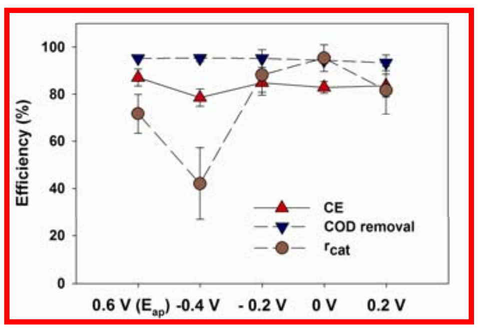
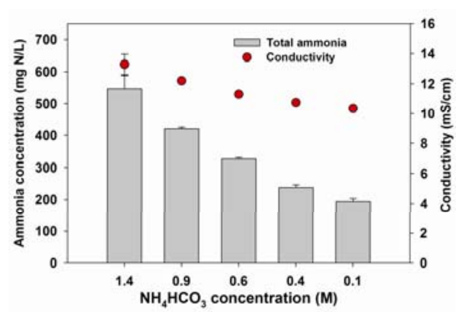
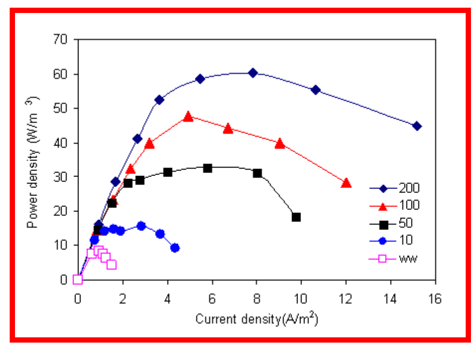
Writing Pointers

Part I: FIGURES

Bruce Logan, Penn State





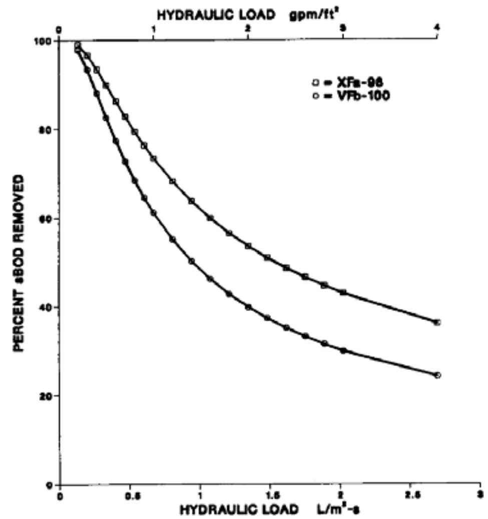


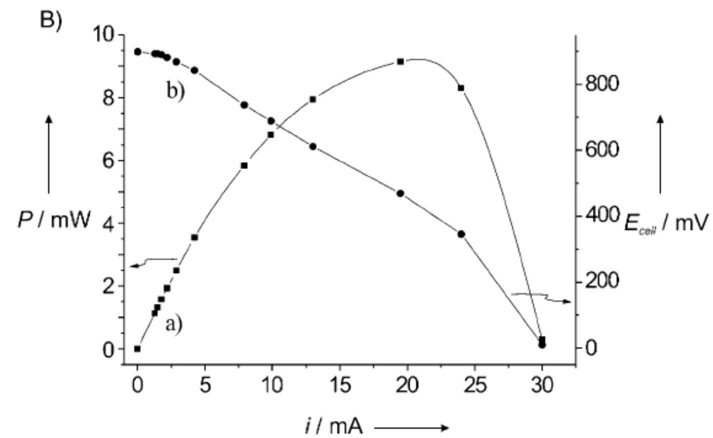
Figures

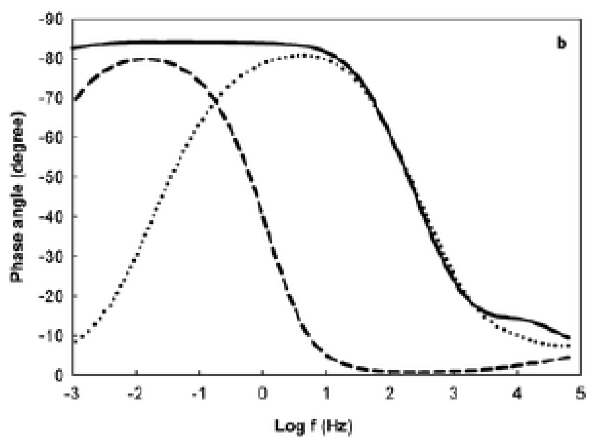
- Nothing demonstrates the quality of the paper more than the quality of the figures!
  - Bad figures = bad science?
- Create beautiful figures.
  - They provide clarity to your results, and demonstrate a professional approach and tells the reader you pay attention to details.
  - Do your figures have the right size fonts? A quick test is that if Excel chose them, they are too small!

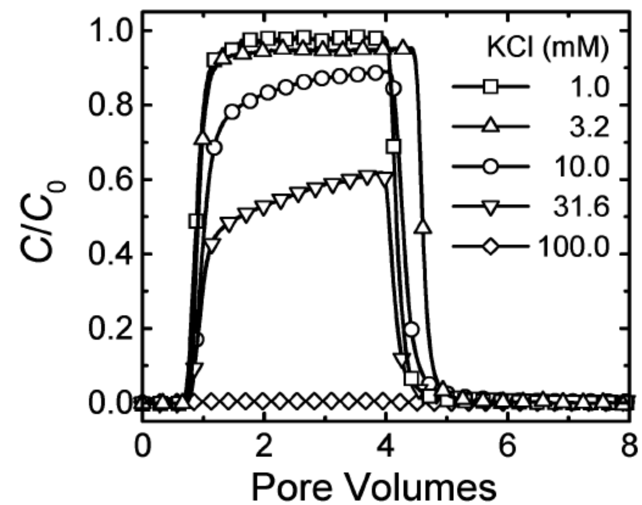
Publish great quality figures!

Examples: 3 poor ones, 1 good one …









Logan et al. (1987) *J Wat Pollut. Control Fed.*

He & Mansfield, *Energy & Env. Sci.*, 2008.

Schroder et al. (2003), *Angew. Chem. Int. Ed.* 2003

Redman et al. (2004) *Environ. Sci. Technol.*

Figures

- Legends and notation
  - Keep notation simple: avoid long subscripts and superscripts
  - Legends should be clear (no boxes; all text inside the plot)
- Reduce the figures to publication size (one column width), and you'll see they get too small.
- Figures should have:
  - Large fonts
  - Large symbols (markers)
  - No bold letters (they don't reduce in size well)
  - No grid lines
  - Good use of symbols, colors and shapes:

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Watch font sizes…
here, the legend is impossible to read…

T.-S. Song, H.-L. Jiang / Bioresource

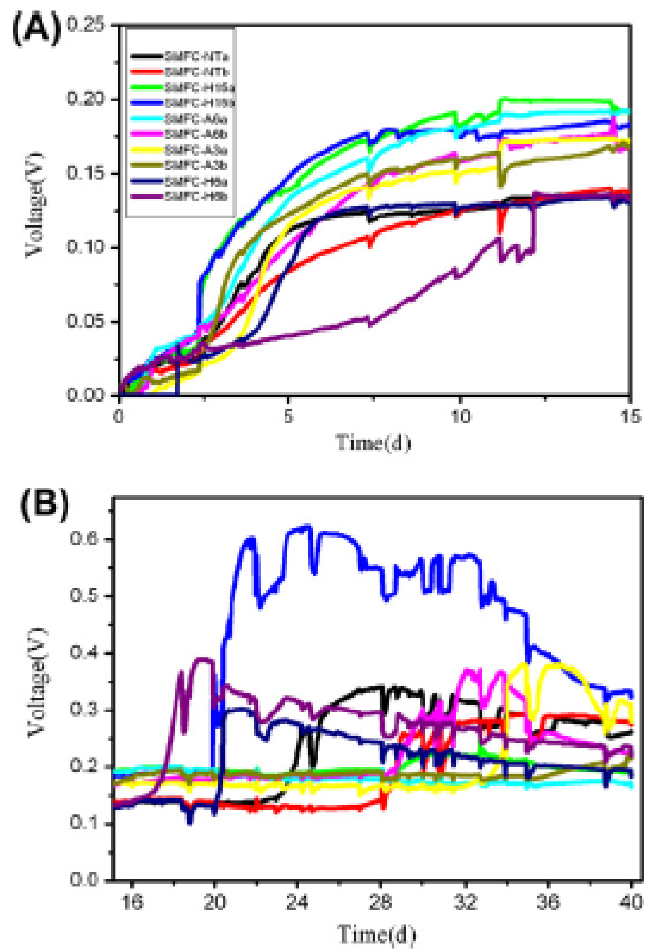

Fig. 1. Voltage generation of SMFCs produced with sediments subjected to different pretreatment methods. (A) 0–15 days and (B) 15 days onwards.

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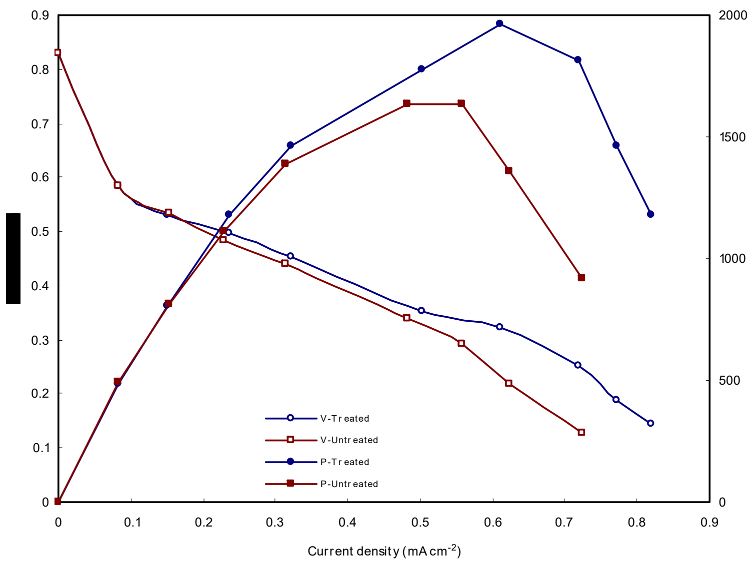
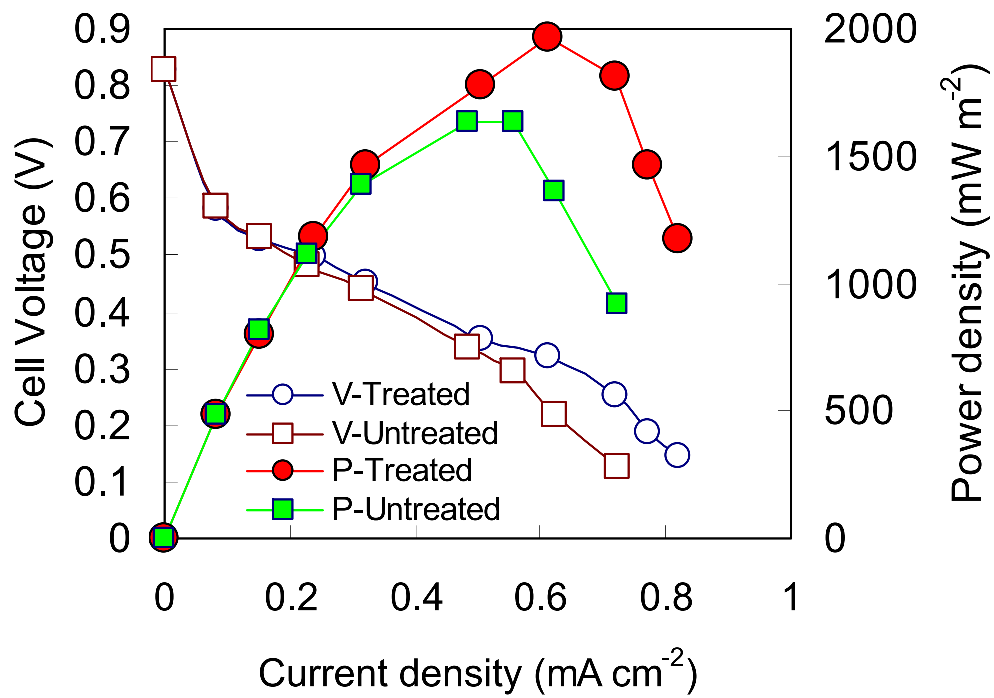
Increase font and marker sizes





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Figures

- Put all legends within the plot box, with no line around the legend box.
  - Either use legends or don't; don't mix it up within one paper.
  - Keep legends simple.
  - You only need one per figure (not in every plot if the same)
- Avoid extra "non-information"
  - Do not use grid lines, but use inside ticks (major and minor).
  - Choose colors so that the symbols, lines or bars all show well in black and white and color.
  - Do not use smoothed lines (just connect points).
  - Put line around plot (i.e. connect axes). Use error bars when applicable.

Think about figure layout in the journal:

Poor layout leads to the use of two columns for a figure that should only take 1 column

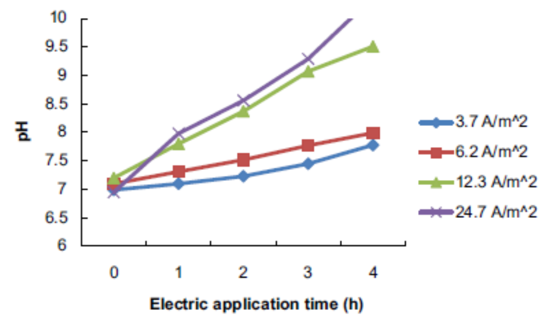


Fig. 4 – Effect of current intensity and duration on pH.

12.3 A/m². Fig. 5 demonstrated that the biomass's SOUR dropped by 42% after 4 h of electric inactivation at current density of 24.7 A/m².

The temperature changes observed during application of electric current at room temperature were displayed in Fig. 6. The maximum change at all current densities during 4 h was less than 2 °C. Therefore, the temperature changes monitored should not have caused any bacterial inactivation effect.

Bacteria experience different micro-environment in an electrochemical reactor, especially when the reactor is not stirred or there is little mixing. As shown in Fig. 7, bacterial cells on the cathode surface were directly subjected to significantly elevated pH and action of electric field, consequently exhibiting highest death rate, whereas bacteria outside the space between electrodes had the highest viability because they were beyond influence of the electric field and are least affected by the toxicity of electrochemical byproducts. Therefore, for a wastewater treatment process in which an electro-technology is incorporated, a strong mixing is desirable to enhance dispersion and diffusion of microorganisms and prevent localized cell inactivation.

Direct currents may also be used to stimulate bacterial activity and metabolism in a process called electro-stimulation. Several studies have been conducted on the stimulatory effects of low level direct currents on microbial growth. Nakanishi et al. (1998) reported that electro-stimulation of cells induces changes in DNA and protein synthesis, membrane permeability and cell growth and revealed that at low level current, bacterial activity and metabolism which were measured in terms of alcohol production were enhanced; the mechanism of these changes is still not well understood. In the research reported here the electro-stimulation effect was not observed.

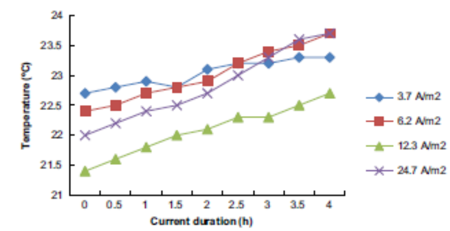


Fig. 6 – Effect of current intensity and duration on the biomass temperature.

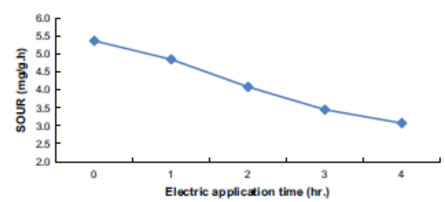


Fig. 5 – SOUR of biomass vs. current duration (current density 24.7 A/m²).

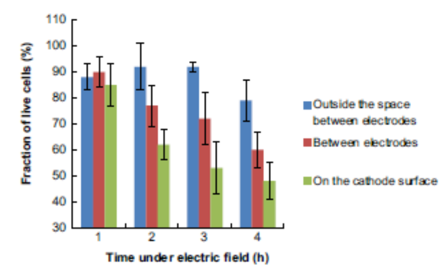
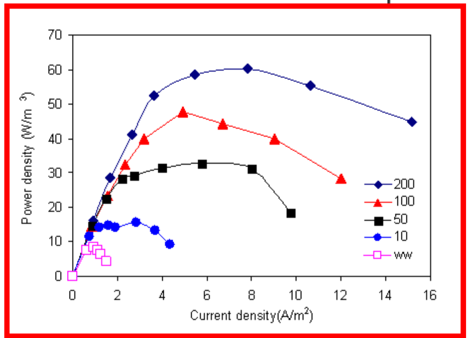


Fig. 7 – Bacterial viability in the different zones relative to electrodes when no mixing was applied in the reactor (current density = 12.3 A/m²).



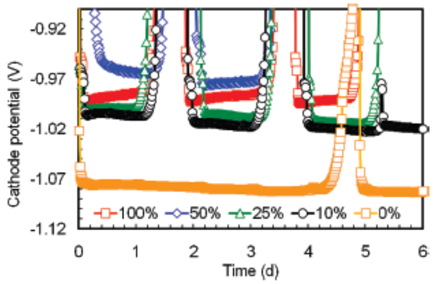


FIGURE 3. Cathode potentials (versus Ag/AgCl) versus time for consecutive batch cycles using SS brush cathodes with different bristle loadings at E_{ap} = 0.6 V.

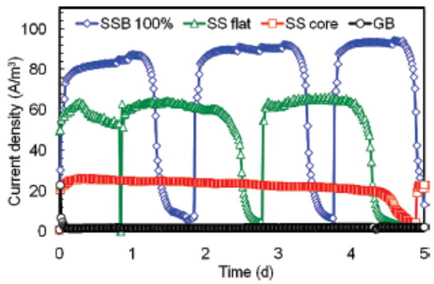


FIGURE 4. Current densities versus time for a 100% loaded SS brush cathode (SSB 100%), a flat SS cathode (SS flat), a SS brush core (SS core), and a graphite brush cathode (GB) at E_{ap} = 0.6 V.

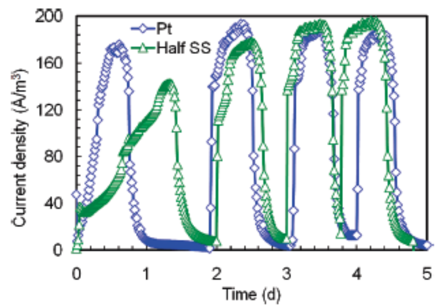


FIGURE 5. Current density versus time for both the platinized carbon cloth cathode (Pt) and the SS brush cathode cut in half (Half SS) at E_{ap} = 0.6 V.

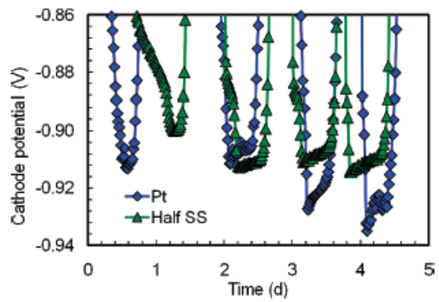


FIGURE 6. Cathode potentials (versus Ag/AgCl) versus time for both the Pt/C cathode and the SS brush cathode cut in half (Half SS) at E_{ap} = 0.6 V.

graphite brush. Thus, large surface area alone could not account for the performance of the SS brushes.

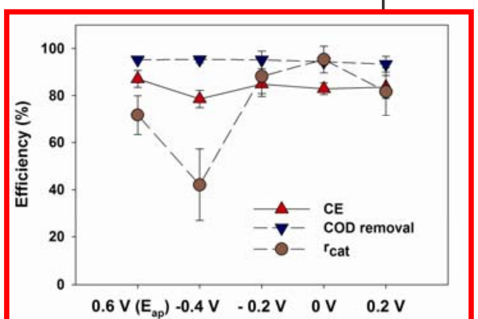
The importance of the SS as a catalyst was further verified by using a flat SS cathode in Reactor FC. Although the specific surface area of the flat SS cathode was more than a hundred fold smaller than the graphite brush cathode, current generation was greater (64 ± 2 A/m³). The current density produced by the flat SS cathode (2.6 cm electrode spacing) was also 2.7 times greater than the SS brush core (24 ± 0 A/m³; 3.5 cm electrode spacing). Although the flat SS cathode had a slightly larger surface area (A = 7 cm²) than the SS brush core (A = 2.4 cm²), the higher current density of the flat SS cathode suggests that the orientation and distance of the cathode was more important for increased current density than surface area.

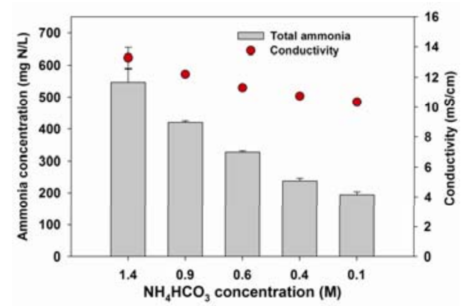
Comparison to a Platinized Cathode. Because the brush bristle loadings did not have an appreciable impact on current production, it was believed that the main factor limiting power generation was electrode distance. Therefore, a fully loaded SS brush was trimmed in half and placed as close as possible above a similarly trimmed graphite brush anode (Reactor VB, A_S = 810 m²/m³) in order to create a configuration capable of generating current densities similar to Pt/C cathodes (*6*). During the first few cycles, the current density was greater in the MEC using the Pt/C cathode (Reactor FC) than in the MEC with the vertically aligned SS brush cathode (Figure 5). Within four cycles, however, Reactor VB was producing the highest current density of 194 ± 1 A/m³, compared to 182 ± 2 A/m³ for Reactor FC. For the final three batch cycles, both reactors generated a similar average current density, with Reactor FC reaching 188 ± 10 A/m³ and Reactor VB obtaining 186 ± 2 A/m³.

The higher current density of Reactor VB with the SS brush was a result of a lower cathodic overpotential than that of Reactor FC with the Pt/C cathode (Figure 6). During the first batch cycle, the Pt/C cathode had a higher overpotential than the SS brush, likely due to the higher current density. By the second cycle, both the SS brush and Pt/C cathode exhibited roughly the same overpotential, but several later cycles the Pt/C cathode showed an increase in overpotential (cycles 3 and 4). This trend may have been due to minor Pt catalyst inactivation in combination with an activation of the SS for the hydrogen evolution reaction (HER). After the first two cycles of reactor acclimation, the SS cathode in Reactor VB produced a cathode potential of −0.910 ± 0.002 V, whereas the Pt/C cathode exhibited a higher overpotential with a value of −0.924 ± 0.003 V. These potentials correspond to cathodic losses of about 0.29 V for the SS brush and 0.30 V for the Pt/C cathode relative to the equilibrium potential of hydrogen formation (−0.62 V vs Ag/AgCl).

Energy Recoveries and Production Rates. The recoveries and production rates for the SS brush in Reactor VB were averaged over the last three cycles in Figure 5. Relative to only the electrical energy input, the energy recovery reached η_E = 221 ± 8%. When the substrate energy was also included, the overall energy recovery was η_{E+S} = 78 ± 5%. The cathodic hydrogen recovery was r_{CAT} = 83 ± 8%, and the average hydrogen production rate was Q = 1.7 ± 0.1 m³-H_2/m³-d.

Linear Sweep Voltammetry. LSV scans performed only





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Figures

- Figure captions go below the figure, table captions above.
- Usually Tables first then figures at the end of a manuscript (although some journals specify otherwise).
- Be sure that items in figures and tables are referred to in the results section.
- Do you have a table that could be a figure?

Writing Pointers
Part II: STYLE

Bruce Logan, Penn State

Writing the paper

- Keep it simple
  - Introduction: 3 paragraphs
  - Methods: short as possible, but can be reproduced
  - Results:

    * *Tell a story* (not a mystery or historical drama)

    * Put your most important figure(s) first.

    * Limit figures to ≤9.
  - Discussion:

    * Don't speculate too much

    * Start out by emphasizing most important finding

    (I recommend that you don't combine Results and Discussion sections)

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Writing the paper, cont'd

- Make it shorter
  - "I apologize for the length of this letter, but I did not have the time to make it shorter" (B. Pascal, from ES&T website)
  - ES&T: Has a 7000 word limit
    - 10 figures = 3000 words
    - Use supplemental information online
  - Avoid useless phrases
    - "It should be noted that…"
    - On the other hand, it can be seen that.."
  - Check for run-on sentences
  - Don't write a conclusions section unless journal requires it (ES&T prohibits it)
- When you are done, make it shorter…
  - I go through a dozen drafts or more for a paper.

General Writing Pointers

- Don't make the table or the figure the topic of the sentence.
  - Avoid "Figure 1 shows that…", "Figure 2 shows that…".
  - Use an intended subject. "Hydrogen production increased with applied voltage (Figure 1).
  - Use active statements that make points: "The maximum power increased to 3000 W/m^2 (Figure 1) by reducing the electrode spacing..."
- Don't make the thesis or an object do things.
  - Don't write "this thesis investigates", "microbes have a hard time".
- Avoid the passive voice.
  - A clear indication of passive voice is the sentence ends with the very, "…is reported", "was determined".
- Avoid double negatives "it is not unreasonable.."

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General Writing Pointers

- Do not start sentences with "connectors".
  - Avoid: "And", "But", "Meanwhile", "Besides" and like connectors of sentences.
- You can't begin a sentence with a number
  - Don't begin with "9 mM"; You have to write it out "Nine millimolar.." in this case.
  - Better to reorganize the sentence "Buffer (9 mM)..".
- Watch for insignificant figures
  - "231.15 ± 10.27 mW/m^2" vs "230 ± 10 mW/m^2".
  - Use the SD and good judgment to round numbers.

General Writing Pointers

- Avoid useless words, particularly at the beginning of a sentence:
  - Avoid: "It is shown here that…", "It should be noted that", "On the other hand"
- Avoid repeating words:
  - Example: "During startup, the startup time was reduced… to improve startup".
- Tighten up your writing:
  - "was found to reduce" change to "reduced"
- Minimize the use of names
  - Try not to write "Zhang et al. (2009) show that..".
  - Make the subject of the sentence the point, not the person.
- Manuscripts: insert continuous line numbers
  - Makes it easier for reviewers
  - (Biores. Technol. makes you take them out!)

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General Writing Pointers

- The first sentence of the paragraph sets a new thought
  - Try reading only the first sentences of a paper. Can you follow the main points? (especially for the Results section)
- Be sure that the first sentence of a new paragraph does not just continue a point made in the previous paragraph.
  - Avoid the first sentence that starts "However"…
- One sentence is not a paragraph

General Writing Pointers

- Avoid giving long lists of things that makes the reader backtrack into the sentence too connect topics and numbers.
  - In short, avoid using the word "respectively".
  - *Avoid*: "The maximum power density in the reactor supplemented with cellulose plus enzyme, enzyme alone, and glucose was 98 ± 0.05, 114 ± 1, and 104 ± 3, respectively, all produced with 1000 Ω resistance."
  - *Instead try this:* "The maximum power density in the reactor fed cellulose and enzyme was 98 ± 0.05 mW/m^2. This is similar to that obtained using only enzyme (114 ± 1 mW/m^2) or with glucose (104 ± 3 mW/m^2)."
  - Note: the latter makes a point, while at the same time giving numbers (and units!) so they are right where they are needed.

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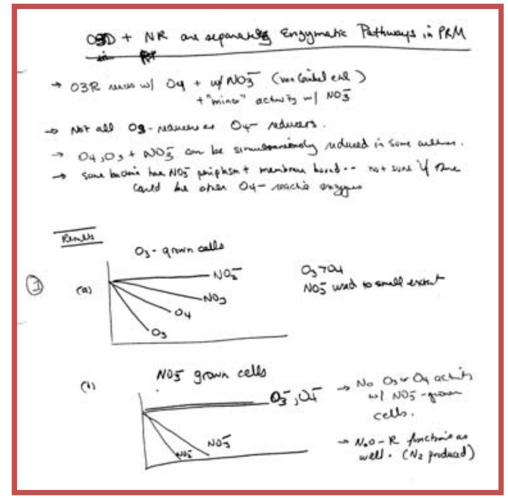
Before you write!

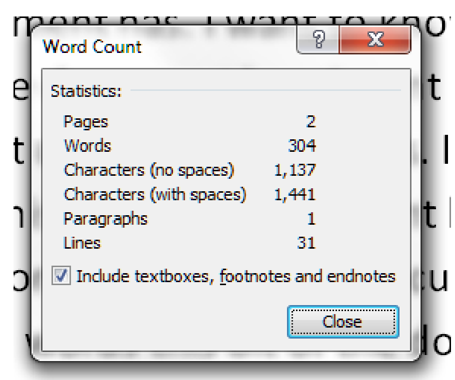


- Do you have a mock paper done? (yes!)

  (See presentation on "Advice on writing papers")
- Meet with your advisor
  - Bring all figures in FINAL publication format.
- Tell your "story" to your advisor.
  - If you can't present a good story verbally, you will have trouble writing the paper.
- Writing order for the sections: 1st - Results, 2nd - Introduction, 3rd - Discussion; Abstract & Methods, can be written anytime

Abstract

- Many journals have word limits
- A double spaced abstract should fit on one page, 12 point font.
- Give specific numbers if possible from your results.
- Do not put references in an Abstract.
- Usually have a concluding sentence in the abstract that summarizes the worth of the study. “These findings indicate that MFCs can be…”



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Introduction

- Too many papers have overly long introductions.
- If you are writing on a specialized topic, the reader probably will already know many things you put in an Abstract… otherwise, they wouldn't be reading your paper!
- Is your Introduction short, say 3 paragraphs?
  - P1 introduces the topic and need for the study.
  - P2 summarizes key papers and what is known about the subject.
  - P3 points out the need for the study and what will be addressed here.

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Methods

- Remove as many words as possible from your Methods section, putting in critical information but not rambling on about minor details.
- Refer to past papers for methods whenever possible.
- Put methods in same order as results.
- Notation in methods section.
  - Don't use double sub- or superscripts or long superscripts; avoid using slanty divide signs,
  - Define all variables upon first use, then just use notation.
  - Keep notation simple.
  - You don't have to use the same notation used in your experiment: use abbreviations that the reader will understand.
    - C and M (where C and M mean something, like a material) as compared to Material 1 and Material 2, where you won't know if it is M or R..

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Results

- I like separate Results and Discussion sections, especially in a thesis.
  - *ES&T* states combined is preferred
  - *Biores. Technol*. requires combined
  - *Appl. Microbiol. Biotechnol.* requires separate sections
- Don't put Methods in the Results section, such as equations and approaches to getting a result.
- If the Results section is separate from your Discussion section, then do not speculate or draw conclusions based on the literature in the Results section.

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Results

- Do your Results (or really any section) flow in an orderly way and make the points you would like it to?

- Does your Results section tell a story?
- We don't want historical dramas or a mystery, but we do want information in a useful order.
  - Start your Results section with the most important findings first
  - Follow with other information (controls, things that didn't work out so well, etc.).
  - Your first figure/graph (if possible) is the main point (biggest finding) and subsequent graphs fill in the surrounding conditions or elaborate further on the topic.

Discussion

- Many readers will scan abstract, figures and then go right to the Discussion section.
- Start out by restating your most important finding
  - What did you conclude from all those results?
  - How does this compare to the literature?
- Continue on with main points/findings, contrasting with the literature.
- You don't need to put in all your thoughts on the subject, and try not to speculate too much (reviewers hate that).

Conclusions

- Requirements on this vary
  - *ES&T* does not allow you to put in a conclusions section
  - Biores. Technol. requires them

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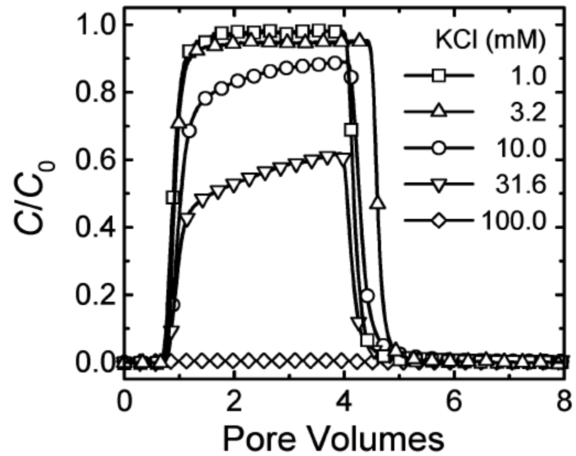
In Summary…

- *Create beautiful figures!*
- *Keep your writing concise*
- *Avoid useless words*
- *Read the first sentence of every paragraph to check on flow*
- *Have fun telling your story.*



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Questions ?

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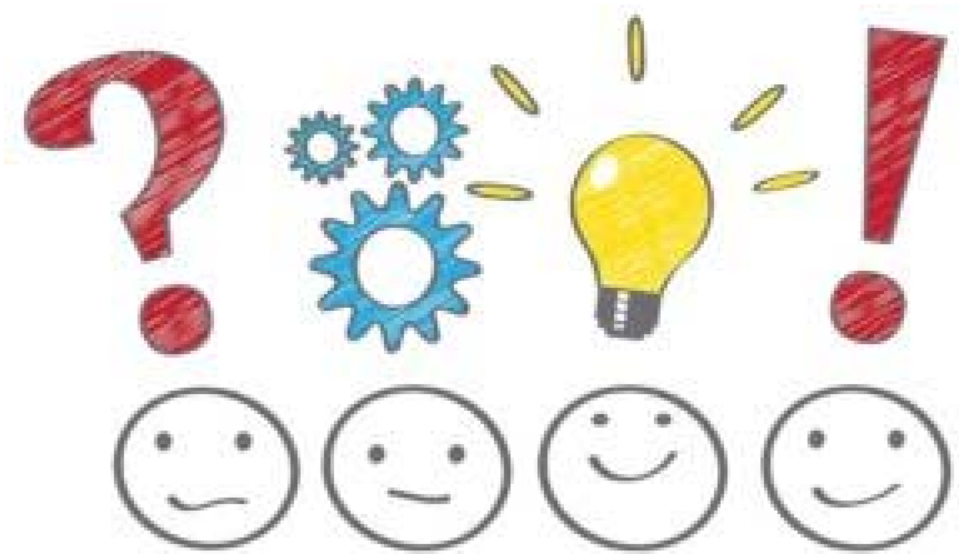
Web page: www.sites.psu.edu/brucelogan/



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