Chemical Engineering App:

Increasing Accessibility of Course Materials, Reference Data and Problem Solving Tools

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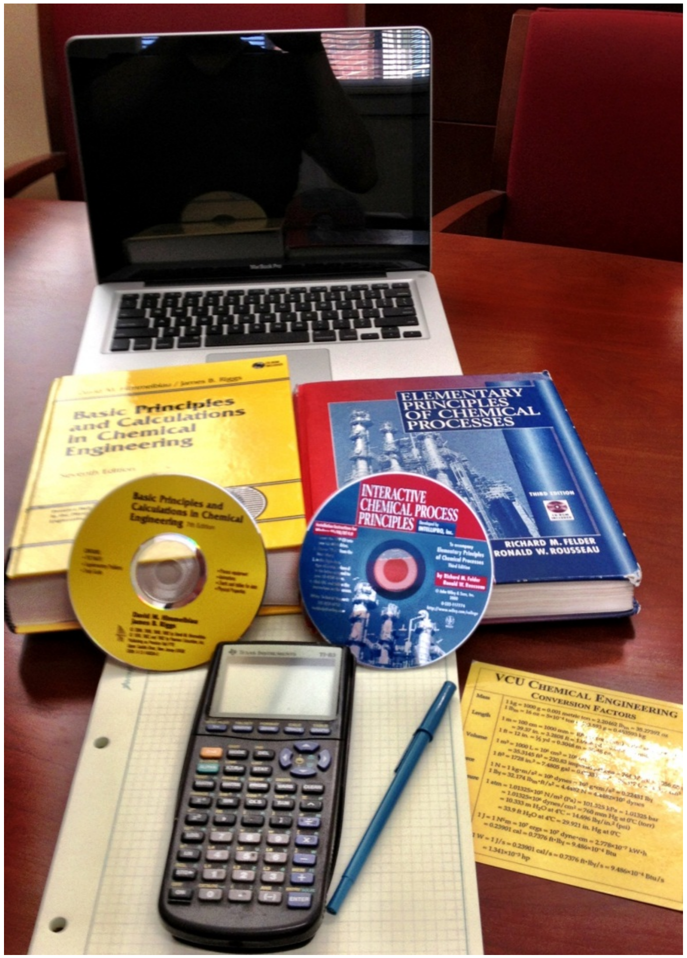
Collaborators

- John Patrick “JP” McLemore – MS 2012
  - Currently with Schlumberger (Aberdeen, Scotland)
- Prof. Heath Turner – UA ChBE
- David Roveda
  - UA ChBE undergrad
- Anna Marthinsen
  - UA CS undergrad
- University of Alabama Computer Based Honors (CBH) Program

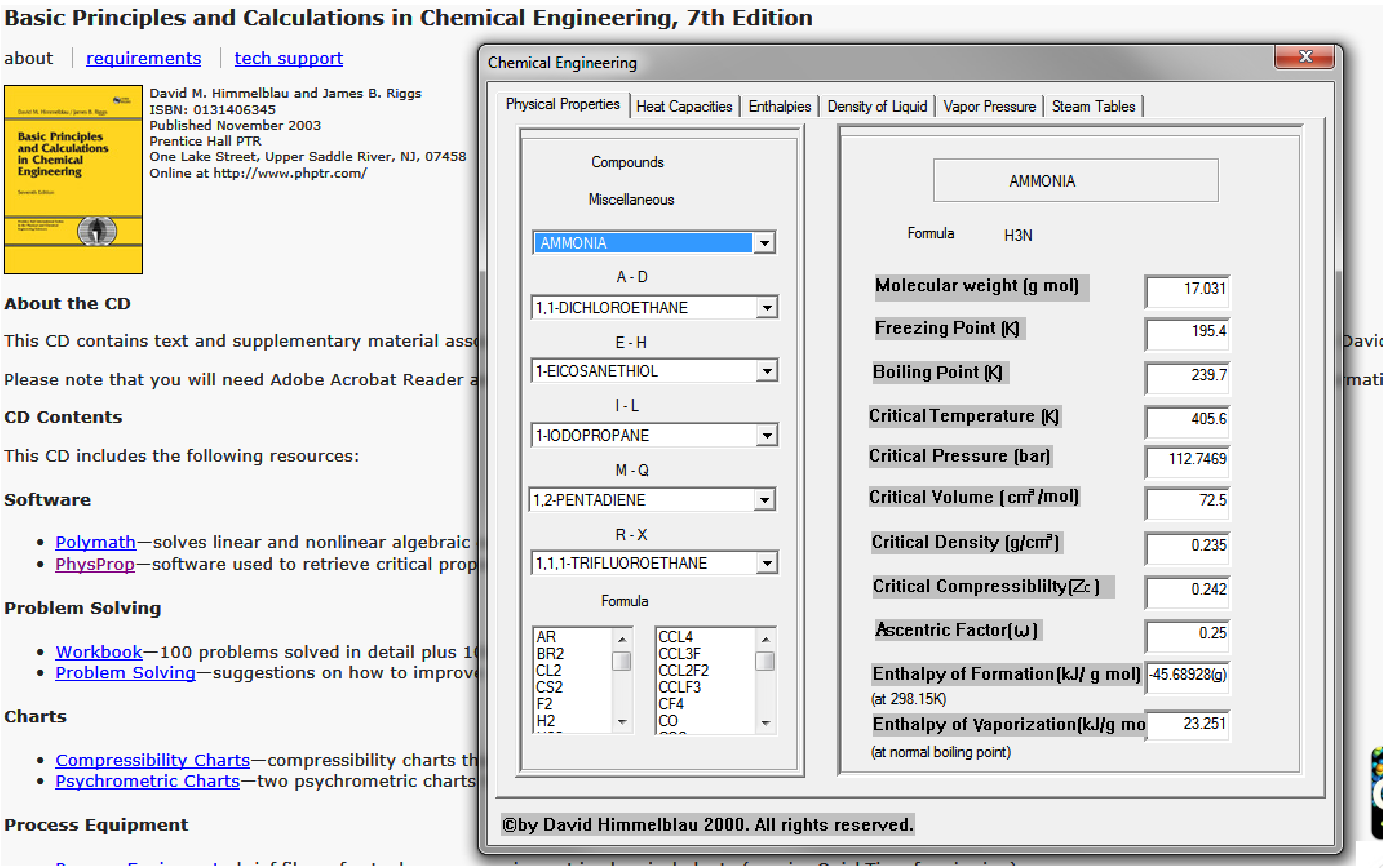
A Crossroads in How We Work & Teach



The bare essentials…

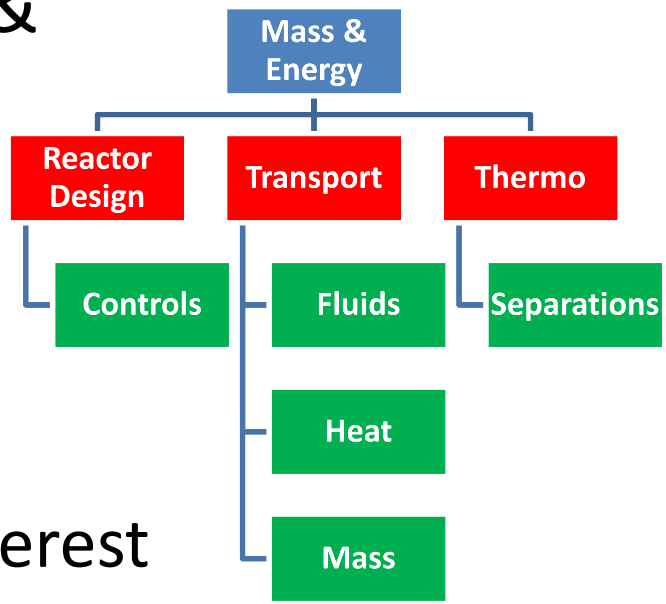
Can we do more with less?

An “App” from the Year 2000



A Vertical Integration of ChemE Education is Possible

- Blur the lines between subjects & **<u>decompartmentalize</u>** knowledge
  - Emphasize “real” vs. “ideal”
  - Facilitate retention of knowledge
  - Give educators modern tools
  - Open ChemE to <u>anyone</u> with an interest
  - Make it exciting!
- **NEED: Deeply integrated sets of thermophysical properties, problem solving tools, graphing and data sharing capabilities**



Motivation behind the ChemE App

- 6 semesters teaching Mass & Energy Balances
- Lack of truly functional ChemE apps
  - Few selections/poor functionality
- Solving equations by hand takes time away from instruction
  - Look up values/constants in table, input into calculator or Excel, linear/double interpolations
- Want to rapidly (i.e. <u>instantaneously</u>) graph data
- ***ChemE needs tools that can do all of this***
  - **And be visually attractive and enjoyable to use!**

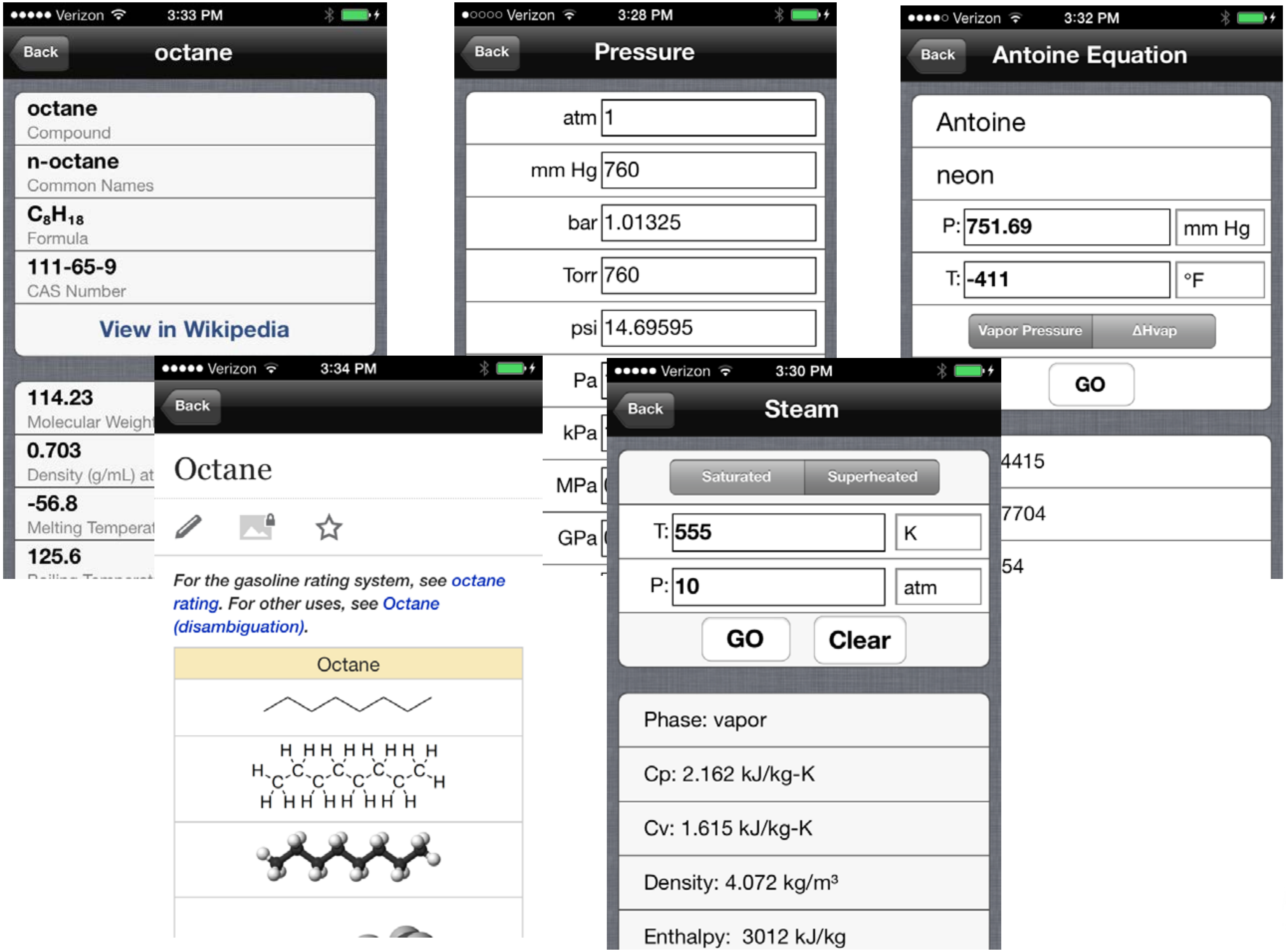
Why iOS (Apple) Hardware?

- Survey of Mass & Energy Balance class showed strong student preference for Apple products
- Of those owning smartphones (71/75 students) >75% owned iPhones
- Of those owning tablets (*not* e-readers) (29/75 students), all but 2 were iPad
- ~90% of class has access to iOS platform in some form

Chemical Engineering AppSuite

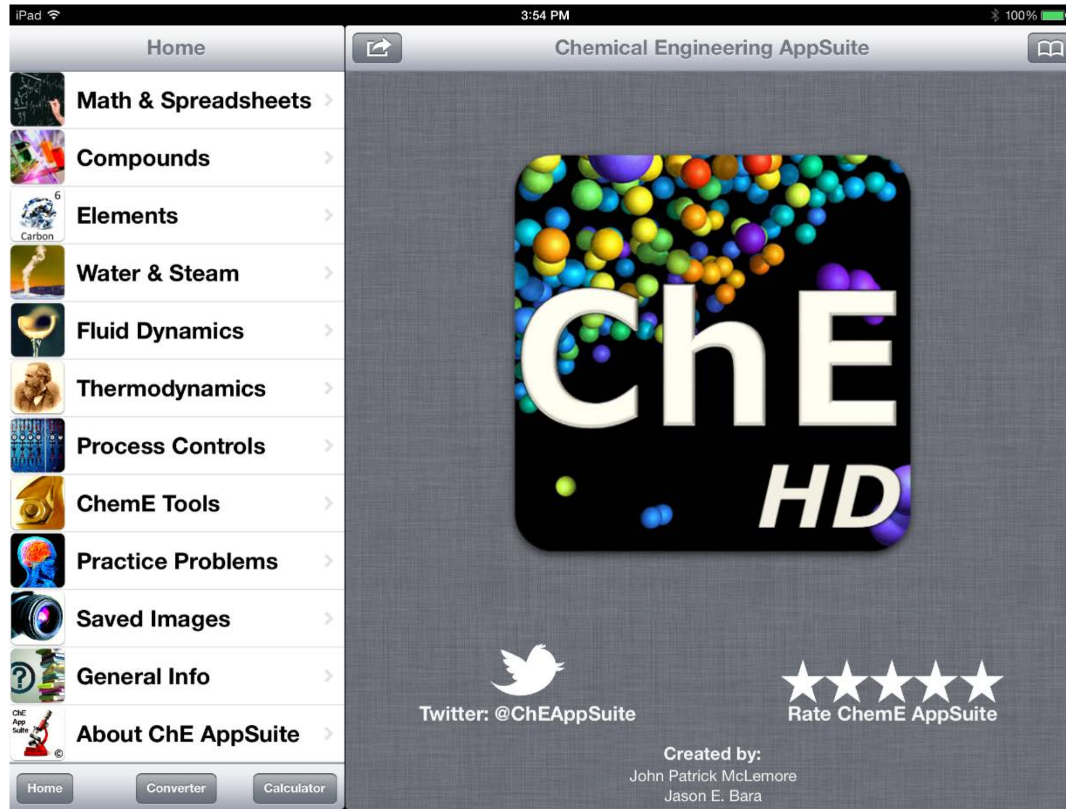
- First launched on iPhone & iPod Touch – January 2012
  - v. 2.1 Aug. 21, 2013
- Features
  - Properties for 1000+ compounds
  - Converters for a variety of units
    - Integrated to automatically solve equations in any units
  - Steam tables
    - Also R134-a, Ammonia & Air
  - Equations of State
    - PR, RK, vdW, SRK, compressibility
  - Antoine Equation, Heat Capacity, Pressure Head
  - Delivery of reference material as PDFs

Example iPhone Screenshots

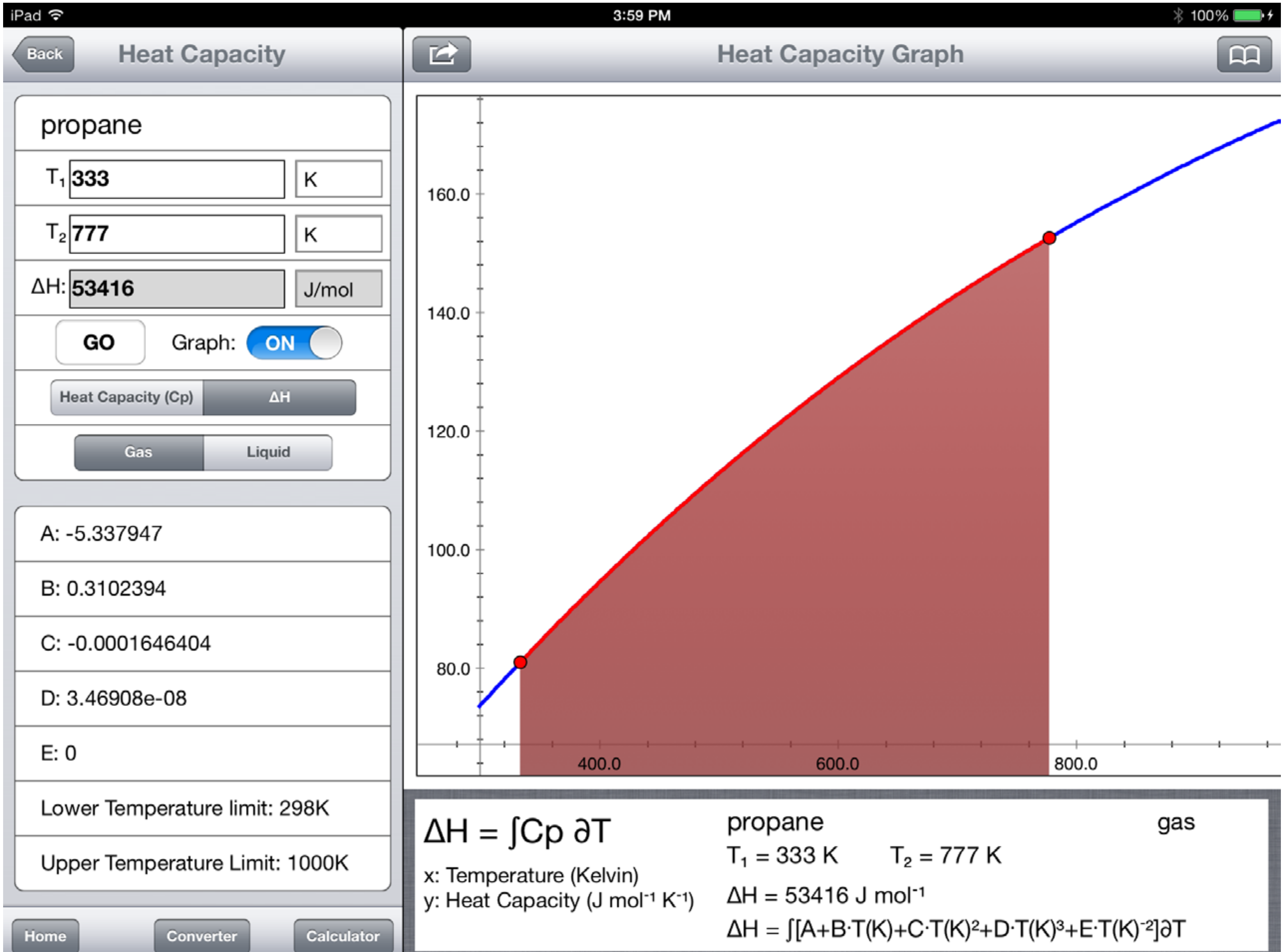


Chemical Engineering AppSuite HD

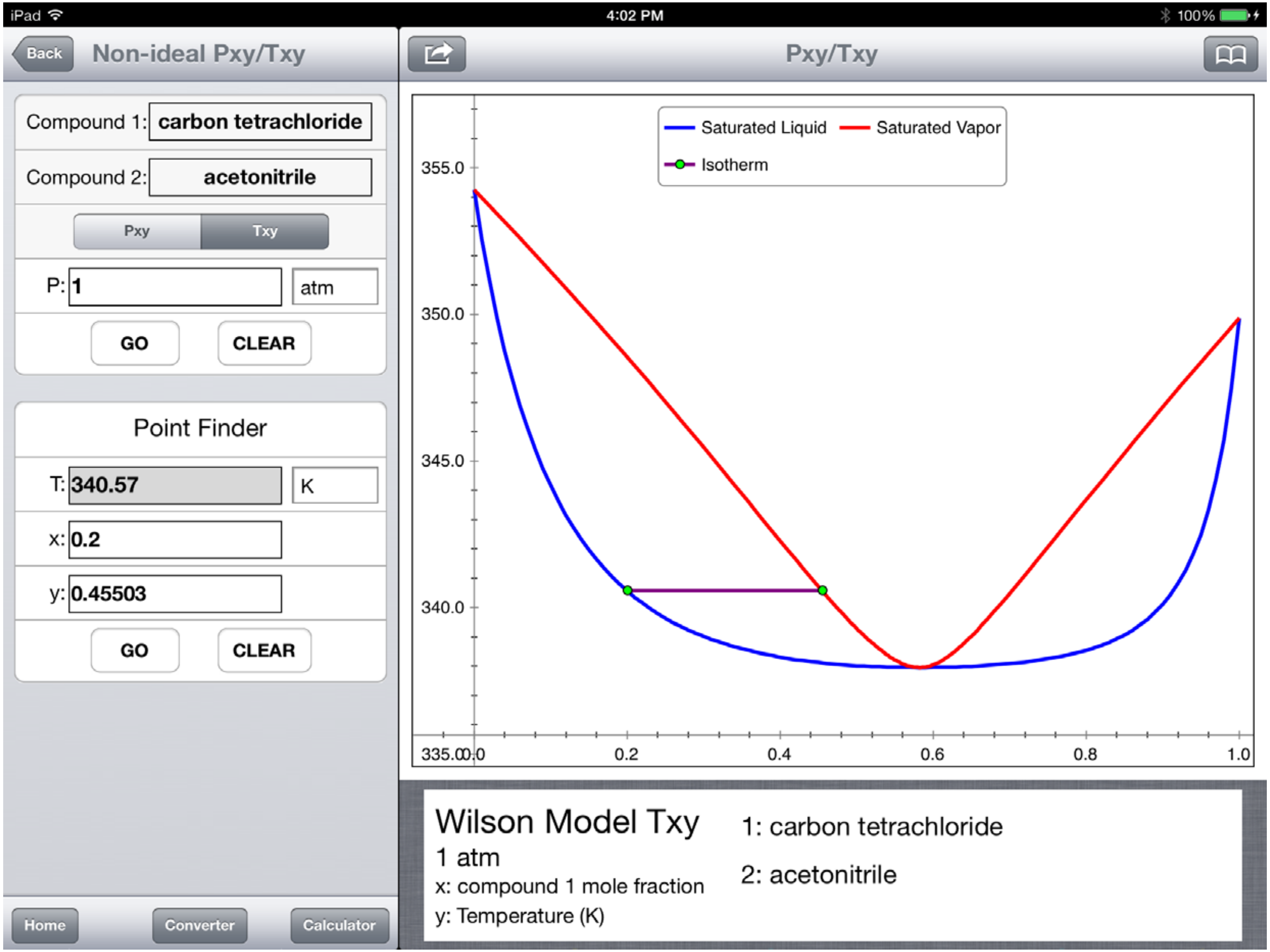
- Chemical Engineering App – Launched May 2012
  - Designed for iPad
  - v. 2.1 Aug. 21, 2013
- Features
  - All of iPhone functions
  - **<u>Graphing</u>**
  - VLE calculation
    - Raoult & Wilson
  - Newtonian Fluids
  - Matrix Operations
  - Spreadsheets, Calculator
  - "ChemE Tools"
  - Practice Problems
  - Ability to save work
  - Integration with Twitter and email



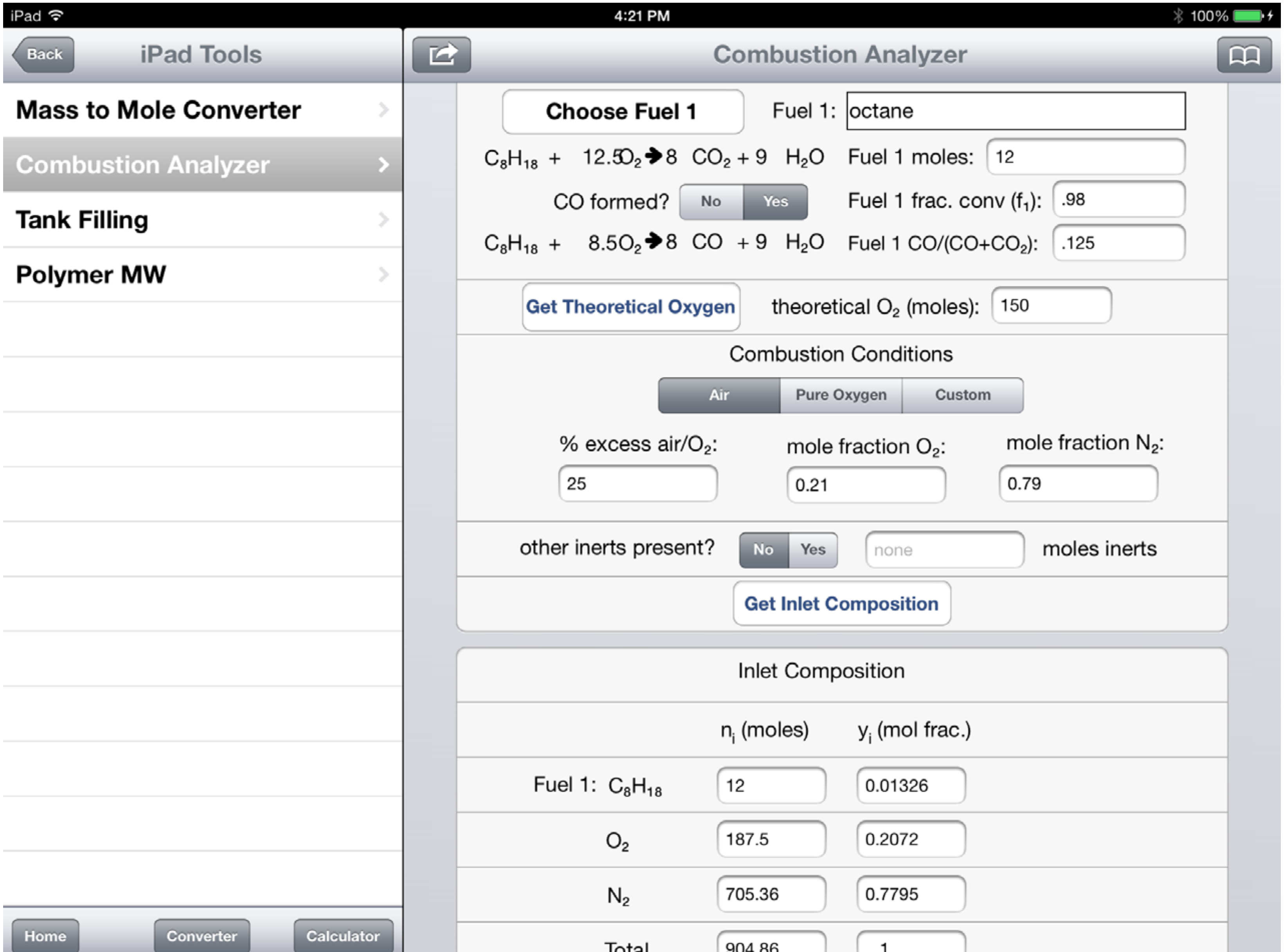
iPad – Heat Capacity & ΔH



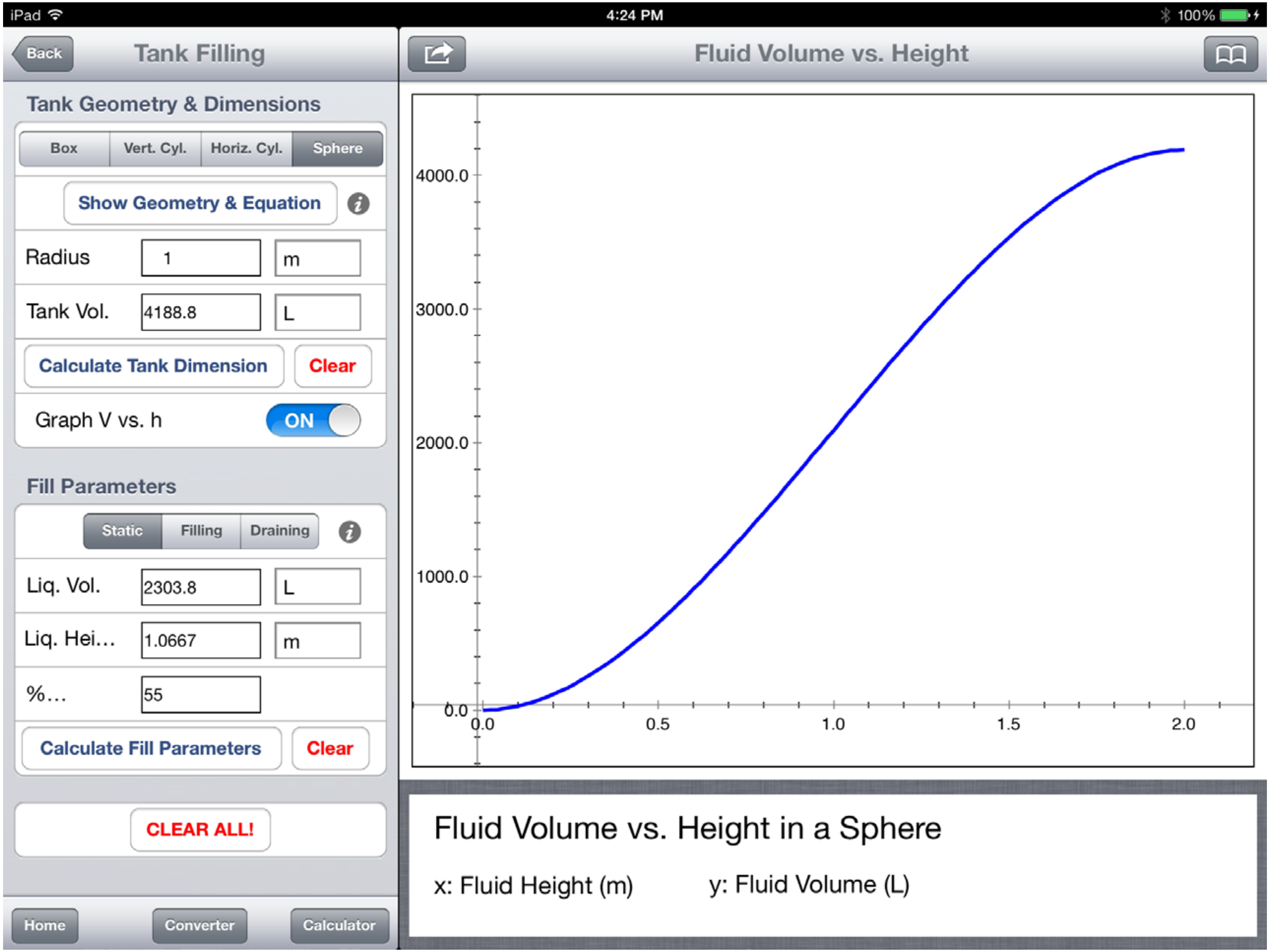
iPad – Wilson Model Txy Diagram



iPad – Combustion Analyzer



iPad – Tank Filling



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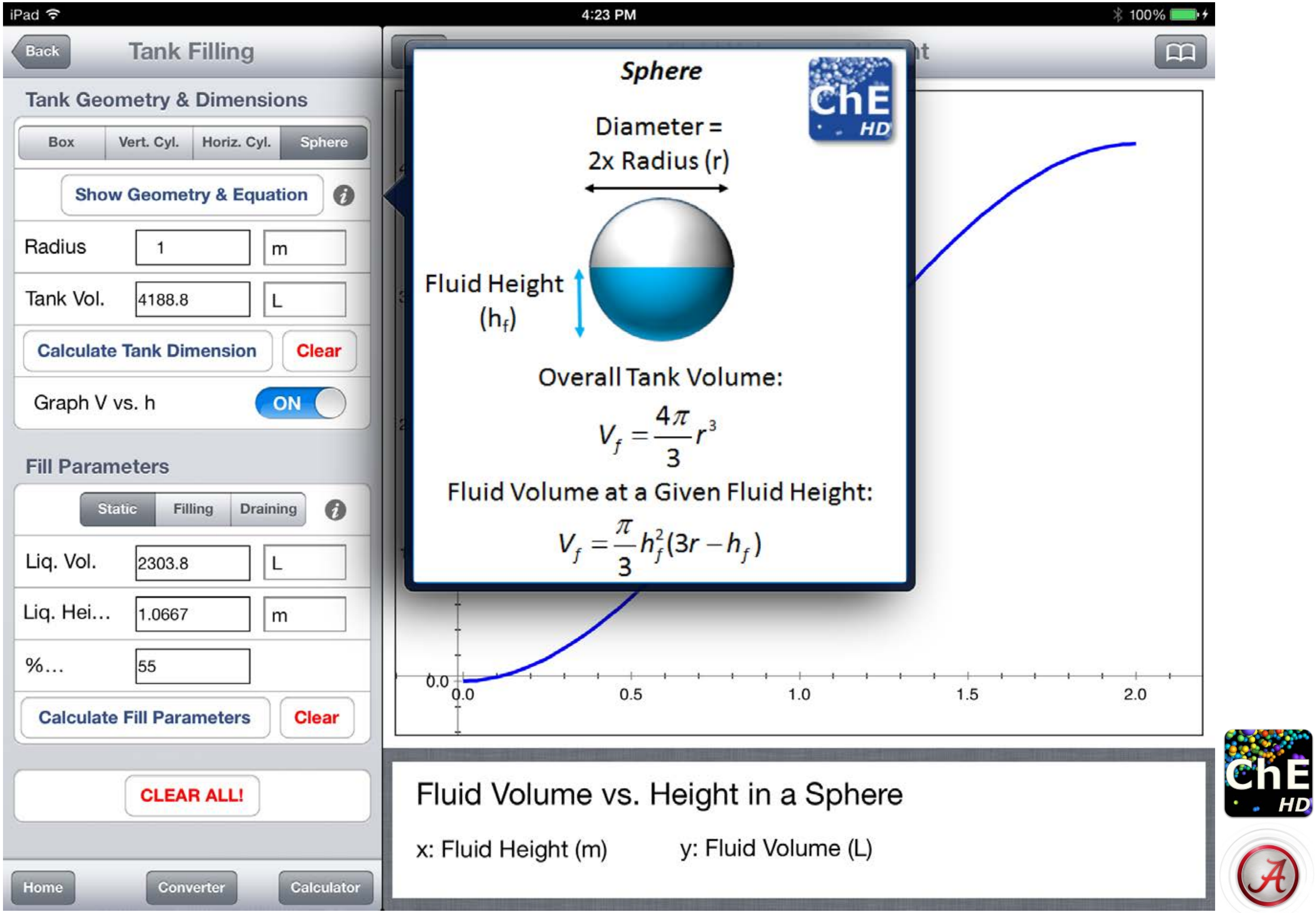
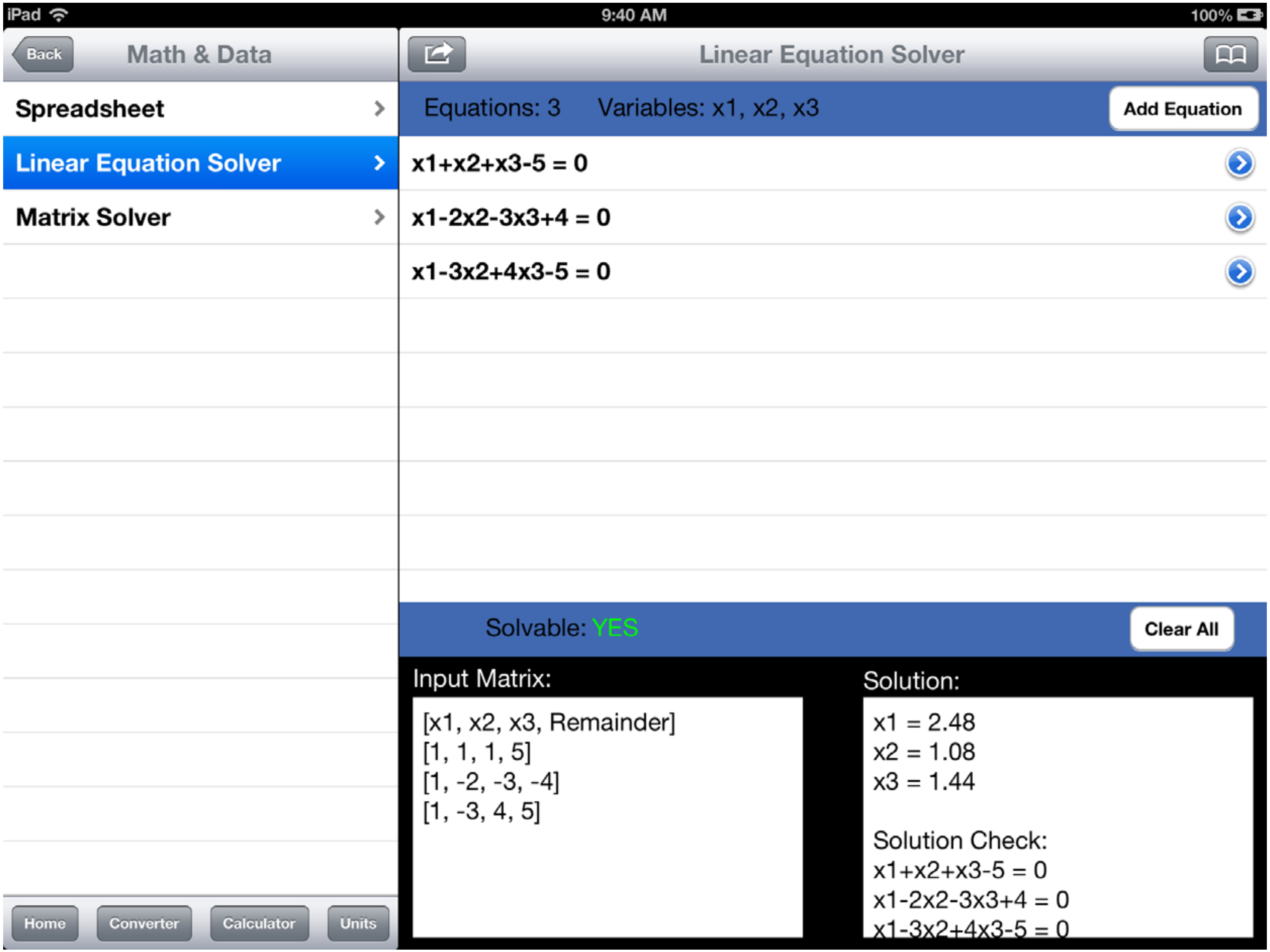
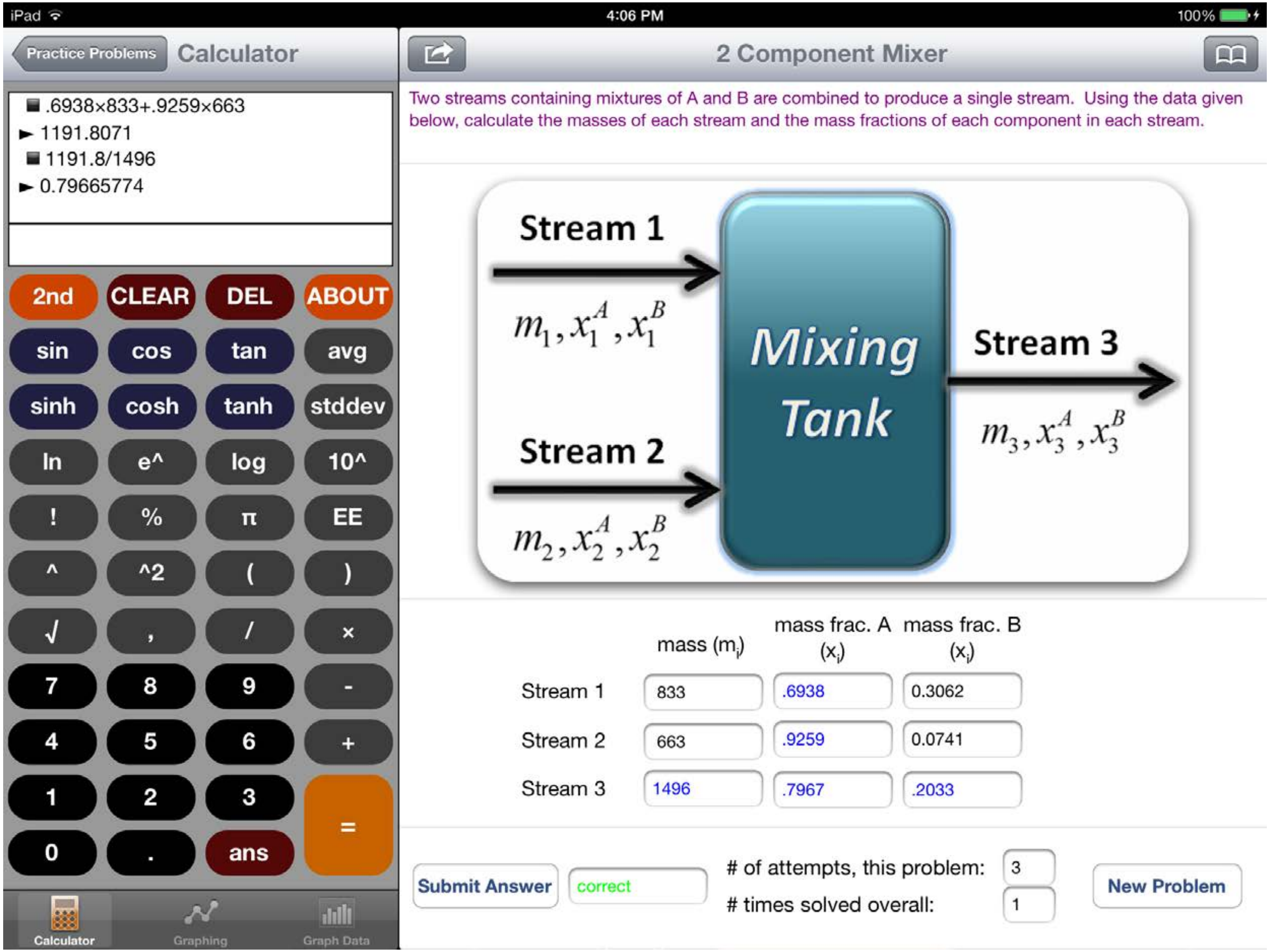


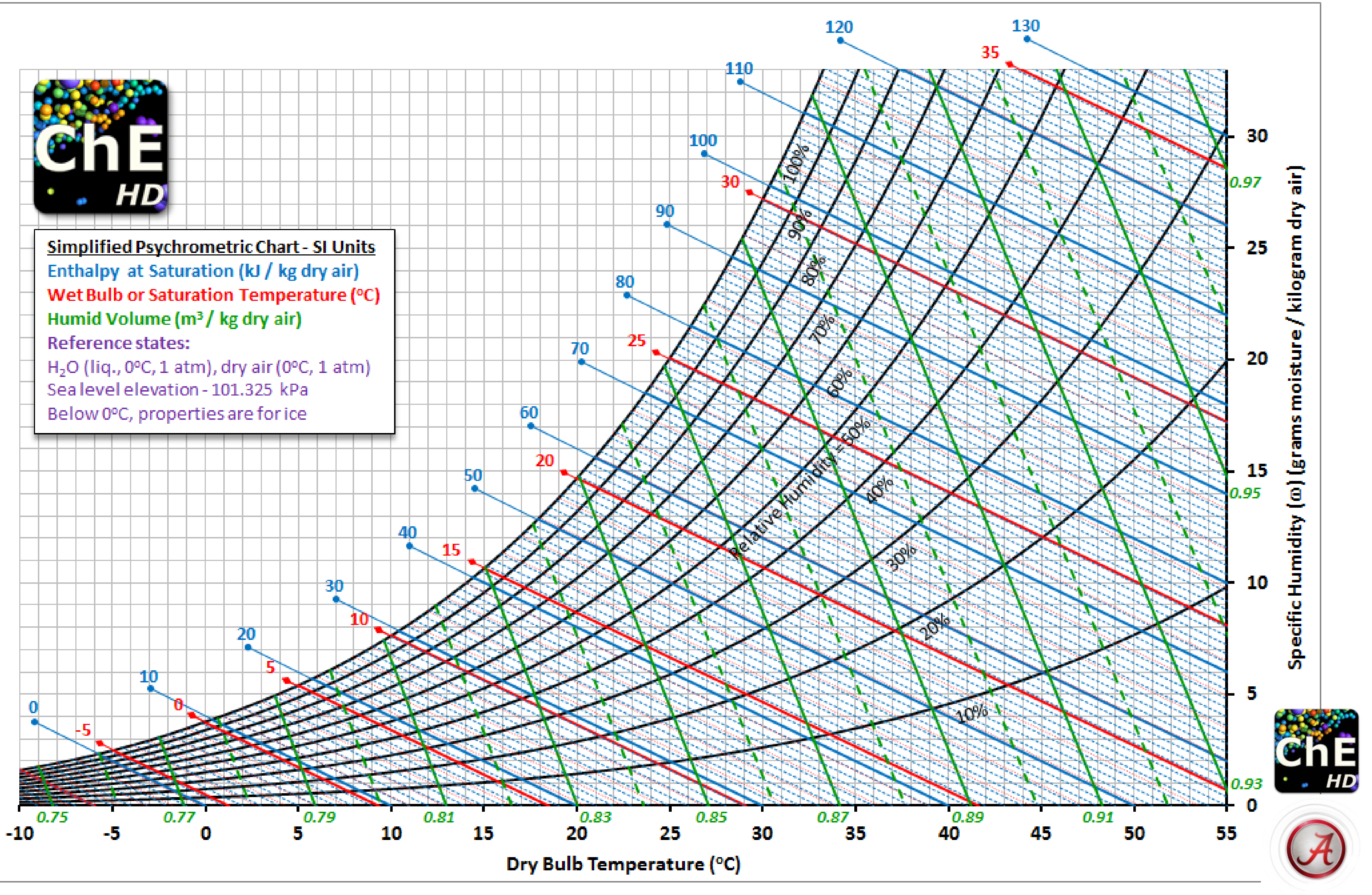
iPad – Linear Equation Solver



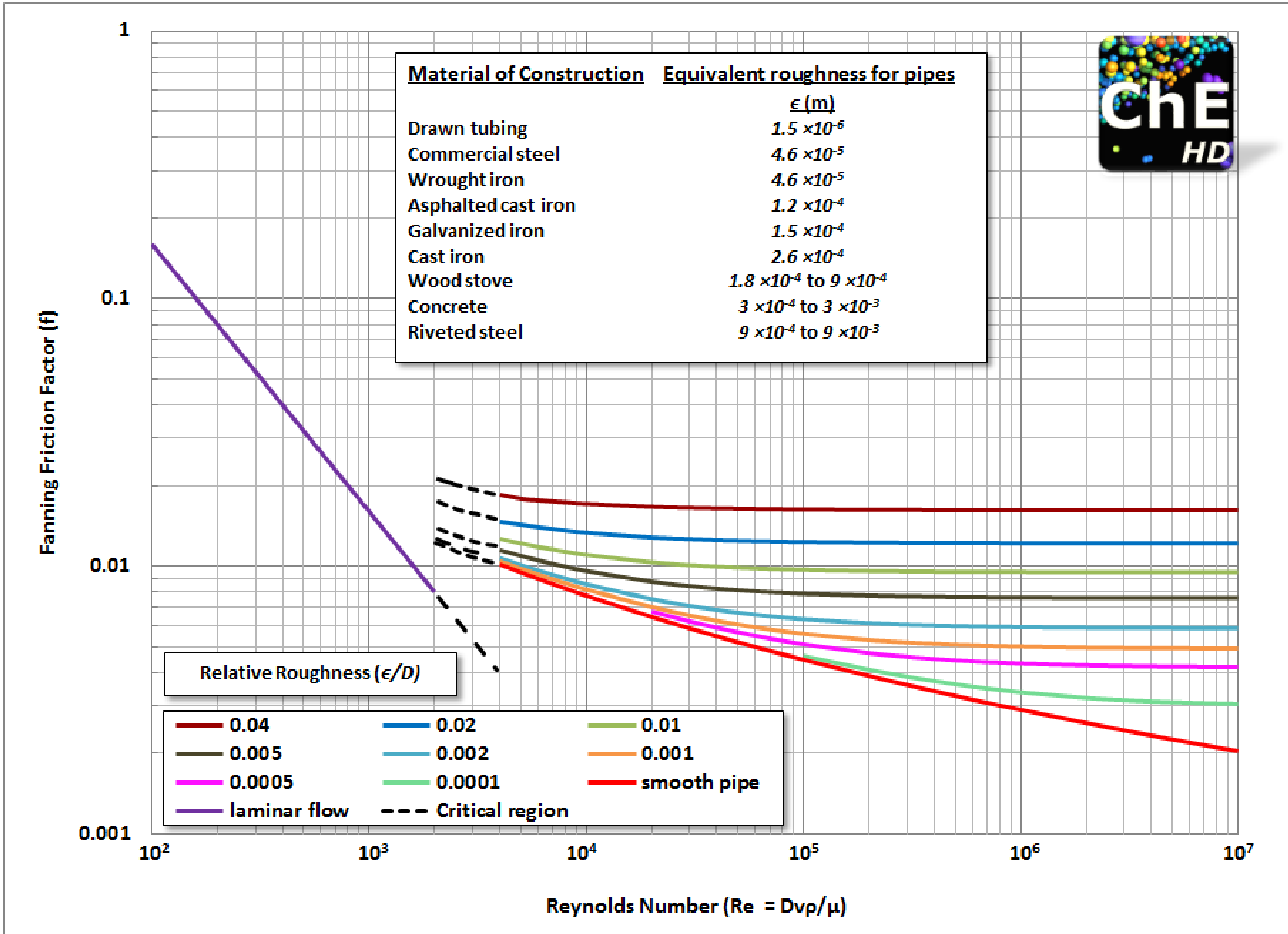
iPad – Mixer Practice Problem



iPad - Reference PDFs



iPad - Reference PDFs



Student Response

- Students have been overwhelmingly enthusiastic about using their iPhones and iPads to solve problems in class
  - Most had not considered these devices in this light
    - View technology primarily for entertainment/communications
  - Appreciate accessibility of spreadsheet, matrix tools
    - Students can be intimidated by Excel, Matlab
  - Enjoy learning about advanced concepts before taking Thermo, Fluids, etc.

Challenges & Opportunities

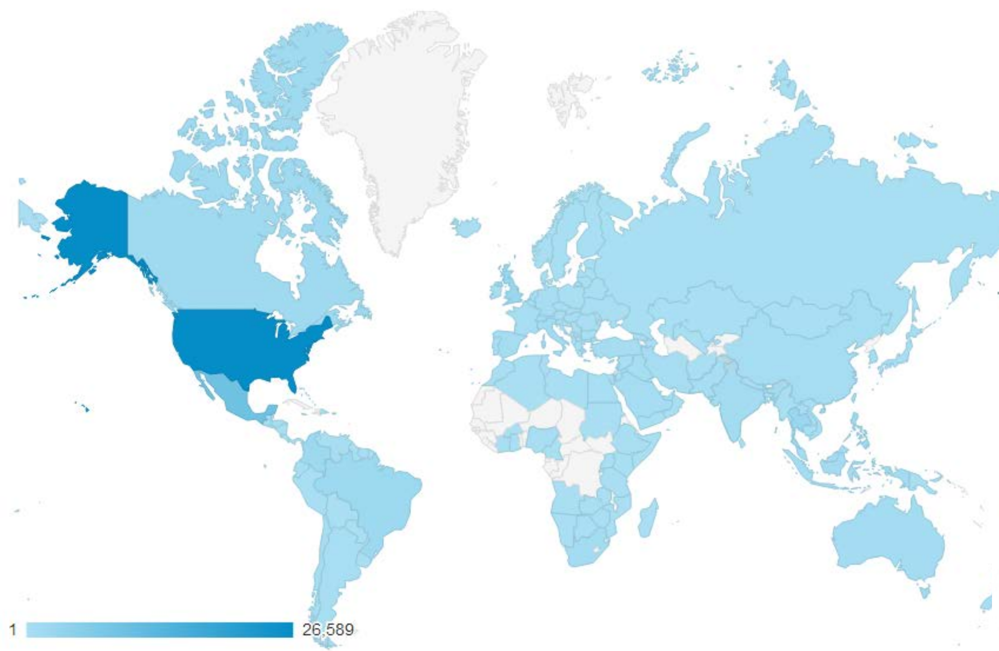
- Not all students have iPhones and/or iPads
  - Can we require an iPad in the ChemE curriculum?
  - Some cite cost as a barrier ($500+), but iPad mini and used devices can lower activation energy (< $350)
- How user-friendly should the software be?
  - Do we allow users to input "bad" values
    - i.e. mass fraction > 1
- Great for well-defined equations but can we make it more open-ended?
  - Parametric analysis in mass & energy balances?
  - Process simulation modules?

Teaching Benefits

- A mobile approach saves time!
  - More rapid equation solving and data retrieval
    - iPad can be displayed on projector
- Students are excited by the visuals
  - See the behavior of functions vs. temp, shapes of molecules
  - Appeal to different learning styles
- Enhance content in mass & energy balances
  - Pull in concepts from thermodynamics, separations
    - e.g. rapidly compare ideal gas law to other EOS
    - e.g. basic principles of stages in distillation columns

A Global Impact

- Since release of v. 2.0 on May 15, 2013:
  - App utilized by > 15,500 users > 67,000 times
    - More than 4200 cities in 153 countries
  - Facilitated > 225,000 calculations
- U.S. is #1 country of use (~40%), but top 6 cities are:
  - Mexico City
  - Tuscaloosa
  - Monterrey, MX
  - Bangkok
  - Bogota
  - Houston



Current & Near Future Plans

- Continue to build a user base
  - App exposure still limited, but growth is accelerating
  - Actively communicate with and get feedback from users

twitter **@ChEAppSuite**

- Consolidate thermophysical property interfaces
  - Expedite calculations of dimensionless groups, etc.
- EOS for mixtures
- Expand practice problems to provide a full course of study in Mass & Energy Balances

Thank You!

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