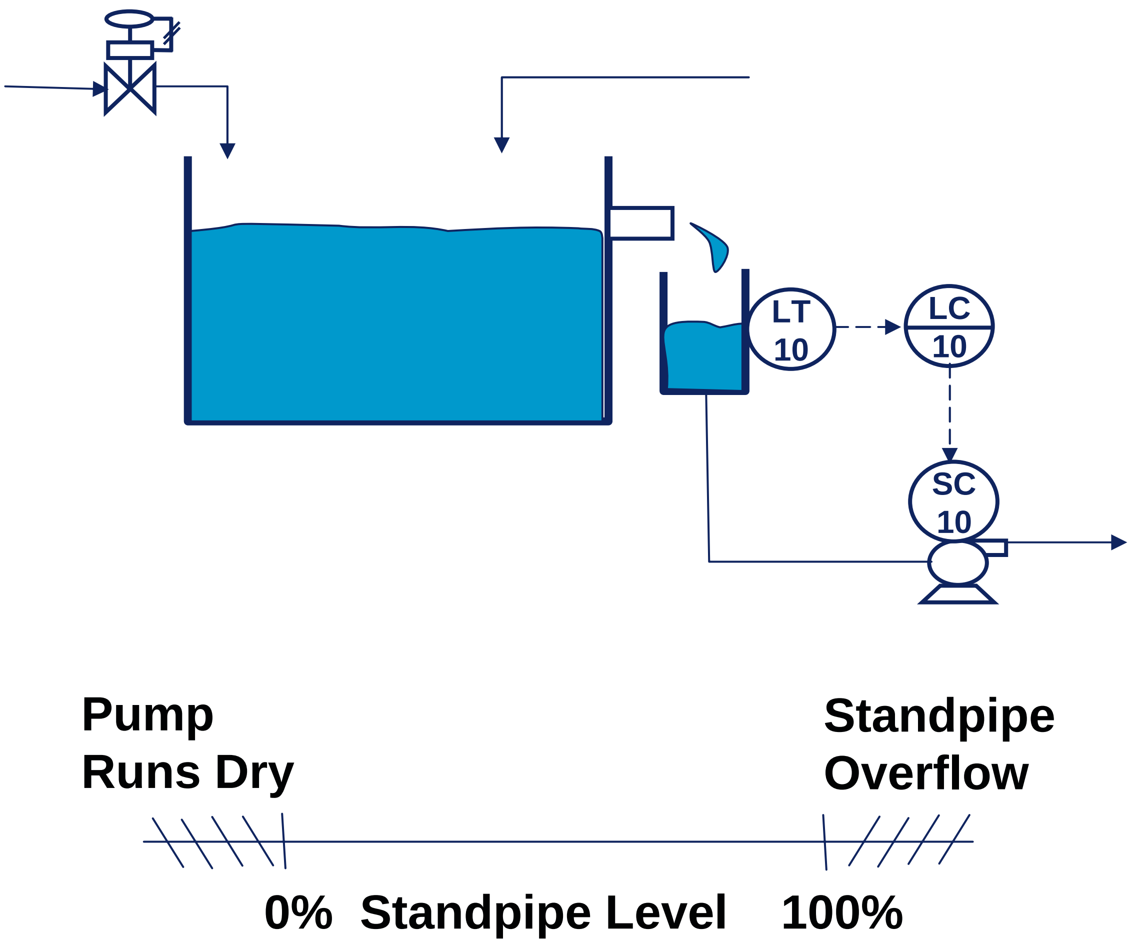
$$= -12.7$$

Safety – Boiler Draft Control



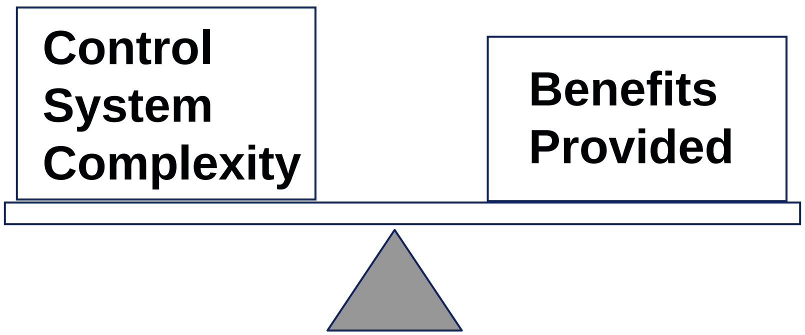
- Boiler draft control is used to remain negative pressure within the boiler.
- If the pressure were to go positive, then hot gases from the boiler could blow back through access ports on operating people

Equipment Protection – Standpipe Level Control



- Standpipe level must be maintained to avoid loss of liquid flow to pump.
- Loss of flow for an extended period of time may damage the pump

Control System Benefits Balance



- Various techniques may be used to improve the control of a process
- As the complexity of the control system increases, so does cost for operator training and maintenance
- The complexity (cost) of the control system should be balanced with the benefits provided
- The benefits of control improvement may be influenced by market conditions i.e. value of product, cost of feedstock, energy cost