WRITTEN COMMUNICATION

Mark J. McCready

PREQUEL

- Because of instant, electronic communication, writing is more important that it had been previously
  - particularly the ability to craft a good message in just a few words, in a short amount of time.
- Also, everyone is "busier" than in previous generations (at least we think we are -- I suppose we are keeping up with our instant communication!) so they will read only the minimal amount of everything
  - This is an opportunity for those of you who are good at it
- Thus, even at 3AM, you could think of report writing as a chance to be getting better at an essential skill!
- (mjm anecdotes!)

A PROPOSAL

Advanced Nanostructured Materials for Energy, Electronic and Processing Applications

A proposal to the *Advancing our Vision* Initiative from the College of Engineering

Contact Person:

Mark J. McCready
Professor of Chemical and Biomolecular Engineering
Senior Associate Dean for Research and Graduate Studies
College of Engineering
mjm@nd.edu

- I don't do research in Materials!
  - But if your writing matches your audience...
  - This is where a first impression can really matter...

INITIAL TEXT

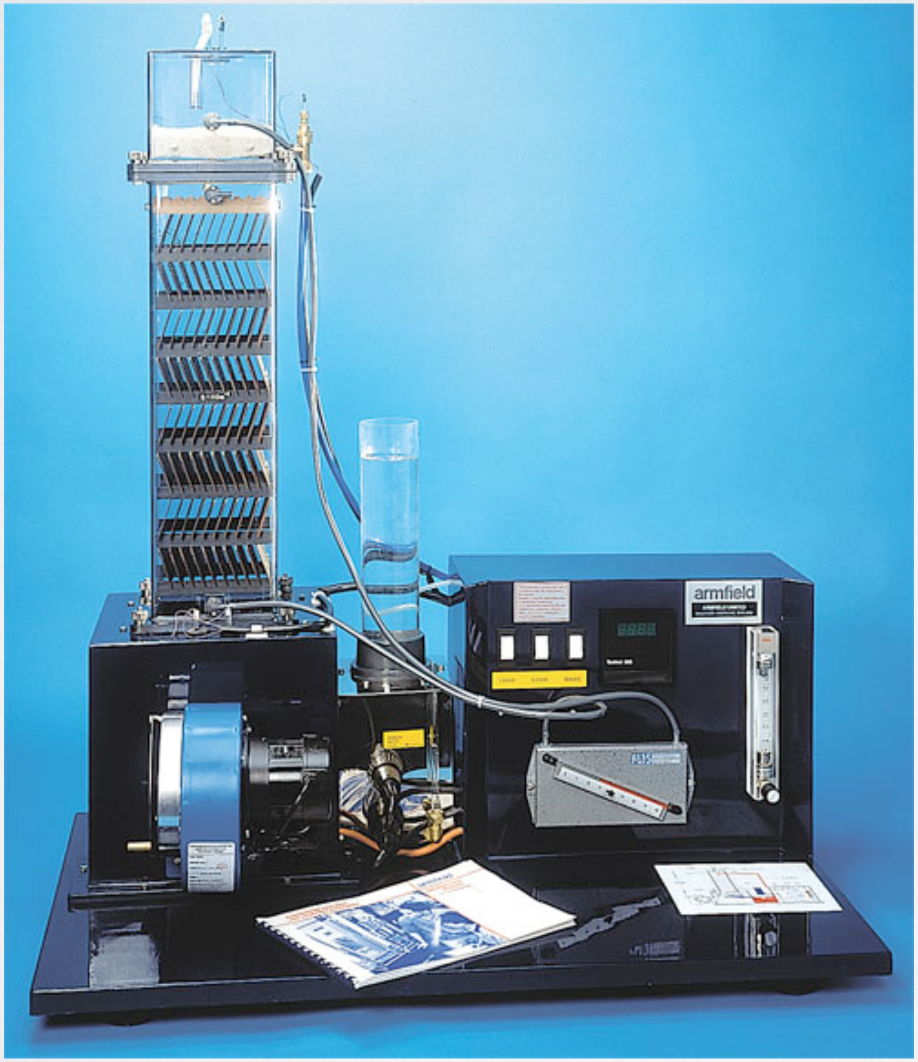
Introduction

It is difficult to overstate the extent to which our lives have been changed by modern, synthetic materials. With the exception of the “bones” of large structures (e.g., steel beams, concrete* blocks, wood trusses) and the natural fibers that are still used in clothing (e.g., cotton and wool), very few items that we use are made of naturally occurring or pre-modern materials. High purity silicon enabled the invention of the integrated circuit. Various light emitting, charge carrying, touch sensitive, and extremely tough and hard materials enabled devices such as the iPhone®. The future of computing and next generation micro- and nanoelectronics will almost certainly involve highly engineered materials such as graphene, nanoscale magnets, or III-V semiconductors or tunneling field effect transistors. All of the chemical reactions of the modern chemical industry are accomplished with catalysts, that have greatly increased the speed and efficiency of processes, and use up to 20% less energy than a couple of decades ago. While the promise of limitless electricity from the sun has not yet been realized, the efficiencies of photovoltaics have continually increased with gallium arsenide surpassing silicon and various multilayer polymeric and inorganic oxide formulations likely to beat both of these in terms of cost and efficiency. While the first household LED lamps for area illumination still cost more than $25 (even at Home Depot®) these will eventually revolutionize commercial and home lighting and reduce energy use for lighting to only about ¼ of the requirements of incandescent bulbs. Boeing’s new 787 uses only about 30% of the fuel of its first generation jet, the 707, which came into use in 1958. Some of the improvements are aerodynamic, but the majority arise from the use of lighter (composite) materials, more efficient flight and engine control made possible with microprocessors and improvements in the turbine blades that allow a higher combustion temperature and larger mechanical stresses.

OUTLINE

- First you need content (good data) and sound understanding
- General thoughts and principles of technical writing
  - Be clear and efficient
  - Correct grammar is important
- Writing an abstract
  - The idea is write 2/3 of page that communicates the most important results quantitatively and allows the reader to envision what your device looked like and how the experiment proceeded
- The rest of the report
  - Follow the guidelines in the lab manual -- Discussion is important
- References and what you can and can’t do as far as using the work of others.

WATER COOLING TOWER



SCHEMATIC OF EXPERIMENT

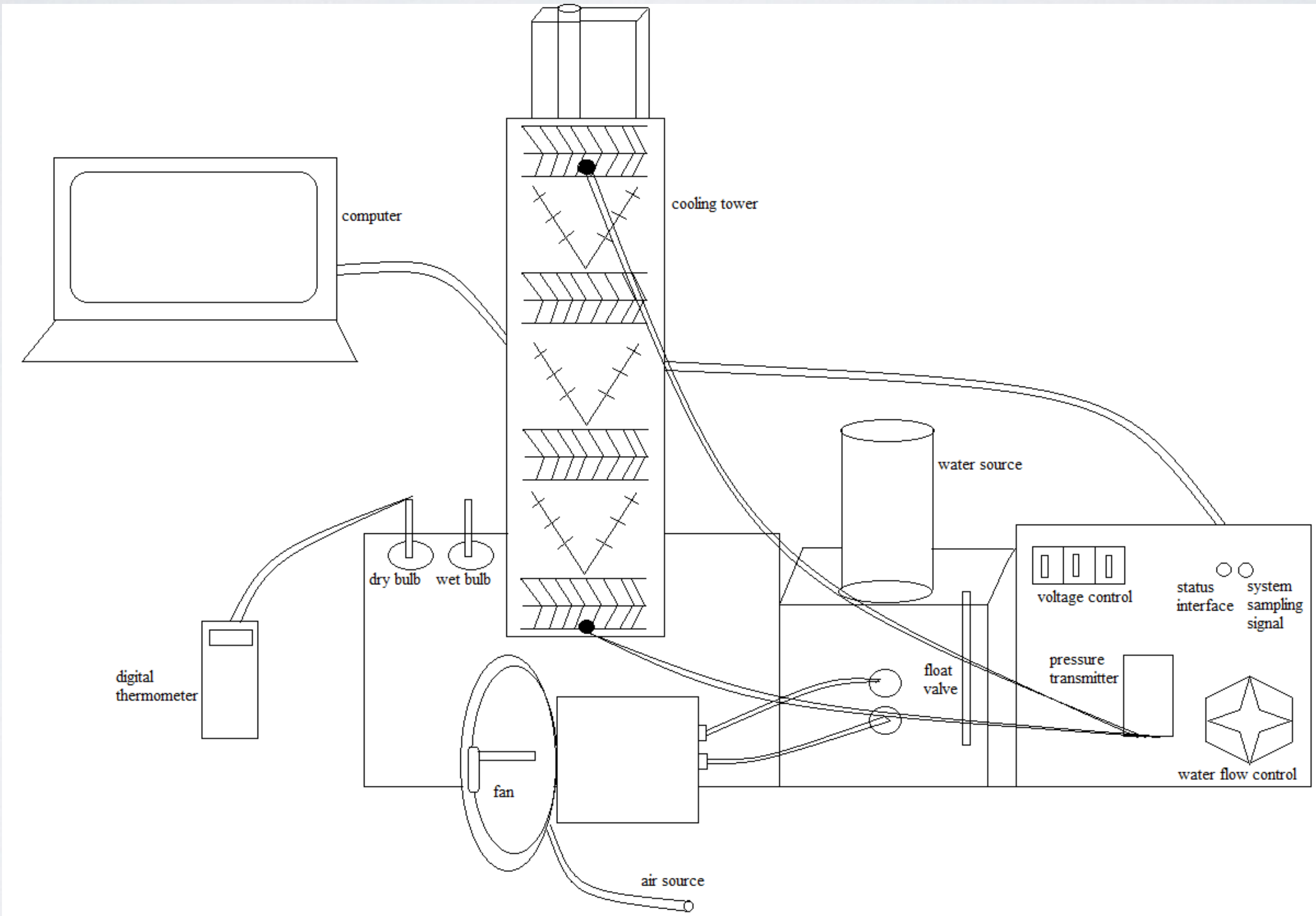


Figure 3. Computer-Linked Bench Top Cooling Tower Schematic

FUNDAMENTAL PRINCIPLES

- A gas absorption or desorption process can be described with a concentration driving force (limit might be Henry's law) and we can commonly use an activity coefficient to correct a vapor pressure to get fugacity and write the expression for phase equilibria in vapor-liquid binary mixtures.

- For water evaporation, the high heat of vaporization makes the energy balance for phase change just as important as the mass balance when describing the device.

  - So an enthalpy driving force is commonly used

    - The last time I was at the final reports, both groups missed this!!!

EXPERIMENTAL TECHNIQUE MATTERS!

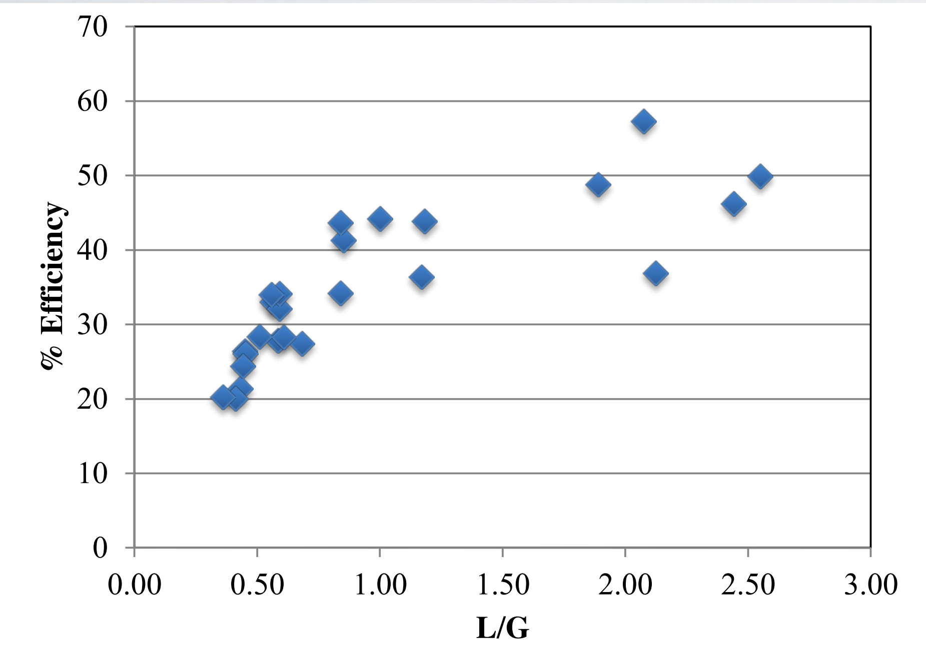


Figure 6. Percent Efficiency of the cooling tower as a function of L/G input.

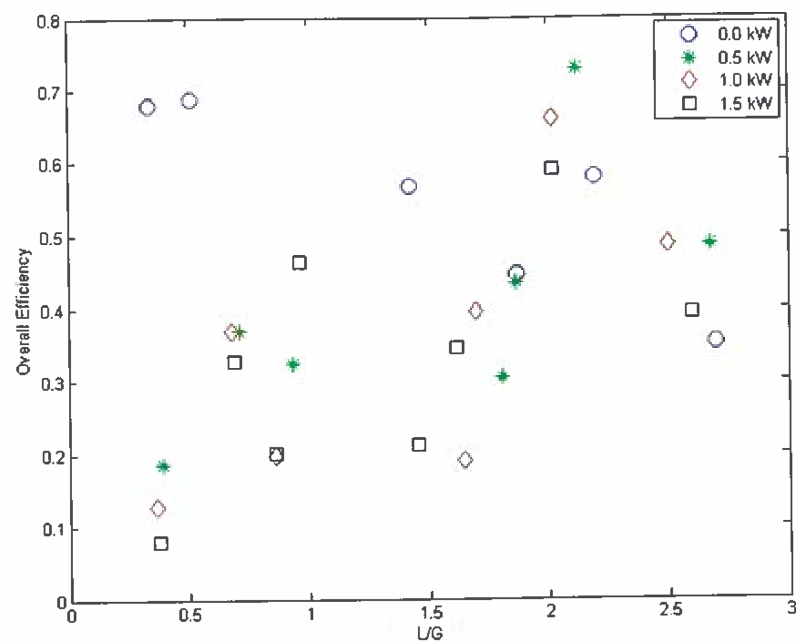


Figure 9. Column Efficiency variation with flow rate ratio

IT MATTERS WHO IS DRIVING!

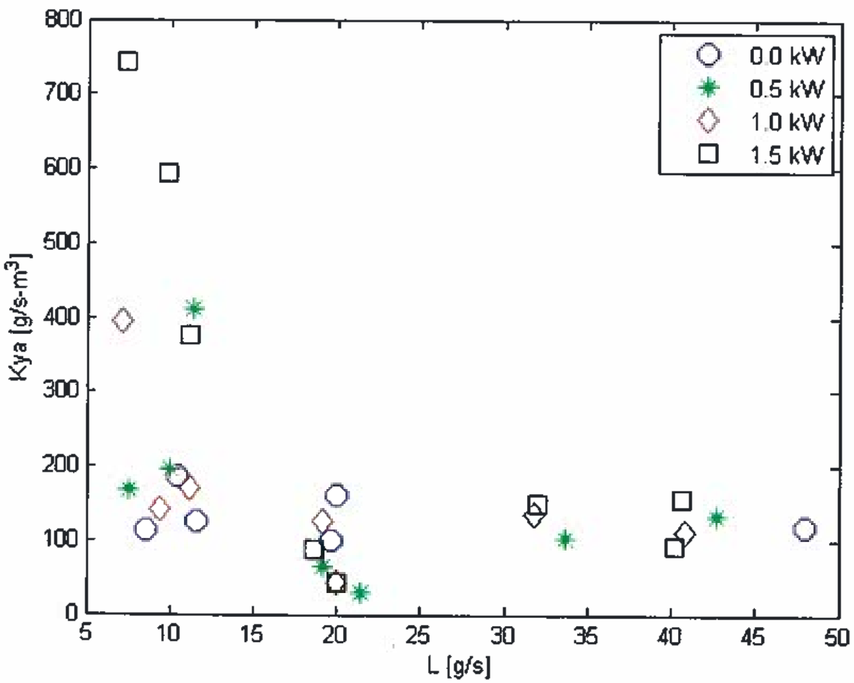


Figure 6. Variation of K_ya with Liquid flow rate

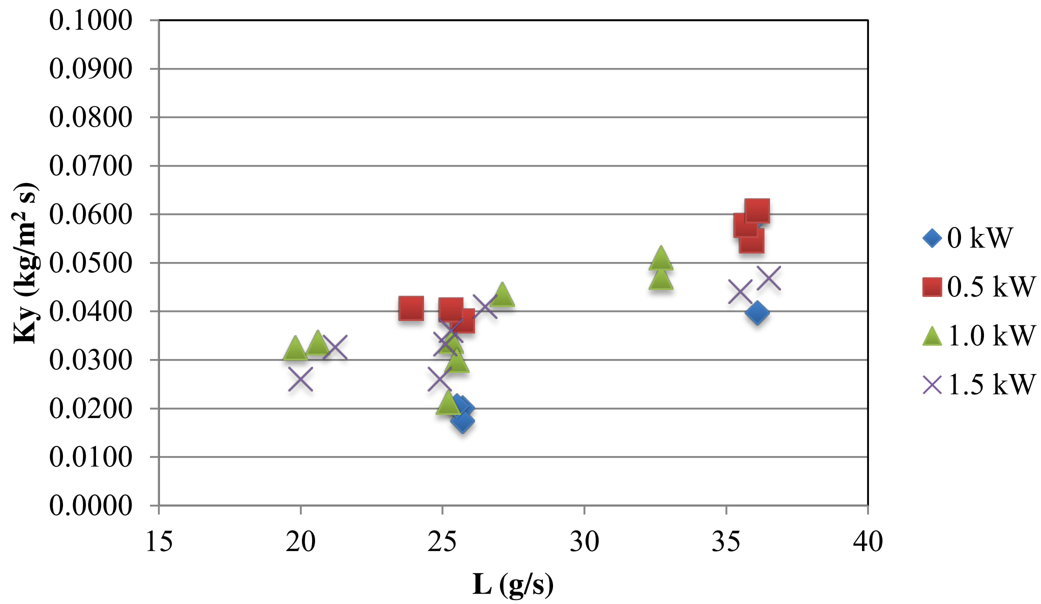


Figure 5. Ky as a function of water flow rate input for various powers.

GENERAL THOUGHTS

- You are not writing to fill up space
- You should respect the time and effort of the reader
- The reader should have exactly the conclusions that you are trying to convey --
  - if the fix to a process is a 10C decrease in temperature, you don't want the reader thinking it is a 10C increase!
  - Ethanol from corn is fundamentally a bad idea and so the reader should not get the end and not be sure of this.

FIRST TIME THROUGH A THOUGHT

Well, it happened again, another topic that I mentioned many times in classes that seemed to need some attention by the medical procession, has received it. Many times in the mass and energy balances class I have mentioned that I could not understand how drug dosing was done. That is, the dose for adults for almost all drugs that I have seen prescriptions for, is the same -- be it one, two, three or 4 times per day. I could no help but wonder how small women and really large men could need the same dose when a simple mass balance tells us that if it some systemic concentration of drug is needed for efficacy, then dose should scale roughly as weight. If there is partitioning of the compound in different types of tissue (e.g., fat tissue which would be hydrophobic), then perhaps a more nuanced criterion is necessary. However, in either case, all adults are not equal.

~~IWell, i~~t happened again~~, another topic that~~ . I have mentioned many times in ~~classes~~ the mass and energy balance class that I could not understand how drug dosing is done. ~~that seemed to need some~~I suggested that this needed attention by the medical procession~~, has received it.~~ (as brazen as this seems!) ~~Many times in the mass and energy balances class I have mentioned that I could not understand how drug dosing was done.~~ That is, ~~the dose for~~ for all ~~-~~adults, the dose ~~s~~ for almost all drugs ~~that I have seen prescriptions for~~, is the same -- be it one, two, three or 4 times per day. I could not help but wonder how small women and really large men ~~could~~would need the same dose when a simple mass balance tells us that if it some systemic concentration of the drug is needed for efficacy, then dose should scale roughly as weight. If there is partitioning of the compound in different types of tissue (e.g., fat tissue which would be hydrophobic), then perhaps a more nuanced criterion is necessary. However, in either case, all adults are not equal~~.~~ (despite the claim in the founding documents of the US!)

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ABSTRACT

- “stand alone” document -- you do this last!
- Succinctly state the system/process/phenomenon being studied with enough quantitative information for an unconnected reader to understand what you did.
- Give the analytical technique if it is important
- Give range of parameters that were covered
- State the results quantitatively while giving context, usually in comparison with literature values or correlations
- Could give one statement of significance of the results in a broader sense or suggest a better way to address the problem.

Abstract

The purpose of this experiment was to determine the correlation between friction factors and Reynolds numbers for smooth pipes of differing diameters, a rough pipe, and a packed bed. The losses due to several fittings and valves were also studied. This was done at laminar and turbulent flow conditions using a pipe flow apparatus, rotameter and manometer. For Reynolds numbers in the range of 100-20,000, friction factors were determined to be in the range of $8*10^{-4}$ to $1*10^{-2}$ and inversely proportional to the Reynolds number for both laminar and turbulent flow. The experimentally determined friction factors were lower than the ones predicted by theory at a given Reynolds number for smooth pipes. The experimental data for the rough pipe did not correspond to theory due to error in the pressure measurement. For the packed bed, the friction factors in the laminar regime were determined to be one order of magnitude higher than those of the smooth pipe. The losses due to the fittings and valves were calculated using Bernoulli's equation. The experimental K factor for an orifice plate was 2.41, which was 12% higher than the theoretical value of 2.15.

Abstract

This experiment analyzed the diffusion of gaseous CO_2 into a liquid of Stoddard Solvent at 1 atmosphere of pressure with temperatures of 25, 30 and 35°C. The variables determined at these conditions were the solubility, diffusion coefficient, and the enthalpy of solution. The CO_2 was measured and delivered by a gas detector to a sealed cell containing Stoddard Solvent via a pipe and valve system. This airtight system allowed for the determination of the moles of CO_2 delivered to the cell of Stoddard Solvent at a given time. Using a molecule penetration theory derived by Higbie, mathematics based on the diffusion theory of molecules, and this data the diffusion coefficient was calculated. The average diffusion coefficient was $4.918*10^{-3}$ [cm²/s] $\pm 1.57*10^{-4}$ at 25°C, $4.692*10^{-3}$ [cm²/s] $\pm 1.33*10^{-4}$ at 30°C, and $6.555*10^{-3}$[cm²/s] $\pm 1.25*10^{-4}$ at 35°C. These were generally high by two orders of magnitude when compared to the literature value of $2.11*10^{-5}$ [cm²/s] (298 K, 1 atm). In order to quantify this significant source of error, one trial excluded the use of a bath stirrer. However, the calculated diffusion coefficient for that trial was found to be comparable to the other trials. It was concluded that the bath stirrer did not contribute significantly to the error, and must have been caused by either the vibration of the lab as a whole or from the convection of the CO_2 gas. The solubility was calculated by measuring the total moles that would dissolve in the Stoddard Solution. The average solubility was $6.197*10^{-5}$ [mol/cm³] $\pm$ $2.71*10^{-7}$ at 25°C, $5.903*10^{-5}$ [mol/cm³] $\pm 2.81*10^{-7}$ at 30°C, and $5.549*10^{-5}$[mol/cm³] $\pm$ $2.81*10^{-7}$ at 35°C. These calculations were comparable to the solubility of CO_2 in n-pentane (a similar hydrocarbon molecule): $8.206*10^{-5}$ [mol/cm³]. The heat of solution was calculated through the use of Henry's Law, which assumed that the CO_2 was greatly diluted in the solution, and an equation derived from the Gibbs-Helmholtz Equation. This derived equation allowed for the calculation of the heat of solution because it related the Henry's Law constant with the temperature. The temperature was known and the Henry's Law constant was calculated through the solubility and fugacity of the CO_2 gas. The heat of solution was determined to be –8856.395 [Joule/mole] ± 651.465. This experiment may be improved in the future by making slight chan

FORMATION OF WAVES ON A HORIZONTAL ERODIBLE BED OF PARTICLES

W. Ç. KURU, D. T. LEIGHTON and M. J. McCREADY
Department of Chemical Engineering, University of Notre Dame, Notre Dame, IN 46556, U.S.A.

(Received 5 August 1994; in revised form 26 April 1995)

Abstract—The mechanisms responsible for the initial growth of sand waves on the surface of a settled layer of particles are studied experimentally and theoretically. Experiments employ water–glycerin solutions of 1–14 cP and glass spheres ($\rho_s = 2{,}4\,g/cm^3$) that are either 100 or 300 μm in diameter. The particle Reynolds number and Shields parameter are of order one and the flow Reynolds number is of order 1000 to 10,000. Experimentally obtained regime maps of sand wave behavior and data on the wavelengths of the sand waves that first appear on the surface of the settled bed are presented. Turbulence in the clear liquid is not necessary for formation of waves and there is no dramatic change in behavior as the flowrate is increased across the turbulent transition. The initial wavelength varies as the Froude number to the first power. Because a flowing suspension phase is observed before waves form, linear stability analysis of the clear-layer–suspension-layer cocurrent two-phase flow is presented. The suspension phase is modeled as a continuum that has an either constant or exponentially increasing viscosity. Neither of the models correctly predicts the wavelength for the first observed waves, their growth rate or their speed. However, the initial wavelength is found to agree well with the trajectory length for a saltating particle obtained from a model for forces on individual particles.

Key Words: particle transport, dune formation, particle resuspension, saltation

Origin of Roll Waves in Horizontal Gas-Liquid Flows

The mechanism of formation of roll waves on a horizontal liquid layer sheared by a gas flow is examined. Measurements of the wave amplitude spectrum show that, for liquid film Reynolds numbers greater than about 100, roll waves evolve from disturbances that initially have wavelengths much longer than the film thickness and which grow slowly with distance. Predictions of linear stability analysis are shown to agree well with the observation of these instabilities and not the visual transition to roll waves as was suggested in earlier studies. For very thin films, the data do not give conclusive proof of the origin of roll waves, but it is speculated that these are actually solitary waves which have begun to break.

Kenneth Bruno and M. J. McCready
Department of Chemical Engineering
University of Notre Dame
Notre Dame, IN 46556

Evidence for Nuclear Emissions During Acoustic Cavitation

R. P. Taleyarkhan,[1*] C. D. West,[1†] J. S. Cho,[2] R. T. Lahey Jr.,[3]
R. I. Nigmatulin,[4] R. C. Block[3†]

In cavitation experiments with deuterated acetone, tritium decay activity above background levels was detected. In addition, evidence for neutron emission near 2.5 million electron volts was also observed, as would be expected for deuterium-deuterium fusion. Control experiments with normal acetone did not result in tritium activity or neutron emissions. Hydrodynamic shock code simulations supported the observed data and indicated highly compressed, hot (10^6 to 10^7 kelvin) bubble implosion conditions, as required for nuclear fusion reactions.

- It turned out that this was either fraudulent or a really bad mistake!

INTRODUCTION

- What is being studied
- Why is it relevant
- What did you “do”

Introduction

In experiment TD2, phase equilibria and liquid diffusion are the two main topics. Liquid diffusion or more accurately diffusion through a liquid occurs, in reference to the experiment, when CO_2 gas was brought in contact with the Stoddard Solvent. At this point of contact the CO_2 penetrates through the gas-liquid interface and slowly diffuses further into the liquid medium. This process of penetration is based on the "penetration theory" proposed by Higbie. Because gaseous molecules can diffuse rather quickly they have little difficulty entering the liquid interface. However, the diffusion process slows dramatically once the gas molecules enter the liquid phase. Since diffusion from the interface is so much slower than diffusion into the interface it can be assumed the interface is always saturated with gas molecules. This assumption helps mathematically because it indicates the diffusing material's concentration at the interface. Assuming the cell is semi-infinite, meaning it would take an extremely long time for the CO_2 molecules to diffuse from the interface to the bottom of the cell, an unsteady-state differential equation can be derived. (See theory) This equation includes the diffusion coefficient, which is dependent upon the diffusing species and the medium in which it is diffusing through. By obtaining the diffusion coefficient one can determine just how quickly one species can diffuse into another. Not only is this differential equation applicable to liquid diffusion, but it also describes solid-solid diffusion. In this way information can be gained about how one metal can diffuse into another to produce an alloy. Heat transfer through a semi-infinite wall can also be described this way if the diffusing species is considered to be heat or temperature. Solving the differential equation in this case would provide a temperature profile of a material at any time. Applications of a gas diffusing into a liquid body, as in this experiment, can be found in global warming predictions. That is, one can get an idea how much the greenhouse gas CO_2 will dissolve in a body of water (oceans) over a given period of time.

Various factors that may effect the diffusion of a gas into a liquid are either the pressure of the system or the convection of the gas. Because pressure acts as a driving force for any gas system, the higher the pressure the more the gas will dissolve into the liquid. In the case of carbonated water CO_2 does not dissolve readily into water unless a high pressure is exerted. The diffusion equation mentioned before assumes that the gas is

GRAPHS

- Readability is critical
- Data are single points with error bars
  - Never just draw a line through the data!
- Theory and correlations are “lines”

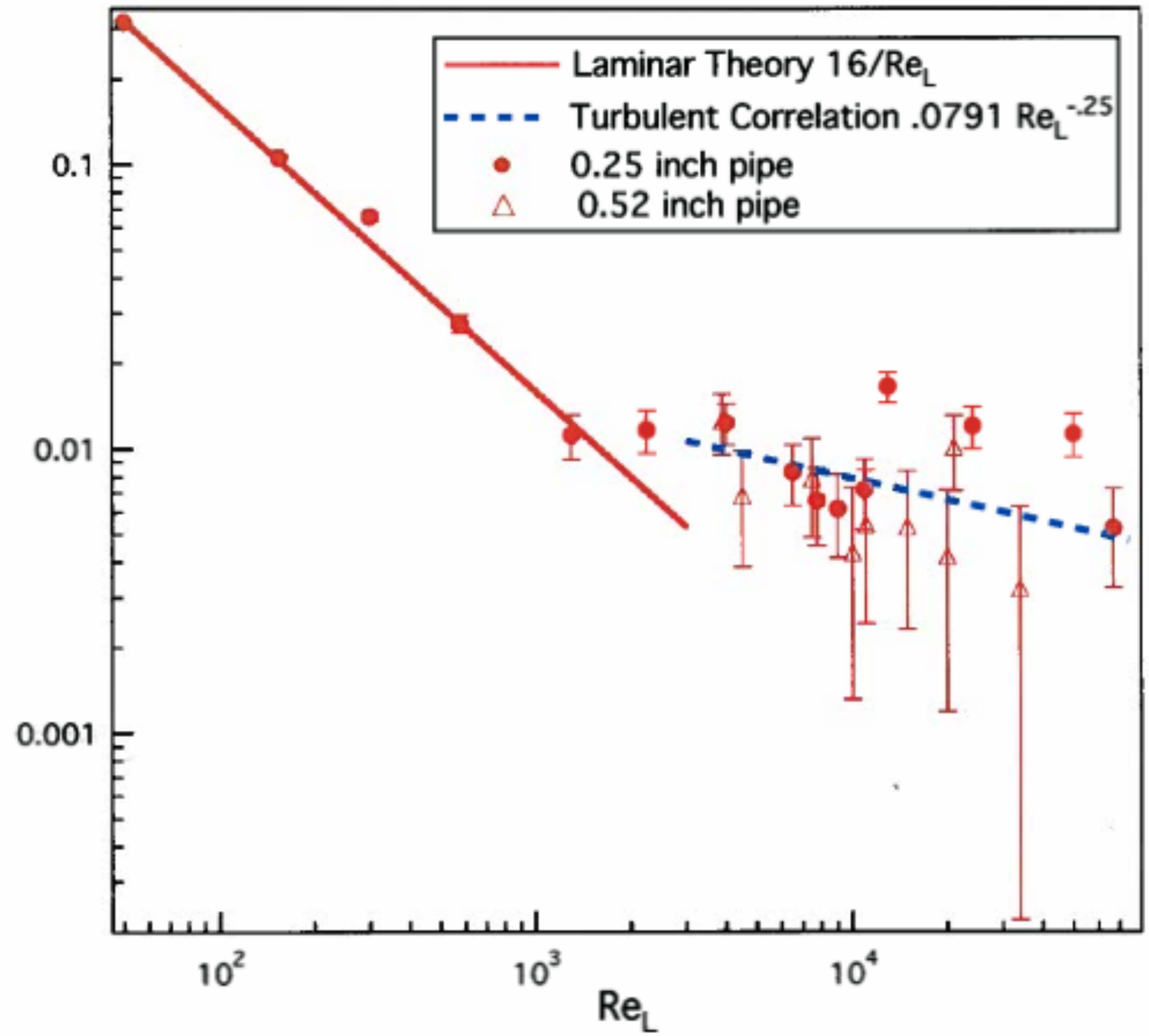


Figure 1. Reynolds number - Friction factor data for all pipes

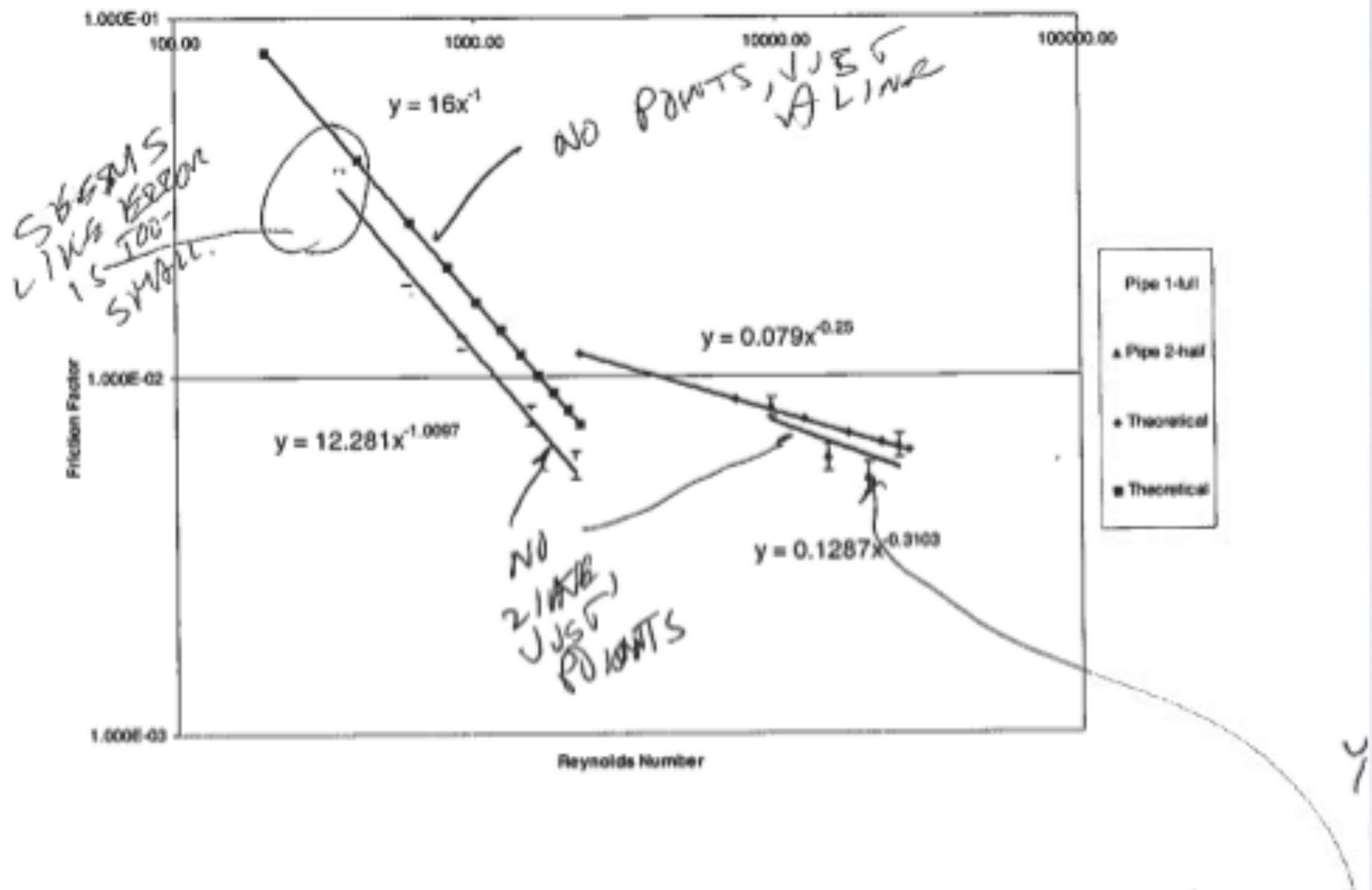
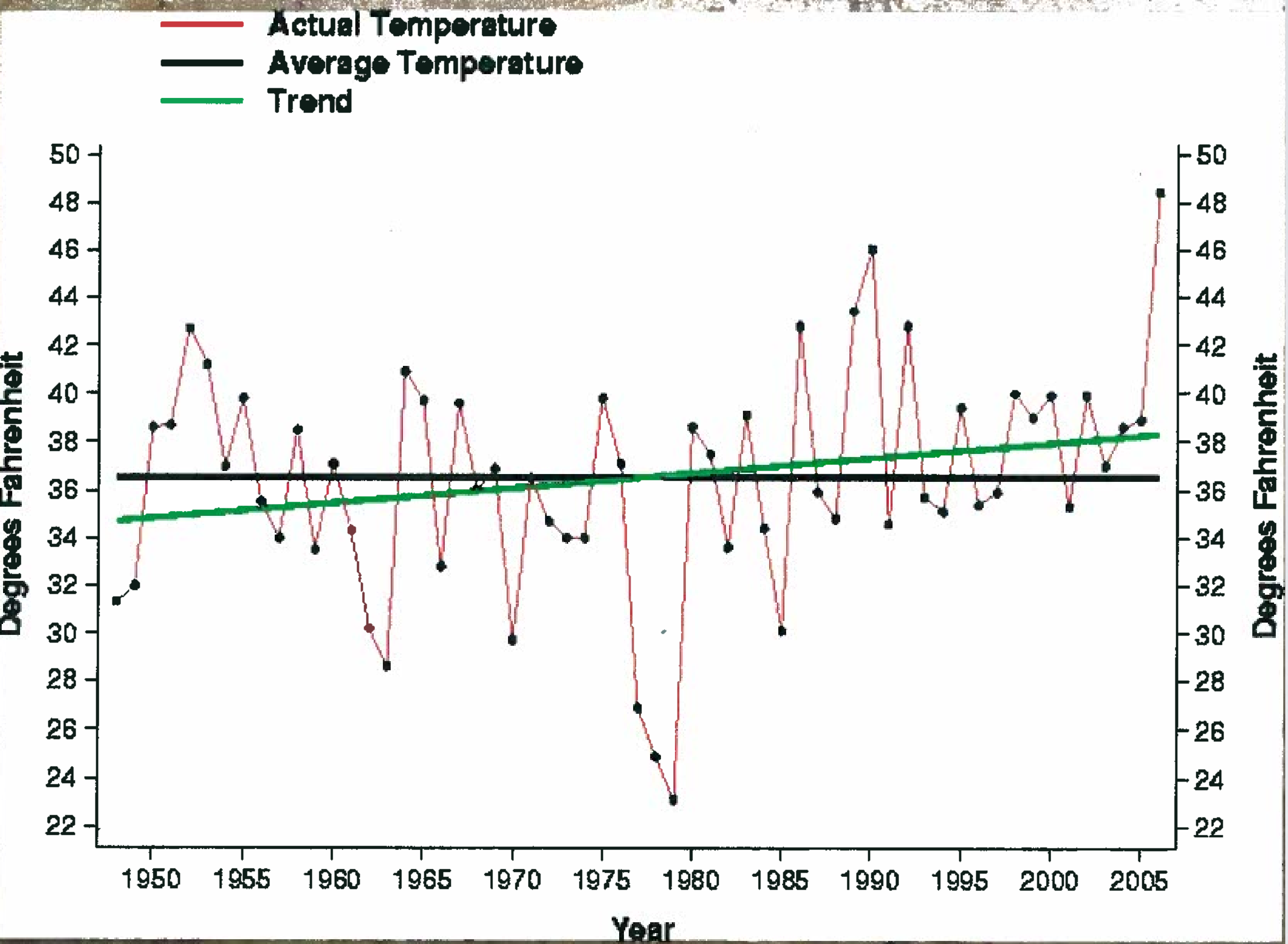


Figure 3. Laminar and turbulent flow in smooth pipes of varying diameter showing the relationship between Reynolds number and friction factor.

HTTP://WWW.NCDC.NOAA.GOV/OA/CLIMATE/RESEARCH/CAG3/V3.HTML



DISCUSSION

- Explain all of the important results in light of the theory
  - to what extent is there agreement
- Critically evaluate the experiment
  - even if it works

REST OF THE REPORT

- Follow the format
- The discussion is particularly important
  - This is where we find out if you know anything!

10. Literature Cited

Only references cited in the report are to be listed is this section since it is not a bibliography covering all references but only the most pertinent ones. Footnotes on individual pages of the report are not to be used. References cited in the text of the final project report should give the last name of the author (both authors when only two; first author et. al. when more than two) and the corresponding page numbers. An example is given below.

"The Reynolds number can be interpreted as the ratio of inertial to viscous forces at work in the fluid (Denn 37-39)."

References are to be listed in alphabetical order according to author or equivalent and should not be numbered. Use Chemical Abstracts Service Source Index journal abbreviations. For the previous example the citation would be the following:

Denn, M. M. "Process Fluid Mechanics"; Prentice-Hall; New Jersey, 1980

Typical citations for a journal are given below.

Danckwerts, P. V.; Sharma, M. M. Chem. Eng. (London) 1966, <u>202</u>, 244.

Danckwerts, P. V. Chem. Eng. Sci. 1979, <u>34</u>, 443.

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