**Reply to Editorial comments:**  
*1. Please take this opportunity to thoroughly proofread the manuscript to ensure that there are no spelling or grammar issues.*

**Ans**: We have tried our best to proofread the manuscript to avoid spelling or grammar errors.

*2. Please obtain explicit copyright permission to reuse any figures from a previous publication. Explicit permission can be expressed in the form of a letter from the editor or a link to the editorial policy that allows re-prints. Please upload this information as a .doc or .docx file to your Editorial Manager account. The Figure must be cited appropriately in the Figure Legend, i.e. “This figure has been modified from [citation].”*

**Ans**: We have uploaded the acquired copyright permission document, and denote the citation as suggested.

*3. Please combine all panels of one figure into a single image file.*

**Ans**: The figures are combined as suggested.

*4. Figure 1: If possible, please use the same x-axis scale for both panels to facilitate comparison.*

**Ans**: The figures are modified as suggested.

*5. Figure 2: Please use the same y-axis scale for both panels to facilitate comparison.*

**Ans**: The figures are modified as suggested.

*6. Keywords: Please provide at least 6 keywords or phrases.*

**Ans**: We have added more keywords as suggested.

*7. Please rephrase the Introduction to include a clear statement of the overall goal of this method.*

**Ans**: We have rewritten the last paragraph of the Introduction to state more clearly the overall goal of this protocol.

*8. Please use SI abbreviations for all units: L, mL, µL, h, min, s, etc.*

**Ans**: The units are modified to follow SI abbreviations as suggested.

*9. JoVE cannot publish manuscripts containing commercial language. This includes trademark symbols (™), registered symbols (®), and company names before an instrument or reagent. Please remove all commercial language from your manuscript and use generic terms instead. All commercial products should be sufficiently referenced in the Table of Materials and Reagents. For example: Barnstead MicroPure, SHOWA, Homy Tech, Scharlab, etc.*

**Ans**: The commercial languages are removed from the manuscript, and the Table of Materials and Reagents are modified as suggested.

*10. 1.4: Is lead oxide added to methanesulfonic acid? Please specify the liquid.*

**Ans**: Yes, we have modified and rearranged this protocol section to make it more readable and less confusing.

*11. 1.4-1.5: Are these steps conducted in the fume hood?*

**Ans**: Yes, and this protocol section is rearranged to make it more readable and less confusing.

*12. Please revise the protocol (lines 119-124, etc.) to contain only action items that direct the reader to do something (e.g., “Do this,” “Ensure that,” etc.). The actions should be described in the imperative tense in complete sentences wherever possible. Avoid usage of phrases such as “could be,” “should be,” and “would be” throughout the Protocol. Any text that cannot be written in the imperative tense may be added as a “Note.” Please include all safety procedures and use of hoods, etc. Please move the discussion about the protocol to the Discussion.*

**Ans**: This protocol section is rewritten and rephrased as suggested.

*13. 4.1: How to confirm the electrode is adequately polished?*

**Ans**: The purpose of electrode polishing is to remove impurities left behind from commercial fabrication. We have modified the protocol section accordingly and added further explanation in the first paragraph in Discussion.

*14. Please include single-line spaces between all paragraphs, headings, steps, etc.*

**Ans**: We have included single-line spaces between all paragraphs as suggested.

*15. Representative Results presented cycling performance, throwing index experiments and SEM images, but how to obtain such data are not mentioned in the protocol. Please consider including how to evaluate cycling performance, how to conduct throwing index experiments, and how to acquire SEM images in the protocol.*

**Ans**: We have included the protocols and calculations in the Protocol section as suggested.

*16. Please revise to explain the Representative Results in the context of the technique you have described, e.g., how do these results show the technique, suggestions about how to analyze the outcome, etc. The paragraph text should refer to all of the figures. However for figures showing the experimental set-up, please reference them in the Protocol. Data from both successful and sub-optimal experiments can be included.*

**Ans**: We have modified the Representative Results section to better explain the additive effects in terms of galvanostatic charge/discharge, TI measurement, and SEM results.

*17. As we are a methods journal, please revise the Discussion to explicitly cover the following in detail in 3-6 paragraphs with citations:  
a) Critical steps within the protocol  
b) Any modifications and troubleshooting of the technique  
c) Any limitations of the technique  
d) The significance with respect to existing methods  
e) Any future applications of the technique*

**Ans**: We have modified the Discussion section to better cover the points suggested by the editor.

*18. References: Please do not abbreviate journal titles. Please include volume and issue numbers for all references.*

**Ans**: We have followed the Reference style as suggested.

*19. Please revise the table of the essential supplies, reagents, and equipment. The table should include the name, company, and catalog number of all relevant materials in separate columns in an xls/xlsx file.*

**Ans**: We have revised the table of essential supplies, reagents and equipment as suggested.

**Reviewers' comments:**  
  
**Reviewer #1:**   
Manuscript Summary:  
The author reported extending lifespan of soluble lead flow batteries with sodium acetate additive. It is an interesting and effective work, but following issues are needed to address:  
  
1. The comparison of Figure 1a and Figure 1b should be merged into one graph. What is the calculation formula of efficiency of columbic, voltage and energy? The exact point of cycle number should be marked.

**Ans**: We thank the reviewer for the comment. We have merged Figure 1a and 1b into one graph, and supplied the calculation formula of coulombic, voltage and energy efficiencies in Protocol 1. We have also explained the meaning of cycle number in the first paragraph of Representative Results.

2. The relationship of MDR to LR in Figure 2 needs to be expounded in more detail.

**Ans**: We have elaborated on the meaning of MDR to LR in our TI measurement in the second paragraph of Representative Results as suggested by the reviewer.

3. The SEM results have been well explained. What is the experimental equipment? Model and experimental condition.

**Ans**: We have included the experimental condition for the acquired SEM sample in the third paragraph of Representative Results, and listed the experimental equipment model in the table of essential supplies, reagents and equipment.

**Reviewer #2:**  
Manuscript Summary:  
This work purportedly attempts to demonstrate the effect of an additive on the deposition morphology of PO2 in soluble lead flow batteries. However, it is very clear to me that this is a sub-standard manuscript. The authors had put the very minimal effort in producing it, hoping to get just one more citation. The experiments are described in an unacceptably vague manner. Basic experimental data is missing. Discussion is almost inexistent. This work is mis-guided and, unfortunately, its results cannot be used to draw any meaningful conclusions. See detailed reasons below. Unfortunately, I have to recommend the authors to familiarize themselves with electrochemistry, battery and flow battery technology by reaching to basic text-books before attempting any further activities in the field. I recommend outright rejection. I am aware that the authors might have a video on this, and that the manuscript is a sort of a support for it. But my objection remains valid to any work performed in such conditions and reported in such manner.  
  
Major Concerns:  
-The first two references have been cited already too much and does not describe the "high efficiency and long cycle life" of the vanadium battery. This reveals the inexperience of the authors in this field. There are several, up to date reviews with the actual performance of modern systems, including vanadium, and the advantages of flow batteries. The authors failed at finding well-known recent publications on soluble lead flow batteries.

**Ans:** We have replaced reference 1 and 2 with two more recent reviews on redox flow batteries to make more appropriate. We also include a review on the SLFB published this year as reference 10.

-Can the authors explain what is the purpose of pre-treating the electrodes in potassium nitrate? This is not a usual procedure; therefore, its purpose should be stated.

**Ans:** The purpose ofthe electrochemical pretreatment with potassium nitrate is to remove impurities that may induce redox reactions between the potentials of 0 to 1.8 V vs. Ag/AgCl.We have included such a description in the first paragraph of the Discussion section.

-Regarding the results in Fig. 1. Temperature of the experiment is not even mentioned, for neither of the plots. The volumetric flow rate and average flow speed of the electrolyte at the electrode compartments is not mentioned in the author's work, an inacceptable omission in a paper about flow batteries. Without this information, the authors work simply can't be related to the results by Lin et al., the comparison is invalid. Increased number of cycles in this manuscript might well be result of the reaction environment and not of the presence of the additive. Do the results in Fig. 1b have an ethanoate additive? This should be mentioned.

**Ans:** We have discussed these experimental conditions in the second paragraph in Discussion section, and they are stated as the following:

*Since the focus of this study is on the electrolyte additive effects, we employed beaker cells rather than flow cells to minimize uncertainties derived from flow conditions. The beaker cell is magnetically stirred at a rotation rate of ~200 rpm to maintain a certain level of concentration uniformity of the electrolyte without sever agitation. The temperature of beaker cells is not controlled in our experiments, which leaves it close to the atmospheric temperature in our lab (25±5 ℃). While temperature variation may affect the deposition quality and battery performance, the two compared experiments are conducted in parallel to avoid the temperature perturbation interference.*

Also, Figure 1 (now Figure 3 in revised version) is plotted based on data published in our previous work, Ref. 11, with permission.

-Other omissions by the authors: the thickness of the electrode compartment is not reported, the presence or absence of a membrane, the actual electrode potential and cell potential of the battery is not given in a plot (without this, the reported efficiency % is not backed by any evidence.)

**Ans:** Since a beaker cell is used in our experiment, we have reported the electrode distance of 18 mm and the electrolyte volume of 260 mL instead. We don’t find it necessary to provide cell potential figures in the manuscript, but attached here per the reviewer’s request (The one up to 300 cycles is with NaOAc while the one up to 200 cycles is without NaOAc)

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-It is not described how did the authors measured the throwing index. The 'throwing index experiments' mentioned in the caption for Fig. 2 must be carefully described. Can they provide an equation for this? Simply referring to the work by Lin et al. is not acceptable, the authors should describe their own experiments. Not even a reference is suggested to the reader. Moreover, and critically, the state of charge for the SEM of the deposits is not reported. The morphology of these will be different depending of the state of charge, number of cycles, temperature, thickness of deposit, flow rate, etc.

**Ans:** We have added Protocol 2 in the manuscript on throwing index measurements and calculations, as well as a schematic diagram (Figure 2) describing the Haring-Blum cell. The PbO2 electrodeposit for SEM is acquired after full 50-cycle charge/discharge, and we have added the information in the third paragraph of Representative Results section.

-Not surprisingly, the caption for Fig 3. is a single sentence. No parameter or further experimental condition is even mentioned. Figure 3b. seems to be out of focus. The nucleation of lead or the morphology of the deposit was not observed or discussed by the authors. Usually, it is rather easy to see the effect of an additive on the PbO2 morphology using SEM, but this is not the case.

**Ans:** We have added Protocol 3 on SEM sample preparation, and the ordinary morphology of PbO2 is polished off. But the excess defects in the electrodeposit plated without NaOAc is easily observed. We have also described the experimental information of the SEM sample in the third paragraph of Representative Results section.

-In the discussion, the authors say that reduced PbO2 is observed in the 'beaker cell'. Does this mean that the experiments were not carried out in an actual flow cell? This is rather disappointing, as the title of this paper refers to "soluble lead flow batteries". Again, the experimental set-up is never described. Was it a beaker or a flow cell? Stirred or not? Which volume of electrolyte was used? Again, what was its temperature? Not a diagram or photo is supplied.

**Ans:** We have added a schematic diagram of the beaker cell setup (Figure 1) in the revised manuscript. Since the focus of this study is on the electrolyte additive effects, we employed beaker cells rather than flow cells to minimize uncertainties derived from flow conditions.

**Reviewer #3:**  
Manuscript Summary:  
The manuscript titled "Extending lifespan of soluble lead flow batteries with sodium acetate additive" submitted to JoVE has been critically reviewed. The authors have addressed a very interesting problem to stabilize the active material dissolution in SLFBs to enhance life of the systems. It is a very important necessity since redox flow batteries do serve as a potential alternative for large scale grid storage and large cycle life is essential for economic use of the batteries for desired application. The authors have identified pH fluctuations causing active materials loss as the degradation mechanism and have suggested additives approach as a method to stabilize pH resulting in enhanced cycle life. The approach is motivating because of the ease of the solution and they have demonstrated significant cycle life enhancement.  
  
Minor Concerns:  
I would like to suggest some minor changes before the manuscript can be considered for publication.  
1. What are the other types of electrolytes used for SLFBs and how do they perform? A comparison needs to be discussed and why do other electrolytes cannot offer pH control?

**Ans:** We thank the reviewer for the comments. We have seen perchloric acid and fluoroboric acid employed for soluble lead flow batteries, as listed Ref. 1 and 2 below. However, in this work we focused on methanesulfonate electrolyte system. Whether the strategy of NaOAc additive will work or not in those other systems requires further examination and is beyond the scope of this work.

Reference

1. LIU, Dong-Yang, Jie CHENG, Jun-Qing PAN, Yue-Hua WEN, Gao-Ping CAO, and Yu-Sheng YANG. "All-Lead Redox Flow Battery in a Fluoroboric Acid Electrolyte." *Acta Physico-Chimica Sinica* 27, no. 11 (2011): 2571-2576.
2. Sun, Yanzhi, Shicheng Guo, Yu Wang, Junqing Pan, and Pingyu Wan. "A new lead single flow battery in a composite perchloric acid system with high specific surface capacity for large-scale energy storage." *Journal of Solid State Electrochemistry* 21, no. 12 (2017): 3533-3543.

2. The relevance of an electrolyte additive needs to be mentioned. How does this specific additive control the pH fluctuations?

**Ans:** In our previous work (Ref. 11, Fig 2), we have shown that a buffer effect of NaOAc will lead to levelled-off pH curves along with charge/discharge cycle. However, we believe NaOAc additive induces other effects on electrodeposition that is more important than pH buffering in SLFBs such as what we illustrated in TI and SEM results. Thus, we didn’t include the pH data in this manuscript.

3. An image or a schematic of the cell setup is helpful to understand the half- cell reactions in the textual manuscript.

**Ans:** We have added a schematic diagram of the beaker cell setup as Figure 1 as suggested by the reviewer.

**Reviewer #4:**   
I am pleased to review the paper titled "Extending lifespan of soluble lead flow batteries with sodium acetate additive". The paper provided a method for the construction of a soluble lead flow battery with extended cycle life by using sodium acetate additive. This presents interesting results. I think the paper can be accepted with minor revision. The comments are as following.  
1. Spelling mistakes should be corrected carefully. Line 66, the abbreviation "SLFB" should be followed by its full name. line 137, "1 M potassium nitrate" should be "0.1 M potassium nitrate".

**Ans:** We thank the reviewer for the suggestions and we have made modifications accordingly.

2. It is suggested that how to conduct throwing index experiments and electrochemical experiments should be given. In addition, the experiment parameters for the SEM images should be given.

**Ans**: We have included the protocols in the Protocol section for TI experiment and electrochemical experiments as suggested. We also have included the experimental conditions for the acquired SEM sample in the third paragraph of Representative Results, and listed the experimental equipment model in the table of essential supplies, reagents and equipment.

3. Will sodium acetate additive be consumed by oxidation? The authors should give some comments or additional results and discussion.

**Ans:** In our previous work (Ref. 11, Fig 1), we have performed comprehensive cyclic voltammetry study on the methanesulfonate electrolyte with and without sodium acetate, and no additional redox reaction is observed in the potential range of SLFB operation. We have added an additional comment in the end of the first paragraph of Representative Results to clarify this concern.