

ECHE 460
Unit Operations Presentations

**The Good,
The Bad, and
The Ugly**

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March, 2007

Introductions

- Should motivate the topic
- Should have some broader scope
- Use images if possible to get audience engaged
 - Cite Images appropriately
- Should prepare audience to some extent

The Good

Background

- 18th Century: Zeolites discovered by Axel Fredrik Cronstedt
- Found when heated rapidly, causing them to “dance”
- Named zeolite, or “stone that boils”



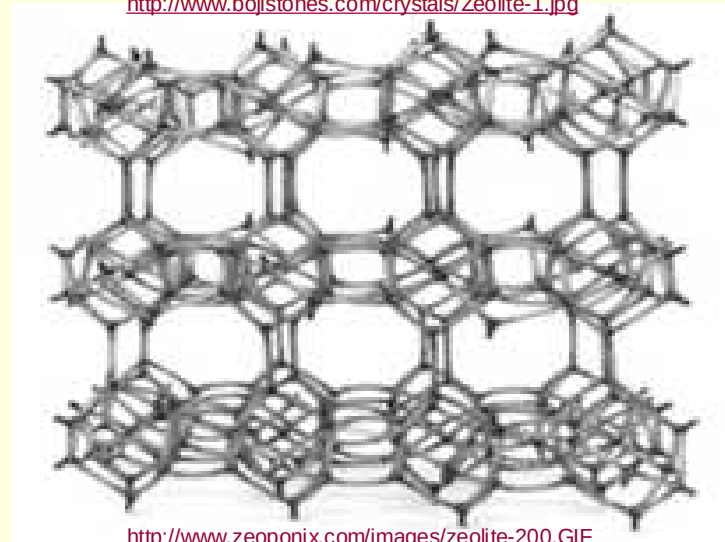
<http://www.bgf.nu/ljus/bilder/cronstedt1.gif>

Zeolite Properties

- Porous, crystalline solid with highly ordered microstructure
- Natural and man-made
- Function depends on structure
- Work as catalysts, catalyst supports, and adsorbents



<http://www.bojstones.com/crystals/Zeolite-1.jpg>



<http://www.zeoponix.com/images/zeolite-200.GIF>

Gas Chromatography

- Two components: solute gas and carrier gas
- Mobile mixture injected through stationary phase
- Separates solute gas from carrier gas



<http://www.b100supply.com/images/products/193.jpg>

The Bad

Introduction

- **Centrifugal Pumps**

- Class of pumps that moves liquids and generates pressure by rotation of a single or several impellers
- Impellers promote centrifugal force on a liquid causing an increase in pressure and velocity
- Pump casings help convert kinetic velocity of the fluid into pressure by directing and containing spiral flow of the liquid

- **Pipe Network Flow**

- Pipes, valves, and fittings combine together to form a network that allows liquids and gases to be transported
- Each component affects the flow individually through resistance

The Ugly



Introduction

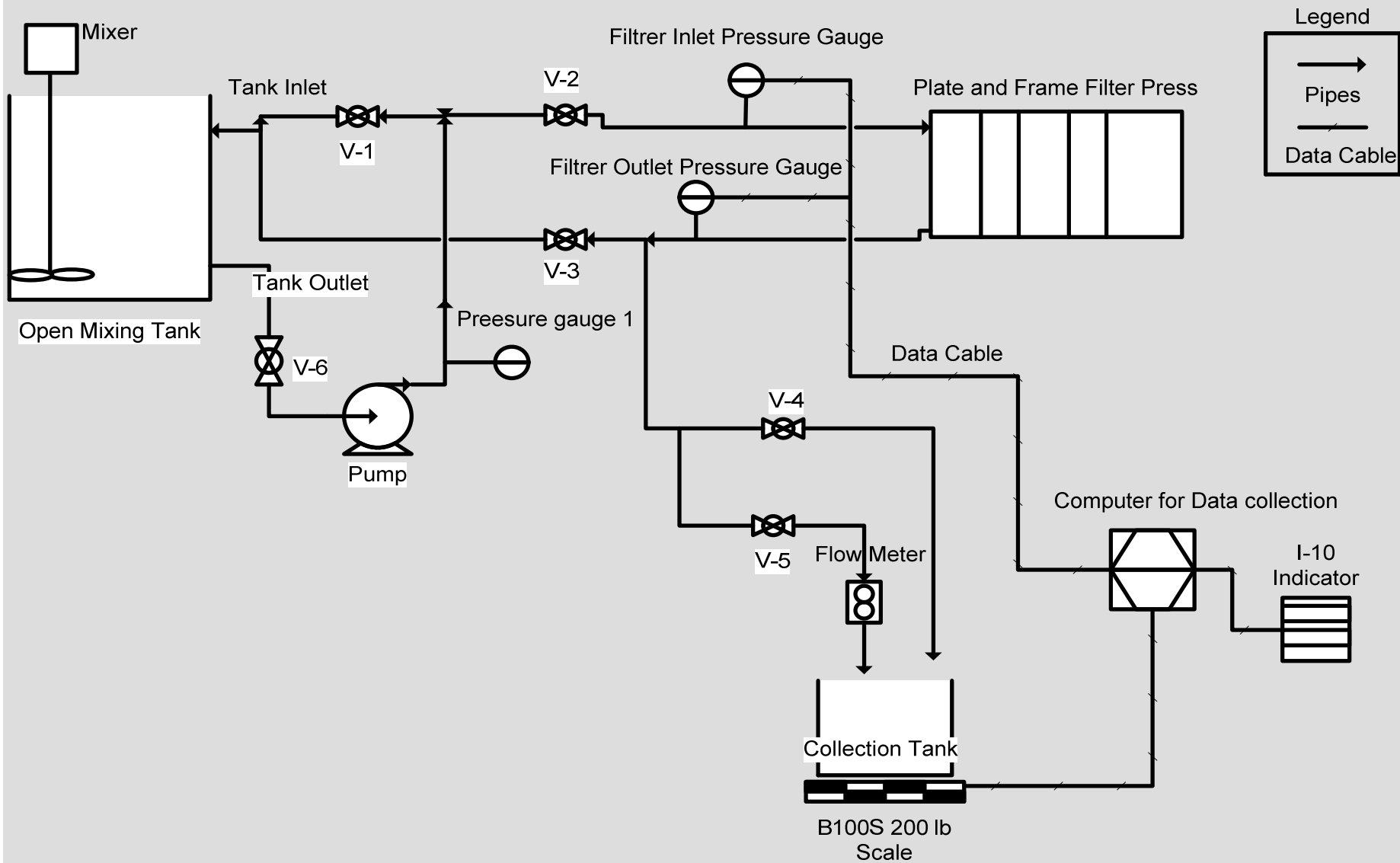
- Heat transfer can be used in a variety of applications
 - Distillation Columns
 - Heat exchangers
 - Cooling towers
 - Cooling of electronics

Schematics

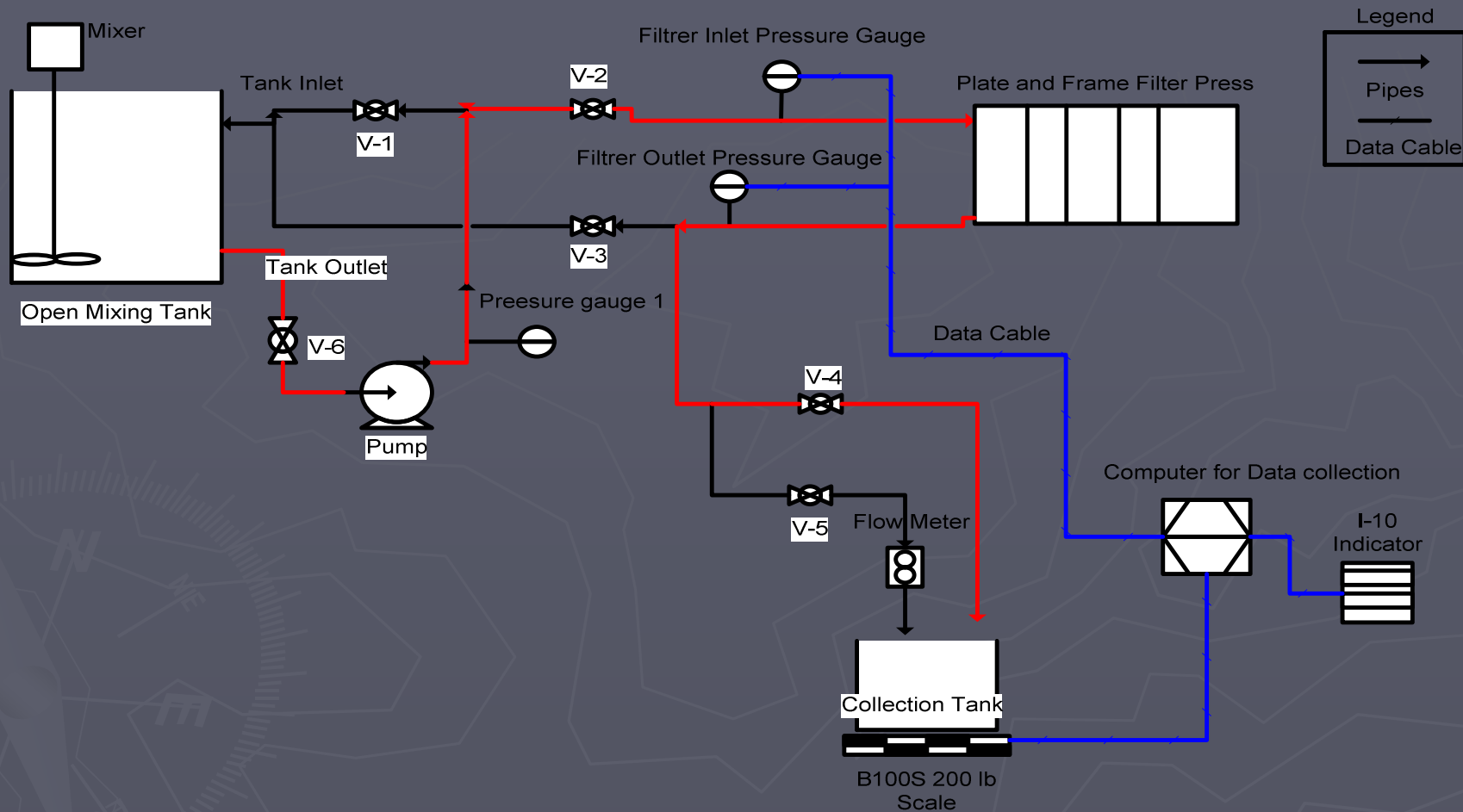
- Should represent the physical system
 - Not necessarily same layout
- Should have appropriate level of detail
 - Too much = too complicated
 - Too little = too useless
- Can use exaggerated “cartoony” representations

The Good

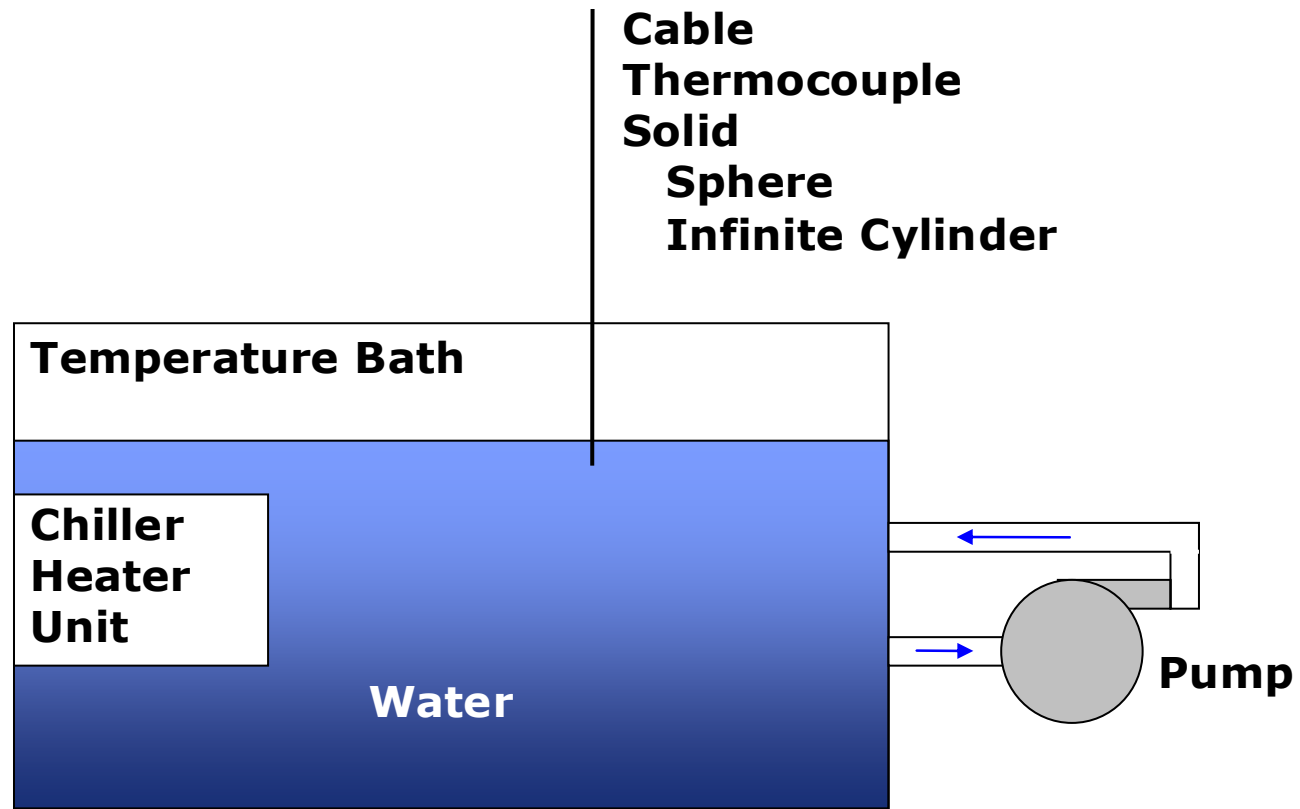
Apparatus



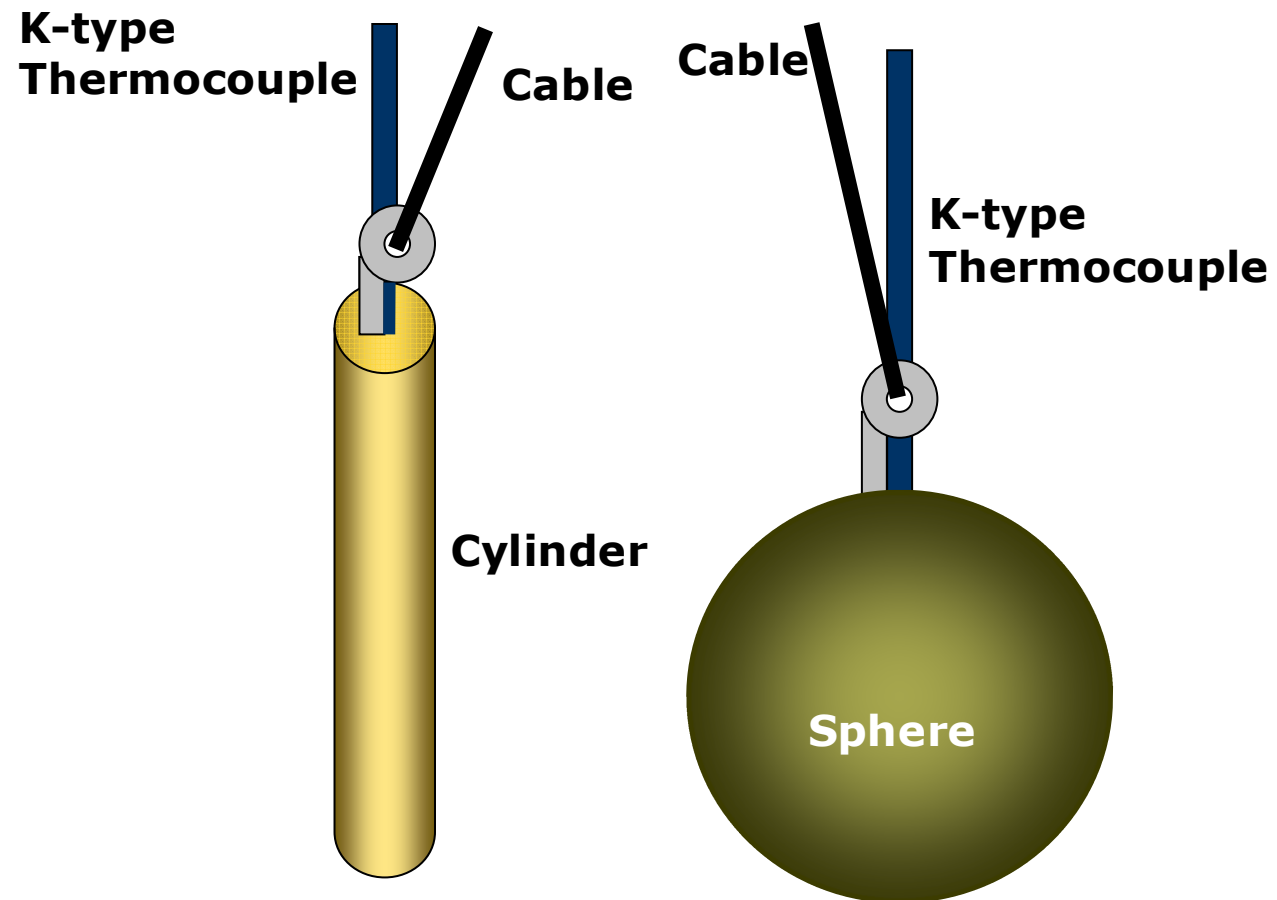
Constant Pressure Mode



Apparatus

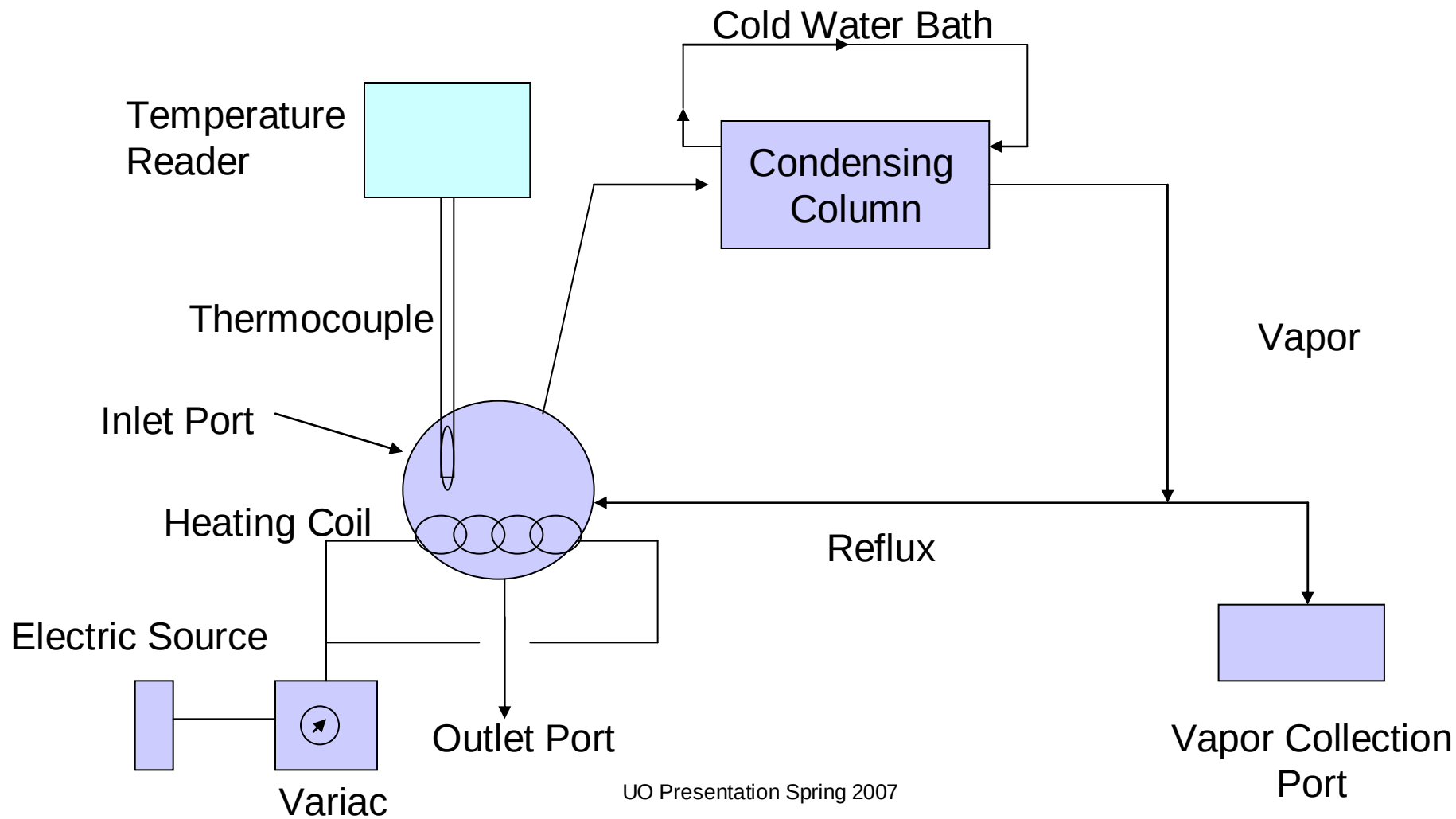


Apparatus



The Bad

Apparatus



Apparatus

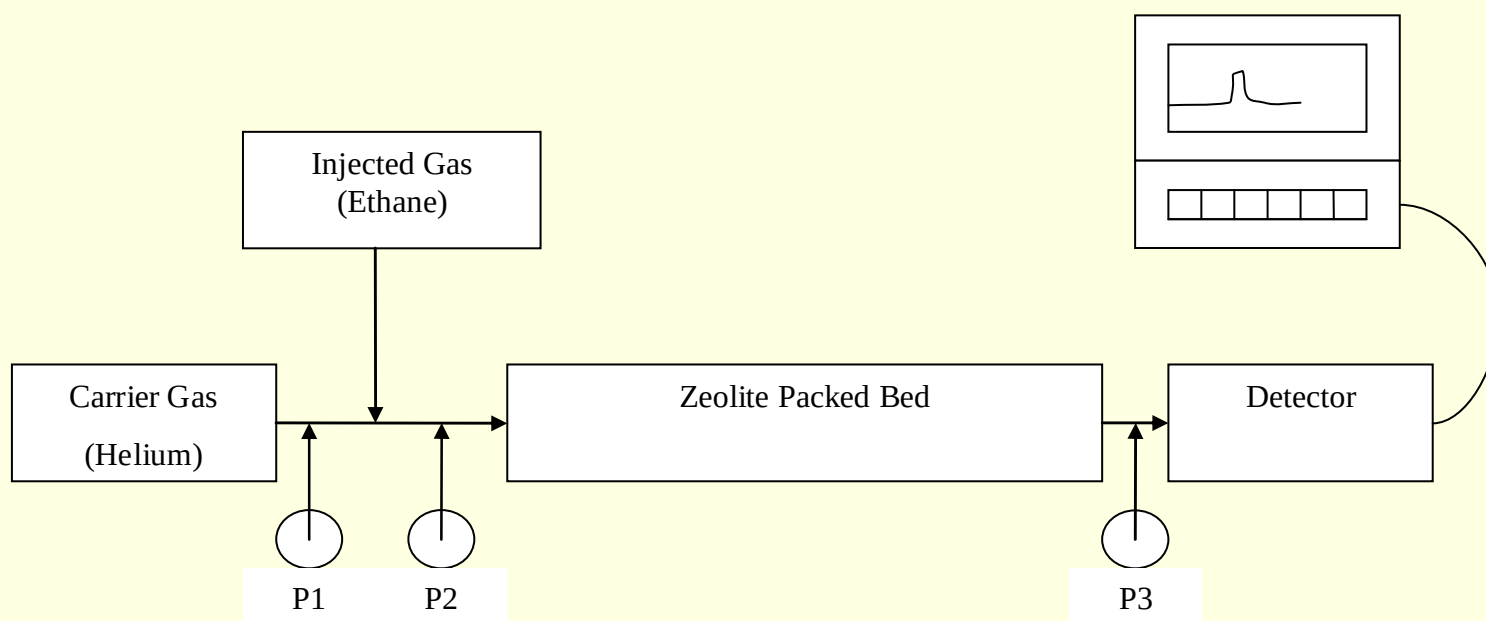
- Gas Chromatograph:
 - SRI 8610B with Thermal Conductivity Detector (TCD)



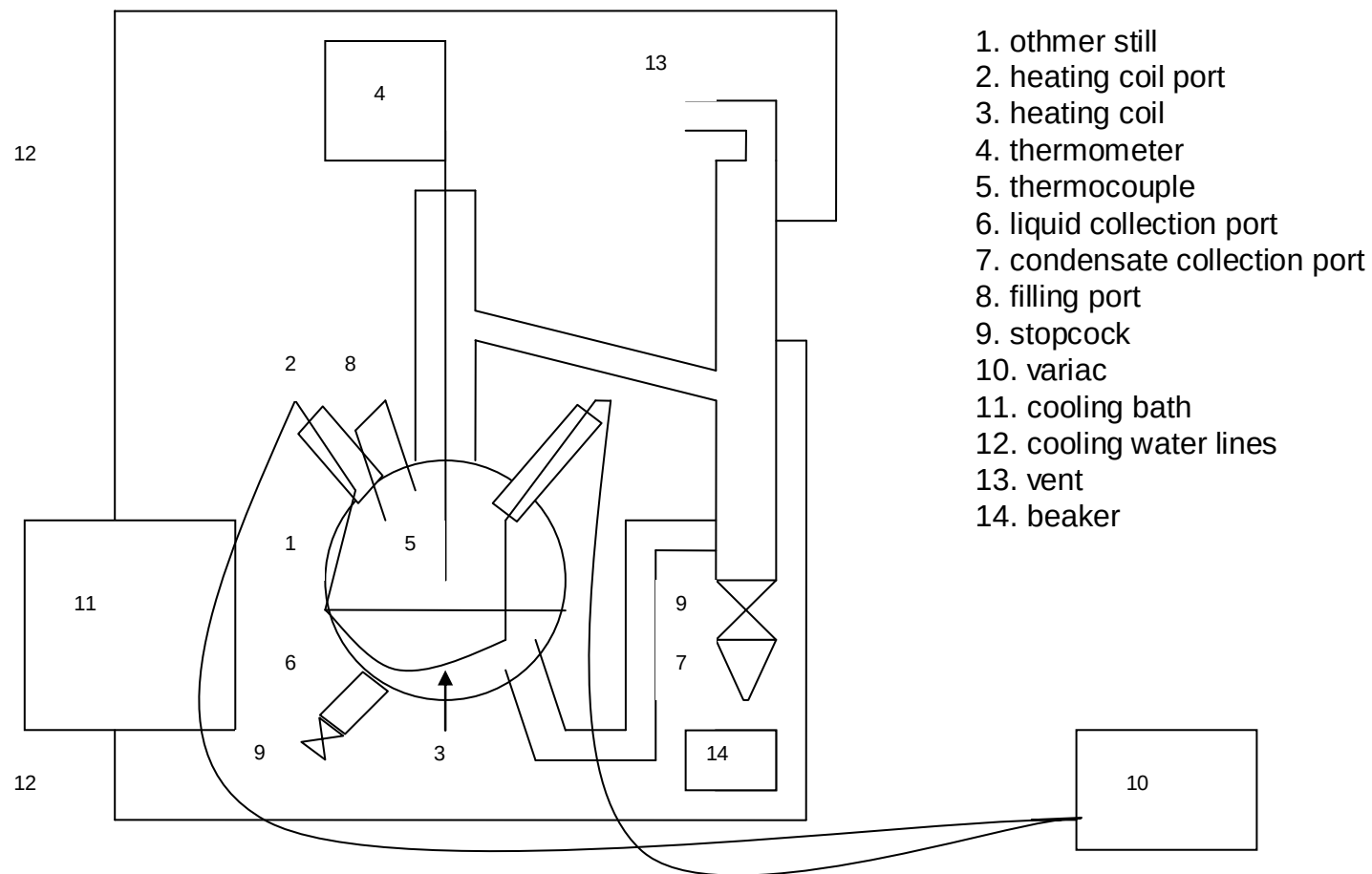
http://images.google.com/imgres?imgurl=http://www.betatekinc.com/images/SRI/6-MG2.jpg&imgrefurl=http://www.betatekinc.com/SRI_Multiple_Gas_Analyzer_No.2_GC_System.html&h=247&w=200&sz=29&hl=en&start=16&tbid=oAtD5084lFY7oM:&tbnh=110&tbnw=89&prev=/images%3Fq%3DSRI%2B8610%26svnum%3D10%26hl%3Den%26sa%3DN

Apparatus cont'd

- Gas Chromatograph:
 - SRI 8610B

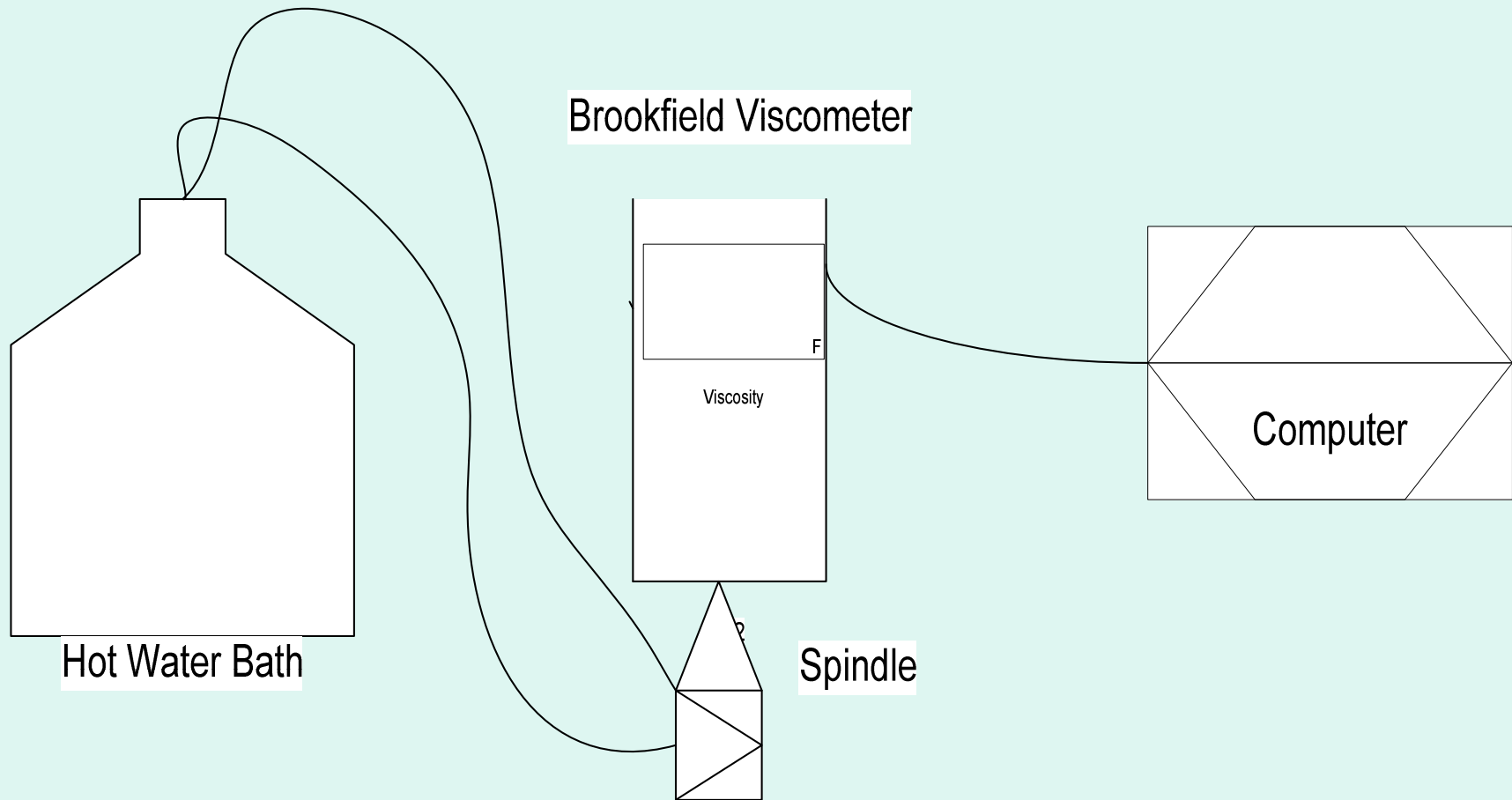


Schematic



The Ugly

Apparatus



Literature Review

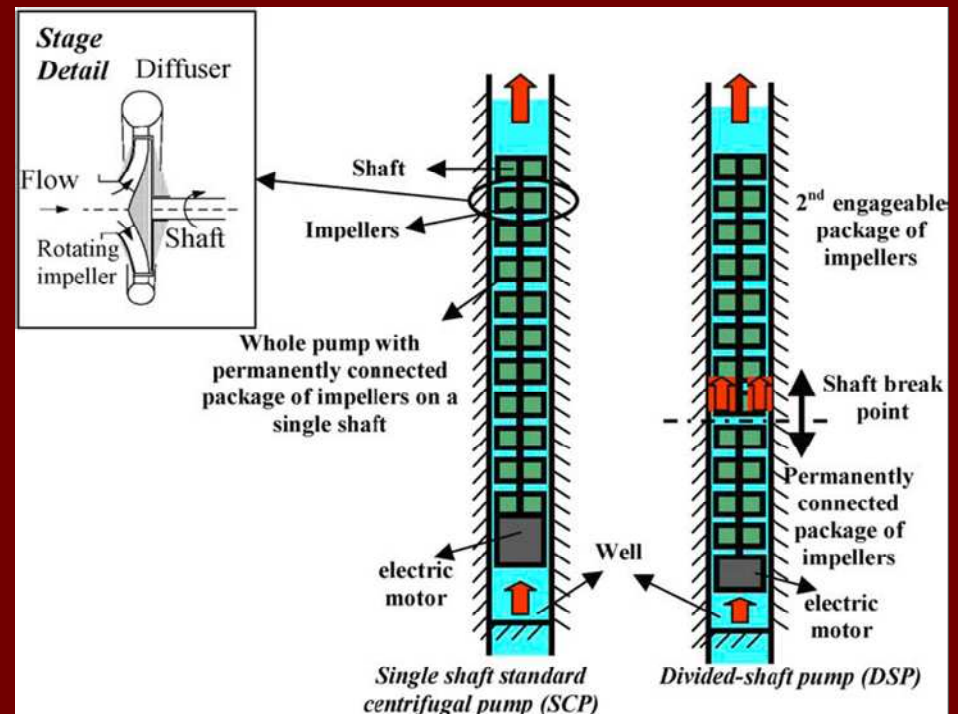
- Should summarize article
- Should be concise, 1-2 pages
- May use images or figures from article
- Should include the full citation

The Good

Literature Review 3

Improving solar pumping systems by addition of modular centrifugal pumps

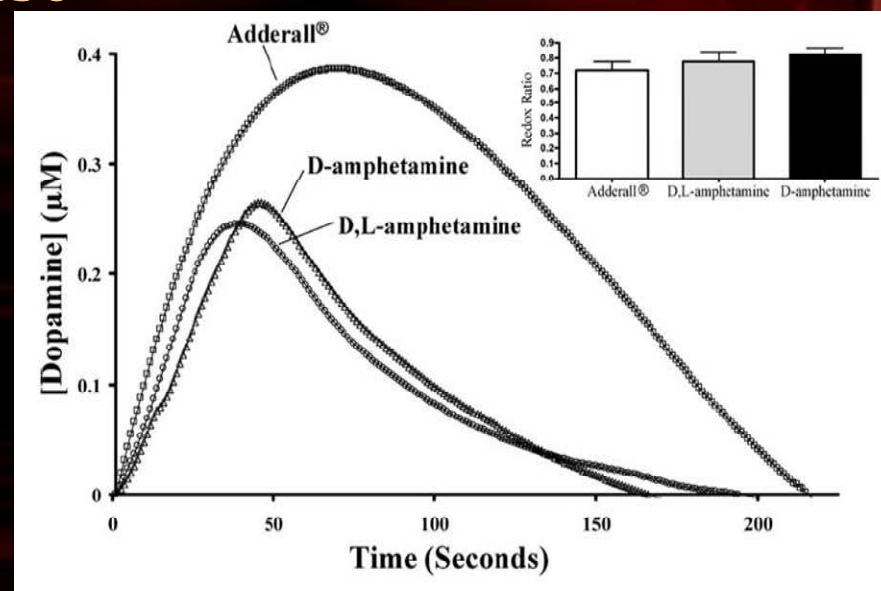
- Divided shaft pumps operate more efficiently than stand centrifugal pumps when solar irradiation is low
- The number of impellers or stages operating varied depending on the amount of irradiation during the day
- Pump power demand is proportional to cube of rotational speed
- Pump design should be based on amount of peak power provided by PV cells



Fiaschi, Daniele, et al. Improving the effectiveness of solar pumping systems by using modular centrifugal pumps with variable rotational speed. *Solar Energy* 79 (2005) 234-244.

Literature Review III: Chronoamperometry to Measure Effectiveness of Adderall in Dopamine Release

- Adderall results in larger amounts of dopamine release (higher amplitude)



- Dopamine release induced by Adderall also has longer time course of activity
 - Shorter rise time, longer clearance time
- Use of each enantiomer singularly is not as effective as combination of components

The Bad

Literature Review

Detection of Cavitation Phenomenon in a Centrifugal Pump Using Audible Sound [2]

- ▶ Studied the onset of cavitation within centrifugal pumps
 - Produced by pulsation waves of bubbles and collapse of vapor bubbles upon entering a region of high pressure
 - Consequence of insufficient required value for NPSH
- ▶ Wanted to find specific noise frequencies dependent upon the start of cavitation
 - Noise increases linearly with:
 - ▶ Flowrate
 - ▶ maximum volume of bubbles
 - ▶ number of bubbles
 - ▶ concentration per unit volume of bubbles
- ▶ Noise levels of 147 Hz are dependent upon cavitation
 - Frequency can be separated from noise spectra
 - Sound signals used to alarm operator of cavitation
 - Alarms can still be used in presence of background noise
- ▶ NPSH required must be maintained to prevent cavitation

The Ugly

Literature Review

- Morrison, et. Al (1990)
 - Studied various salts (NaCl, NaBr, KBr, KCl) as MSAs in ethanol/water system
- Orchillés, et. Al (2007)
 - Studied ionic liquids as MSAs in acetone/methanol system
- Sapei, et. Al (2007)
 - Studied VLE for sulfide/hydrocarbon systems to study more effective separation of sulfur from gasoline

Theory (Working Equations)

- Should include citations when appropriate
- Should include some text summary
- Should include nomenclature
- Can include cartoons to illustrate concepts

The Good

Working Equations

Governing Equation

- ▶ The Bernoulli equation is a generalized energy balance

$$\frac{(p_2 - p_1)}{\gamma} + (Z_2 - Z_1) + \frac{(V_2^2 - V_1^2)}{2 \cdot g_c} + \left(\sum f \frac{l}{D} + \sum K \right) \frac{V^2}{2 \cdot g_c} = h_p$$

- ▶ p = pressure (psi)
- ▶ γ = specific weight of water (lb/ft³)
- ▶ Z = elevation above or below (ft)
- ▶ V = average liquid velocity (ft/s)
entire
- ▶ g_c = acceleration due to gravity (ft/s²)
- ▶ K = fitting and valve loss coefficient
- ▶ f = friction factor
- ▶ l = length of tubing (ft)
- ▶ D = Diameter of tubing (ft)
- ▶ h_p = pressure head for
system (ft of H₂O)

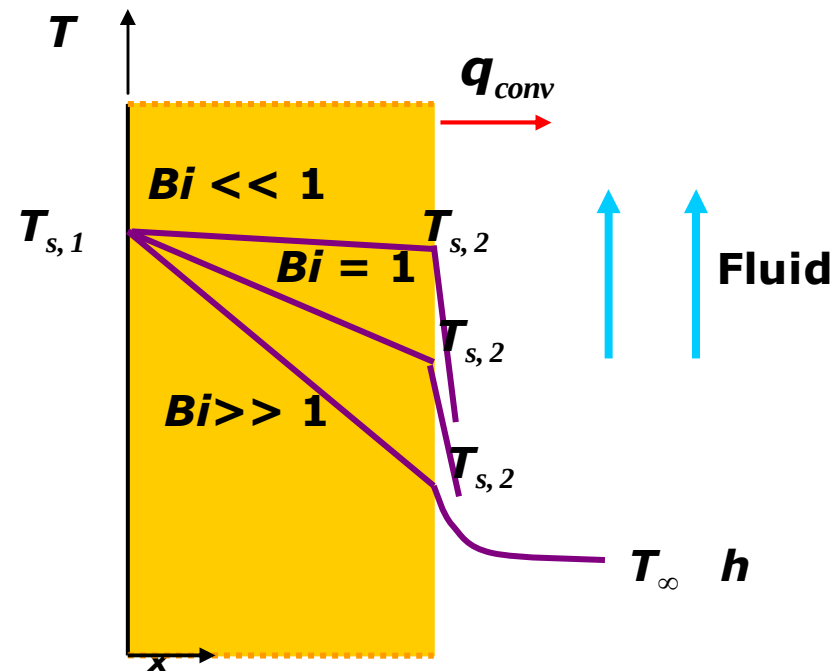
Biot Number

- Resistance to Conduction/Resistance to Convection

$$\frac{T_{s,1} - T_{s,2}}{T_{s,2} - T_{\infty}} = \frac{(L/k \cdot A)}{(1/h \cdot A)} = \frac{R_{cond}}{R_{conv}} = \frac{h \cdot L}{k} \equiv Bi$$

Validity of Lumped Capacitance Method

$$Bi = \frac{h \cdot L_c}{k} < 0.1$$



Chronoamperometry: Cottrell Equation

$$i(t) = nFAC_o \sqrt{\frac{D_o}{\pi t}}$$

F.G. Cottrell, *Z. Physik. Chem.*, **42**, 385 (1902).

i = current transient (A)

n = number of electrons in analyte half-reaction

F = Faraday's constant (96485 C/mol)

A = electrode area (cm²)

D_o = analyte's diffusion coefficient (cm²/s)

t = time (s)

The Bad

Engineering Principles and Working Equations

- The standard variance is often termed the second moment of the response curve and can be approximated by evaluating the following integrals:

$$\sigma^2 = \frac{\int c(t - t_r)^2 dt}{\int_0^{\infty} c dt} \quad (6)$$

The Ugly

Engineering Principles

$$\hat{f}_1^V = y_i \phi_i P \quad \hat{f}_1^V = \hat{f}_1^L$$

$$\hat{f}_1^L = \gamma_i x_i f_i \quad f_i = \phi_i^{sat} P_i^{sat} \exp \frac{1}{RT} \int_{P_i^{sat}}^P V_i^l dP$$

$$y_i \phi_i P = \gamma_i x_i \phi_i^{sat} P_i^{sat} \exp \frac{1}{RT} \int_{P_i^{sat}}^P V_i^l dP$$

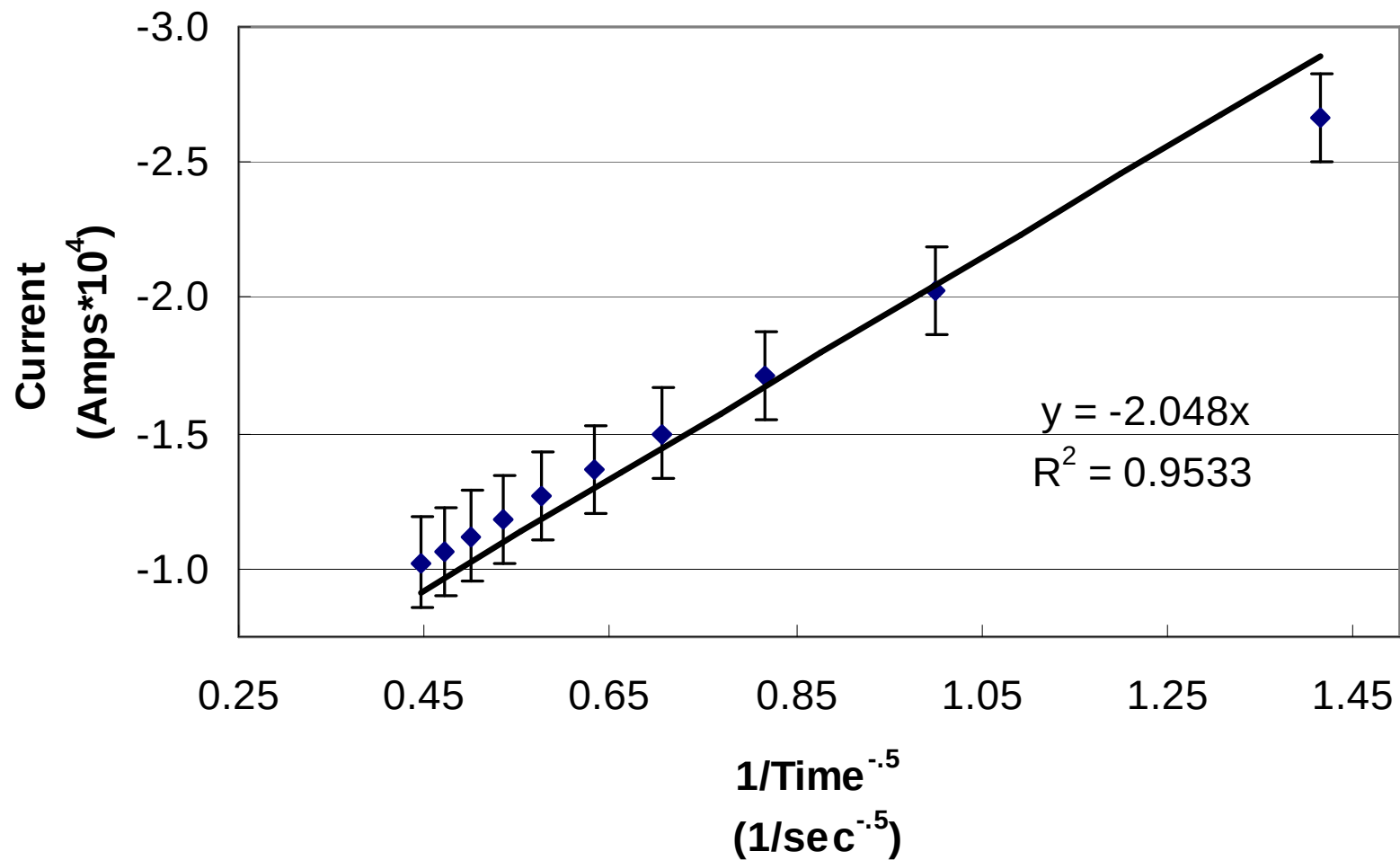
$$y_i P = \gamma_i x_i P_i^{sat}$$

Results and Figures

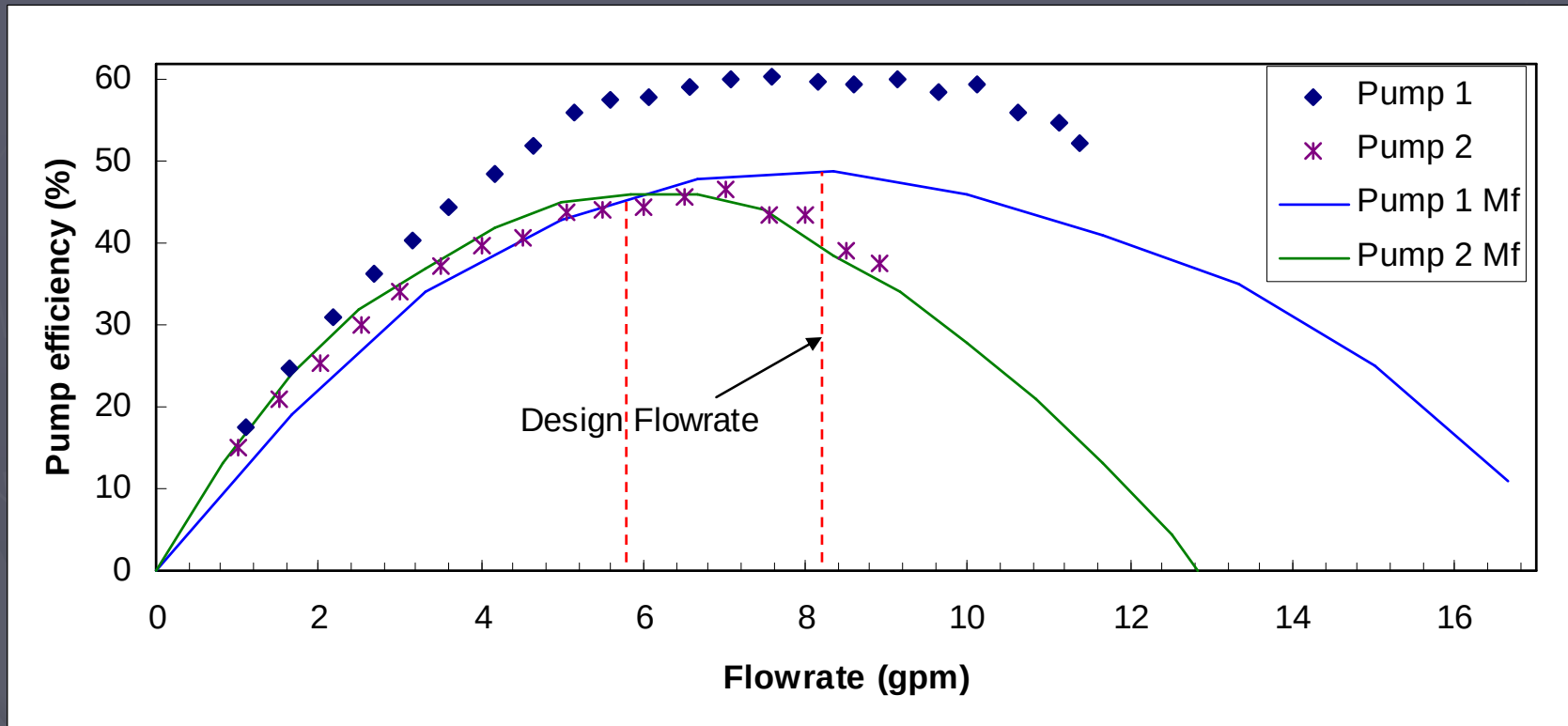
- Should use solid lines and markers correctly
- Should have error analysis if possible
- Should have “nice” axes ranges
- Should have some text explanation
- Should have a legend when needed

The Good

Chronoamperometry 40°C



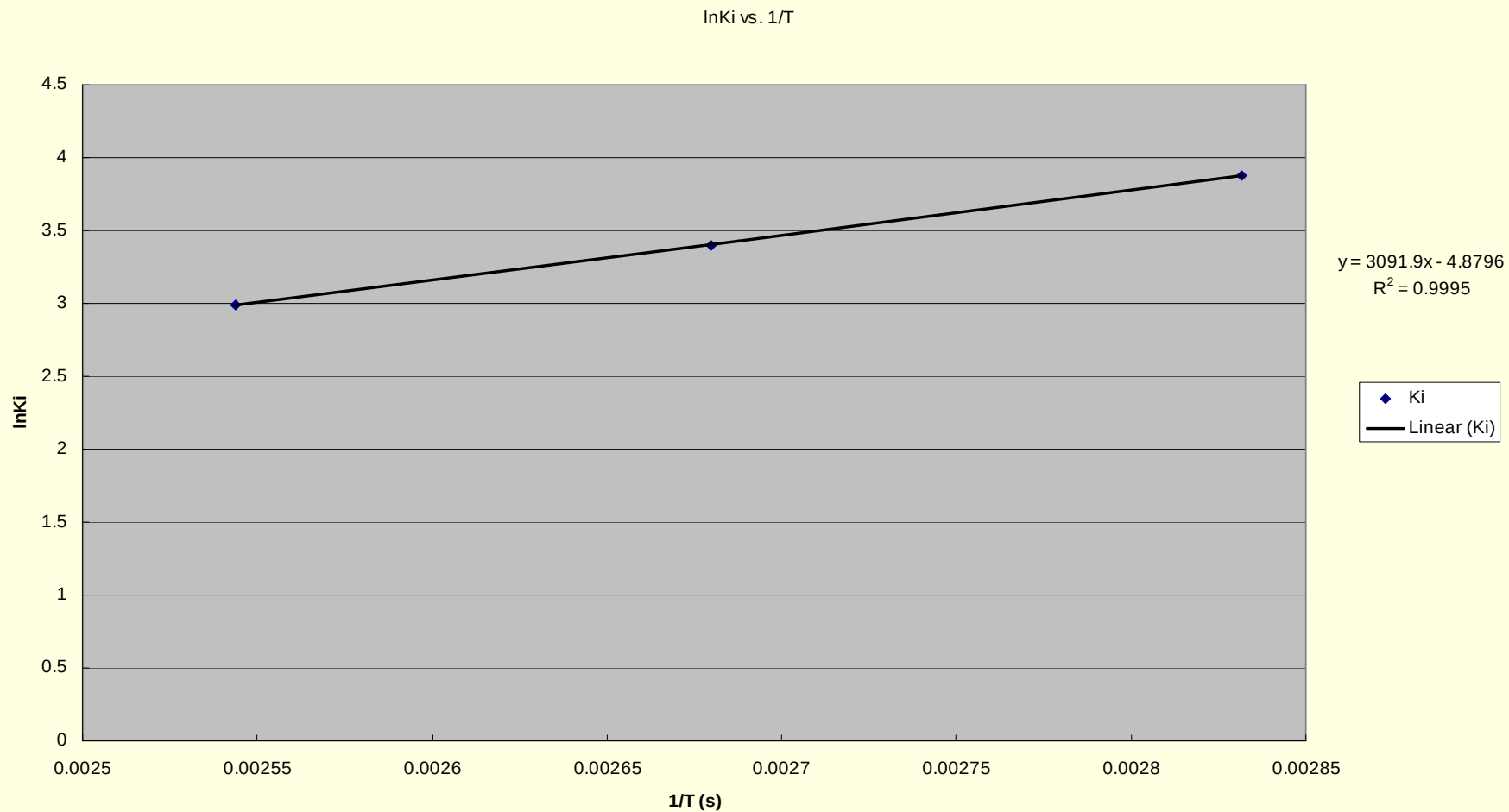
Pump Efficiency



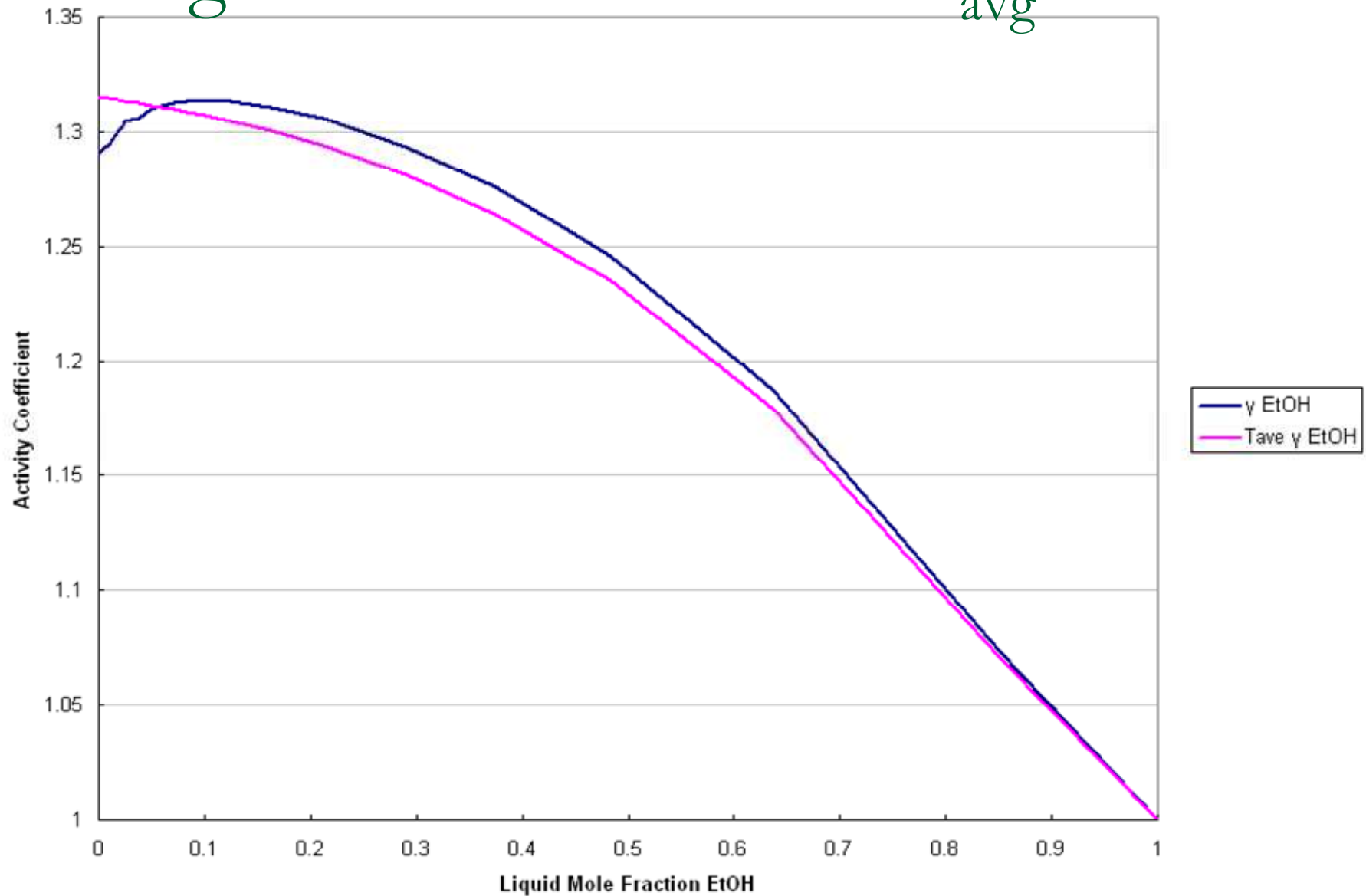
- ▶ Pump 1 efficiency is greater than the manufacturer possibly because of a larger impeller installed
- ▶ Design flowrate lines give the bep for the pump

The Bad

Graphical Method to Determine ΔU



Using Wilson Model with T_{avg}



The Ugly

**(49.5/49.5) Glycerol-Water and (1) Polyacrylamide
(unknown molecular weight), at 30 Degrees Celsius**

