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Measuring corrosion of iron—Yr 12 EEI

Posted by Anonymous on Mon, 2016-05-09 23:57

Hi,

I'd like to get ideas/techniques on how students can measure the amount of rust produced when a nail (iron) corrodes.

In the past years, students have weighed the nails before and after the corrosion, and the difference was assumed to be the amount of rust formed. Would it be better to scrape off the rust as well and weigh the nail without the rust to get a more correct measurement of the mass of rust formed? The main issue I have with this method, is that it will not take into account the dissolved iron ions, which are also products of the corrosion. This leads me to the next question: Can I tell my students to disregard the dissolved irons ions if they wish to do this technique?

To measure the dissolved iron ions, more specifically Fe^{2+} ions, is it correct to use redox titration with permanganate ion? My students did this last year and found that there wasn't enough Fe^{2+} ions in the solution to get a decent amount of permanganate titre (endpoint was reached after 3–5 drops!), and so we've had to dilute the permanganate solution, which then makes the colour fainter and the endpoint was harder to detect. I thought this technique was promising because students can take samples of their solutions at different days and check for any trends.

I've also tried using a conductivity meter to measure the change in the amount of dissolved ions after corrosion, but it wasn't very successful, mainly because the probe we were using didn't pick up the range of microseimens in the solutions.

Can you please comment on the techniques I've described—whether or not we are on the right track. If yes, how can we modify it to get better results? Are there any other techniques that you can suggest that students can use?

I saw an interesting article in the RSC website: http://www.rsc.org/learn-chemistry/resource/res00000453/how-much-air-is-used-up-during-rusting?cmpid=CMP00005146—it measures the change in volume of air (oxygen) after rusting. Do you think this is a suitable technique to measure the extent to which the oxidation of Fe occurred? (Taken from the point of view of how much oxygen was used if iron is in excess instead of measuring the product produced.) In the method, the iron (steel wool) was not placed in the water to rust. Will this method still work should we decide to drop the steel wool in the water? I'm guessing not, because then the oxygen will come from the dissolved oxgen in water...

Thanks in advance. Sorry it was such a long one. :)

Voting:

☆☆☆☆
No votes yet

Year Level:
Senior Secondary
Laboratory Technicians:

Showing 1-1 of 1 Responses

Answer by sue monteath on question Measuring Corrosion of Iron-Yr12 EEI

Submitted by sat on 14 May 2016

Reviewed 22 February 2023

The answers to this long question are answered in-situ to provide proper context.

I'd like to get ideas / techniques on how students can measure the amount of rust produced when nail (iron) corrodes.

In past years, students have weighed the nails before and after corrosion, and the difference was assumed to be the amount of rust formed. This may well be the easiest option in the classroom setting.

Would it be better to scrape off the rust as well (Yes—but students should be aware that it is possible that some Fe(s) will be scraped off as well) and weigh the nail without the rust to get a more correct measurement of the mass of rust formed? Another option is to filter the solution and then completely dry and measure the rust that has separated from the nail. The main issue I have with this method is that it will not take into account the dissolved iron ions which are also products of the corrosion. This leads me to my next question: can I tell my students to disregard the dissolved iron ions if they wish to do this technique? This is a good discussion point for the students in their experimental design.

To measure the dissolved iron ions, more specifically Fe2+ ions, is it correct to use redox titration with permanganate ion? My students did this last year and found that there wasn't enough Fe2+ ions in the solution to get a decent amount of permanganate titre (endpoint was reached after 3–5 drops!), and so we've had to dilute the permanganate solution, which then makes the colour fainter, and the endpoint was harder to detect. I thought this technique was promising because students can take samples of their solutions at different days and check for any trends. Rather than use a 50 mL burette, it would be possible to use smaller volumes and dilute. This, plus weighing the scraped and filtered iron oxide, would be more accurate.

I've also tried using a conductivity meter to measure the change in the amount of dissolved ions after corrosion, but it wasn't very successful, mainly because the probe we were using didn't pick up the range of micro siemens in the solutions. Agreed, this mostly doesn't have the sensitivity required.

Can you please comment on the techniques I've described—whether or not we are on the right track. If yes, how can we modify them to get better results? Are there any other techniques that you can suggest that students can use?

I saw an interesting article in the RSC website: https://edu.rsc.org/lcredir/learn-chemistry/resource/res00000453/how-muc...—it measures the change in volume of air (oxygen) after rusting. Do you think this is a suitable technique to measure the extent to which the oxidation of Fe occurred? (Taken from the point of view of how much oxygen was used if iron is in excess, instead of measuring the product produced.) In the method, the iron (steel wool) was not placed in the water to rust. Will this method still work should we decide to drop the steel wool in the water? I'm guessing not, because then the oxygen will come from the dissolved oxygen in water. Yes—most of the oxygen would come from the dissolved oxygen, but there are ways to measure dissolved oxygen (DO) in water. You could do this as well as the Fe2O3 collection, but it would require controlling the DO (so no exposure of the rusting solution to air at all—plus the temperature would need to remain constant). This would be difficult to do but would be possible using sealed containers that have no air bubbles.

Reference

Royal Society of Chemistry. (nd). *How much oxygen is used when iron wool rusts?* Retrieved (22 February 2023) from the Royal Society of Chemistry website: https://edu.rsc.org/experiments/how-much-oxygen-is-used-when-iron-wool-r...

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