*Segurança e Pesquisa**:

A Case Study of Translation & Localization of Standard Operating Procedures in the *BIOTAR*** Laboratory

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*Safety and Research ** Biological Engineering of Treated Water and Residues

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Abstract

This project addresses the lack of safety documentation in a Brazilian food engineering laboratory by conducting in-depth observations to create a customized standard operating procedure and then translating and localizing the document into Portuguese. To assess the value of human translation, I tested my own translated SOP against a Google-Translated version. In seven weeks, I wrote and translated an SOP by preforming a user-task analysis and hosting user-trials. With my translated SOP, I sought to answer the question: what is the value of a human translation over an automated translation?

Prologue

In the early 16th century, Hernan Cortez and his men landed in South America to conquer the territory for Spain. Cortez's men were awestruck by the clean, modern, and technologically advanced city of Tenochtitlan, at the heart of the Aztec empire. Cortez sought out a meeting with the leader of the Aztec civilization, Montezuma. Montezuma arrived at their meeting being carried by a group of Aztec citizens. As Cortez dismounted his horse, Montezuma was lowered by his followers. According to Spaniard cultural tradition, Cortez reached forward to embrace Montezuma. Montezuma rejected the embrace: *no one embraced Montezuma.* The two men bowed to each other, instead.

The two men could not directly communicate with each other. Cortez's Spanish was as foreign to Montezuma as a Martian language would be to us in the modern day. Cortez was accompanied by a native woman named Malinche, whom the Spanish captured many months earlier. He also brought a Spanish Priest, Geronimo del Aguilar, who had previously been shipwrecked in South America. To communicate a message to Montezuma, Cortez spoke the message to Aguilar; Aguilar spoke to Malinche; and Malinche spoke in the Aztec language to Montezuma.

This convoluted translation scheme worked mechanically but failed to address the cultural implications of language in the Aztec culture. Leaders of the Aztec culture would often speak of themselves as frail and weak, facetiously emphasizing their power and strength. Cortez heard Montezuma admit to weakness and willingly turning over his empire, when the exact opposite was meant. This failure to understand the cultural implications eventually led to war between the Spaniards and the Aztecs.

The story of Cortez and Montezuma inspired this project. From the time Cortez first met Montezuma, the world has continuously become more globalized and the need for translators and intercultural communicators has boomed. Many nations are banding together to attempt to solve the greatest issues currently facing our species: climate change, human rights, and protection of civilizations("United Nations Office for Project Services - United Nations and the Rule of Law," 2019). International cooperation in science and technology is at its peak; engineers and scientists are reaching beyond their political borders to develop ideas to improve society(Wagner et al., 2002). However, countries often have individualist ideas about safety and security in scientific practices("UL Safety Index," 2019).

This project aims to write a technical document for use by researchers in a Brazilian food engineering laboratory, to translate that document, and to study the functionality of that translation. This project provides a bridge between cultures in a technical discipline, seeking to solve the mistakes of Cortez and Montezuma in the modern engineering world. Specifically, this project provided a Brazilian food engineering lab with comprehensive safety documentation, a localized and translated copy of all materials.

Chapter 1: Background

In this chapter, I summarize the literature review I preformed prior to arriving in Brazil. To compliment my Professional Writing training, I conducted background research on the following major themes of this project:

1) technical writing with focus on standard operating procedures and user-task analysis
2) technical translation with emphasis on localization and software-based translation

Section 1: Technical Writing

This project exercises the principles of technical writing. Technical writing refers to the use of straightforward, efficient language to explain a subject, usually involving a set of instructions for a process. Traditionally, technical writing describes creating user manuals, but the discipline has evolved in recent years. In the early 1990s, technical writers were very product focused: documentation would be organized and written based on product features. However, the field evolved into being very user focused: documentation would be structured based on individual tasks and goals. According to Williams and Moore, most of the current common topics at technical writing conventions include the implications of technical writing for users, functions of technical writers on interdisciplinary teams, and managing products with multiple audience (Williams & Moore, 2006).

Technical writing is characterized by its distinct style. Technical writing seeks to use active voice whenever possible, avoiding the addition of ambiguity with passive voice(Tilley, 2013). Technical writing seeks to convey information as efficiently and briefly as possible. As De Silva and Henderson report, most forms of technical writing are joined by a basic narrative structure backbone: one where the user is troubled and the documentation saves the user from struggle, hassle, and potential threats(Silva & Henderson, 2007).

In this project, technical writing will give rise to comprehensive safety documentation in the form of a standard operating procedure (SOP). At the University of Campinas, in the state of Sao Paolo, Brazil, most researchers are native speakers of Portuguese or Spanish and begin their technical careers as graduate students in research laboratories. In the Brazilian food engineering laboratory, researchers are constantly working with bacteria, hazardous chemicals, and dangerous machinery. The researchers are at physical risk when completing daily tasks in the laboratory, creating the need for a SOP to guide researchers through their technical goals on a regular basis.

Standard Operating Procedures

Traditionally, SOPs are written guidelines of instructions which outline how to correctly execute a procedure(Barbé et al., 2016). SOPs include testing procedures for medical exams, instructions on how to brew a cup of coffee at a cafe, or even a pilot's checklist. In the past decade, SOPs have taken a less text-centered form. The Australian Royal Navy documented their process in collecting and re-writing all of their hundreds of SOPs: they found that a more visual, flow chart-based SOP system aided sailors more than traditional text-based SOPs(Tavener & Asenstorfer, 2015). Similarly, a water engineering lab in Flint, Michigan was tasked with creating SOPs to instruct homeowners on how to sample their tap water. The Michigan researchers were challenged by the various levels of literacy in the city: they chose to develop a picture-based SOP. The researchers described it as "text embedded in images, not images embedded in text" (Zarb, McElmurry, & Moldenhauer, 2017). Although SOPs are important for the safe, consistent execution of repetitive processes, they often fall by the wayside. Often times, laboratory managers or industrial engineers will prioritize more immediate needs over writing SOPs (Flynn, 2019).

Standard operating procedures are used across disciplines to ensure accuracy, consistency, and quality in repetitive processes. SOPs are used in manufacturing, government agencies, and academic laboratories(Akyar, 2019). Specifically, in academic laboratories, SOPs are useful for tasks which are carried out by more than one member of the research group. SOPs include the purpose of the task, any equipment involved, how to perform maintenance and shut down on an operation, and a list of safety issues and troubleshooting concerns(Sutton, 2008).

Most SOPs follow the same general structure. SOPs should be accessible where the work is being done. In the case of a food engineering lab, the SOP should be available in the lab and at the specific bench where that task is carried out. SOPs seek to achieve standardization and are therefore "alive" documents: SOPs should be revised and updated every time there are changes in the conditions surrounding the task. Compared to multimedia options, written paper-based SOPs are often the easiest to produce and access(Tavener & Asenstorfer, 2015).

The SOP in this project was created specifically for the Brazilian food engineering laboratory. As a Chemical Engineering and Professional Writing major, I was invited to create an SOP that was both technically accurate and well-written. Being an English-Portuguese bilingual, I was invited to observe and analyze the use of language in the SOP to create a functional translation for the research group. The SOP was written for the daily practices in the laboratory. In my observation of their tasks, I created a user task analysis to identify key high-level processes to focus on in the SOP.

User Task Analysis

Technical documents, such as SOPs, are often tested for reproducibility through user task analysis. User task analysis is the act of observing users during a specific, goal-oriented task. User task analysis can be useful in testing a SOP to verify that the operation described in the procedure is independent of the user. When the Australian Royal Navy revised all of their SOPs, they conducted ‘walk throughs’ of all of their drafts(Tavener & Asenstorfer, 2015). They used both user-task analysis and mental reviews of the processes to validate the contents of the SOPs. The team of researchers reviewed the operations of the SOPs by walking through the tasks involved before, during, and after the SOPs were written. This kind of operational review is useful for discovering gaps within sets of SOPS and for highlighting sub-procedures in a larger operation chain. A major disadvantage of user-task analysis reviews is that it does not account for any deviation in normal conditions(Akyar, 2019).

In this project, I used the user task analysis as a preliminary step to the SOP. The user task analysis allowed me to identify key processes to base the SOP on. The user task analysis also helped me separate procedures from reference information that was key in completing processes. The user task analysis was vital in ensuring an effective SOP before the translation process began.

Section 2: Technical Translation

Multinational and US companies are investing in a professional to handle the translation of their products for a global market. Tatiana Batova conducted a yearlong study of the process a Fortune 500 company uses to translate their user manuals, sales documentation, and other technical writing (Tatiana Batova, 2019). She found that to translate technical documents, some companies are utilizing component content management (CCM); this management strategy seeks to translate documents in pieces rather than a whole unit. When using CCM, a translator works on a single section at a time and later gives the individual translated pieces to an editor to string together into the larger work(Andersen & Batova, 2015).

In technical translation, two relationships govern the quality of the product. The relationship between the original technical writer and technical translation is critical. The technical writer needs to share the original intentions and most significant rhetorical decisions with the technical translation to ensure that the essence of the writing is consistent through translation. The technical translator also needs to have a comprehensive understanding of the end user. Proper knowledge of the end user can help inform the translator's decisions about vocabulary choice, syntax, and approach. If the technical translation does not have a proper understanding of the technical writer and end user, the translated product will most likely succumb to pitfalls(T. Batova, 2018).

The professional translator's time is split focusing on two categories: literal and figurative language. A translator works with literal language by means of direct translation. Direct translation is the act of replacing each word from the source language with its equivalent in the target language. Translation of figurative language is a bit more nuanced. Figurative language translation is known as oblique translation. During oblique translation, a translator seeks to understand the rhetorical function of the language in the piece. Oblique translation is, by nature, more difficult to pull off in professional translation because the translator must truly understand the author's intentions with the use of language. After deciding on the function of figurative language, the translator can either use literal language within the target language or decide on a colloquial phrase that aligns itself with the original work (Matthews, 2019; Molina & Albir, 2002; Pinheiro, 2015)

Research into technical translation has revealed that hierarchical issues often lead to faulty translations. Technical translation teams are often made of the original authors, translators, and bilingual reviewers. These three camps are often divided, both in goals and geographically. The three camps often have contradictory goals and timelines, which can affect the overall quality of the produced translation(T. Batova, 2018).

The second contributing factor to faulty translation is lack of knowledge of end users. Properly understanding the audience is key in all kinds of communication, but this is especially important in technical translation. Technical writing is user-focused, meaning the demographics, education, and background of the user must be considered in designing effective documents. In technical translation, the identity of an intended user of a product may be different between regions of the world. Technical translation must be highly contextualized, with teams collaborating to consider all possible influencing factors on end-users and the product(Tatiana Batova, 2019).

In this project, I wrote the English SOP and conducted technical translation. Because technical writing is characterized by direct, literal statements, the translation in this project was entirely direct translation. The Portuguese SOP was reviewed by local Brazilian researchers in the laboratory for accuracy. After confirming accuracy, the project entered the localization phase to meet the target users' needs.

Content Localization

A key component of translation is the act of localizing content in the target language. Localization is the process of "adapting a product or content to a specific locale or market" (GALA, 2015). Localization considers the ethical, cultural, legal and other aspects of language in a specific global or local context(T. Batova, 2015). Localizations remove any cognitive load the reader might experience when using a product that was not originally meant for them(Bailie, 2019). The goal of localization is to make the user believe that the product was created for them specifically, regardless of their language, culture, or location.

Localization takes the form of many small, but critical, edits after technical translation. Localization can be the conversion of monetary and measurement amounts into the correct value and units (eg. turning $USD into $CAD on an e-commerce site), or the trading of colloquial terms (eg. the British “boot” for the American “trunk”) or changing location-based references. The need for localization has grown with the recent development of globalization (Bailie, 2019).

In my project, the localization phase came after the technical translation had been completed. Localizing the content of the document included employing region-specific terms and changing the vocabulary to be better suited for the researchers in the laboratory. In this stage of the process, I worked with the researchers in the laboratory to designate and employ key phrases and words that were best suited for the group.

Software-Based Translations

Within the past decade, software-based translation apps have attempted to remediate the need for professional translators. The most popular of these is Google Translate, boasting 103 language options. Google Translate is a free service, needing only access to the internet. Google Translate is used by approximately 500 million people each year and translates over 100 billion words each day. The vast majority of Google Translate users are not from the United States, with Brazil being the most frequent Google Translate users(Turovsky, 2016).

Where free and easily accessible services like Google Translate may fulfill social or traveler’s language needs, other softwares have been created to specifically aid in technical translation. Among these technical translation softwares are the Language Grid and a tool created by researchers at Waseda University in Japan. Both technical translation tools used Crowd Assisted Translation (CAT): users with technical expertise post their work and allow users who are fluent in the target language to translate the paper. CAT has been known to yield low-quality translations and does not offer the original author any reviewing power during the translation process. Software based tools for technical translation are still learning to overcome the barrier matching technical prowess with language fluency(Minowa & Hishiyama, 2012; Tanaka, Murakami, Lin, & Ishida, 2010).

Rather than seek software to replace translations, some businesses are looking to software to aid translations. Translation checkers are software applications that review writing for complexity; if the checker detects any writing that is complex enough to compromise the translation, it will notify the writer to revise that section. Boeing, IBM, and General Motors are among the companies adopting this strategy. Translation checkers can be attractive to companies who do not want to invest in their own technical translation teams. These checkers are often limited by a number of factors: reviewing a finite amount of characters at a time, misunderstanding the use of non-direct pronouns, and removing gerunds from the text (Akis et al., 2003). Even with the invention of online translation platforms and translation preparation software, Google Translate prevails as the most convenient and popular translation application.

Chapter 2: Methodology

In this chapter, I describe the methods used to plan, write, and test the accuracy of both the English and Portuguese SOPs. The methods included in this chapter were executed over a seven-week period at the University of Campinas in Brazil. In pursuit of an accurate, culturally relevant SOP written in Brazilian Portuguese, I used the following methods:

1) user-task analysis based on direct observations
2) usability trials to test the accuracy of the content
3) comparison to software via Google Translate test

Section 1: User-Task Analysis

I conducted a User-Task Analysis to assess the scope of the SOP. A template of the User-Task Analysis is available in an Appendix A. I utilized the User-Task Analysis as a tool to identify relevant details about the audience and goal of the document. The User-Task Analysis allowed me to format my notes into topics and tasks. I implemented groups of topics, tasks, and goals in the structure of my SOP.

To plan for the SOP, I developed the User-Task Analysis based on observations and interviews. I conducted a User-Task Analysis which I learned in WPI’s WR 3210: Technical Writing Course with Professor Scott Runstrom. I first observed researchers in their daily observations. In my notes from the observations, I recorded any equipment used and major actions or steps in a procedure. If someone used equipment with multiple buttons or functional options, like a computer, I wrote down specifically what steps they took as a subset of a large procedure. I observed multiple people completing the same tasks.

I interviewed the researchers involved in three sub tasks that, in aggregate, enable the larger technical task that is the topic for the SOP. For each subtask, I asked semi-structured interview questions to learn the major steps and concerns of the process. When I had sufficient detail, I attempted to perform the task myself to continue to add a greater level of detail to my notes. Along with information about the individual tasks, I also noted details about the backgrounds of the people who conducted the tasks. By gathering details about who was completing the tasks, I was able to better understand the ultimate audience for the SOP. The semi-structured interview questions can be found in Appendix B.

Section 2: User Trials

I conducted user trials to measure the accuracy of the SOP translation, following the methods of Seabrook's The Next Word(Seabrook, 2019). I identified a Portuguese-speaker in the lab and asked that they follow the procedures included in the SOP. As they worked through the content, I noted any deviations from the intended procedure, areas of confusion, or potential problems in the SOP. After the test, I returned to the SOP to make corrections as needed. I repeated the user tests iteratively until multiple users were able to successfully execute the processes included in the SOP without issue.

The user-trials were limited because by this point in the MQP I only had a draft of the English SOP. This limited my potential subjects to other MQP students and the two researchers who were very comfortable with English. The user-trials were crucial in testing the accuracy of the SOP. If two or more people were able to successfully execute a procedure, I deemed that procedure ready for the translation phase of the project.

Section 3: Comparison to Software

: To determine if there is a difference between my translation and the translation by a software, I uploaded two pages of my SOP on the Google Translate website. If there was a difference, I wanted to know which version the researchers preferred and why. I ran a 1-2-page sample of my SOP through Google Translate for comparison. I then presented Brazilian researchers with Google Translate sample, my sample, and asked which they preferred. From this test, I sought to see if people could differentiate my work from the software, and if so, what the major differences are.

In this project, I compared Google Translate to my own translated and localized SOP. In this portion of the work, I sought to answer the question: was I worth it? Was it worth it to have a bilingual researcher create a Portuguese version of the document? I ran the English SOP through Google Translate and asked researchers in the laboratory to give feedback regarding which version they preferred: my translation of the Google Translate version.

Chapter 3: Findings and Discussion

In this chapter, I describe the findings from previously described methods. The English and Portuguese SOPs can be found in appendices C and D respectively; the Google Translate sample can be found in Appendix E. The content and structure of the SOP was tailored for the laboratory by applying insights gained about the operations, culture, and structure of the laboratory through:

1) user-task analysis which identified processes to include in the SOP
2) user-trials which assessed the reproducibility of the procedures in the SOP
3) software comparison that revealed a preference for personal translations

Section 1: User-Task Analysis

I completed a user-task analysis as the first phase of my project work. Professor Forester-Carneiro, the sponsor for this project, wanted me to create a table of contents as a proposal for this work. Using my knowledge of the preparation process in the Technical Writing course, I created a User-Task Analysis to plan the details of the SOP. The Technical Writing format helped me parse information into procedural, concept, and reference categories. In the User-Task Analysis, I noted important details about the researchers who would use the manual. The User-Task Analysis helped me divide the overall topic into three large processes with individual procedures. The three large processes were divisible by the timing of the tasks they included: an initial set up of the reactor, a Monday-Wednesday-Friday sample collection process, and a daily data recording process.

My observations acted as further evidence for the need for an SOP in the lab. While observing different individuals, I noted that there were multiple ways to achieve the same result. Researchers executed tasks differently when cleaning implements, storing samples, and operating small features on equipment. For example, half of the researchers would completely seal the reactor between taking a sample and weighing it; the other half would leave the reactor partially open in case they had to collect more sample. This specific variance in execution could have serious implications on the reactor because of the risk of oxygen contamination.

I interviewed four researchers using a semi-structured method. All four emphasized two specific points. The researchers noted the importance of safety in working with the reactors: different procedures required different levels of personal protective equipment. They also made a point to tell me the importance of managing the reactors. The reactors cannot be exposed to air or any foreign residues (hair, plastic, debris) during an experiment. Apart from those two points, the researchers had different opinions on what the most important and difficult procedures were concerning the reactors. One noted that the initial set up was both the most important and difficult procedure because it only happened once every few months. Others noted that taking samples was either the most important or difficult procedure because of the risk of contaminating the reactor or nearby equipment. The semi-structured interviews revealed that the researchers varied greatly in terms of comfort level and knowledge with the procedures associated with the reactor.

The variance between individuals made consultation from Professor Forester-Carneiro essential in later stages of the project. Professor Forester-Carneiro offered guidance on the preferred method of execution for all the procedures in the SOP. She dictated which personal protective equipment were appropriate for specific procedures. She also listed common mistakes researchers frequently made when completing procedures, which became important to look for in the user-trial phase.

Section 2: User Trials

As a result of the user trials, I noted deviations between researchers conducting the same task. Some examples of small deviations include where to put contaminated equipment before the task was completed and completing tasks in series or stopping to clean implements between procedures. Professor Forester-Carneiro provided information about the correct procedures and common errors researchers made in completing daily tasks.

The user-trials enlightened me to the different levels in experience make when completing a task. From the interviews conducted in the user-task analysis phase, I learned that some researchers were very familiar with equipment due to years of experience, but others were just starting out. I also learned that the training process for the laboratory was only a three-month observation period before someone began handling procedures without help. The differences in experience levels showed in the user trials because while completing a procedure: newer researchers would ask me concept related questions. An example of one of these questions is: what exactly is inoculum and is it dangerous? I was struck by this question because I had the same one when I began the technical portion of my MQP in this laboratory. Concept related questions led me to add boxes with key concept information into different sections of the SOP.

A key component of the user-trials was testing the efficacy of the information architecture in the SOP. When designing the SOP, I specifically designed the pages to visually distinguish between the different types of information: chapter titles, section titles, procedure steps, concept information, safety warnings, etc. When conducting user-trials, I was observing to identify whether the different types of information were read and followed in the intended order. At one point in the writing process, I conducted two user-trials for the same procedure: one with a list of prerequisite materials in bullets and another with an in-line list. I observed that the bulleted list was the more effective method of communication. Because of the results of this user-test, I modified the final SOP to contain bulleted lists of necessary materials. The results of the user-tests guided me in the best-practices for the layout of information within the SOP.

Section 3: Software Comparison Results

All the researchers agreed that my translation was of a higher quality than the Google Translate sample. They all noted that my translation was easier to understand and complete tasks from; both because of the rhetorical structures and because of the formatting and design. Two researchers claimed that it took more effort to understand the content in the Google Translated version. On the topic of formatting, professionalism, and usability, all the researchers unanimously chose my Portuguese SOP as the better product.

On the topic of word choice and grammar, two out of the eight researchers offered a unique take on the difference between the two products. Out of the eight researchers I sampled, two were native Spanish speakers: one from Columbia and the other from Peru. They noted the vocabulary I used was easier to comprehend than the Google Translated version. They both noted further searching would have had to be done to understand some of the terms in the Google Translated version.

Chapter 5: Conclusions & Recommendations

The Google Translate comparison revealed a preference for personal translation in the laboratory. This speaks to the value of having a bilingual in a professional setting. A translator can apply the societal and cultural context to a rhetorical situation. On-site translators are rare and expensive, making them impractical for daily use. However, this project highlights the necessity for personal translation of essential safety documentation.

There are limitations in this project because I was both the original document author and the technical translator. In most professional settings, the technical translator will have to interpret the intentions of the original author because they work independently. Because I was preforming both roles in this project, my work represents an experiment in the movement between languages in a technical environment instead of a formal case study in technical translation.

This project required the application of concepts from across a wide variety of professional writing and engineering courses. Future student projects should focus on replicating pieces of this project at different project centers around the world. Future students can base work off this project by examining similar work in a variety of genres and languages.

I would recommend future student projects make some deviations from the methods laid out in this project. Namely, I would recommend students initiate contact with project centers as early as possible to decide on a topic for the original documentation. Getting a head start on picking a topic will free up time for writing and translating. Also, I recommend future students conduct more user-trials than I did here. I intended to conduct three rounds of user-trials but only did two for most of the sections of the SOP. This timeline was affected by difficulties in the technical portion of my MQP.

I consider this project to be a successful MQP because it relied on my skills as a bilingual, training as a Professional Writing major, and experiences as a chemical engineer. My work in the BIOTAR lab was influenced by this portion of my MQP because it alerted me to the importance of standard procedures and inter-cultural communication at the Brazil Project Center. My work will also go on to help other WPI students at the Brazil Project Center by solving the problem of the lack of standardization. This project was an opportunity to combine my cultural background, technical writing work, and knowledge of engineering safety to add value to the Brazil Project Center by customizing safety documentation and conducting an informal research project with it.

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Appendix A: User Task Analysis Template (WR 3210 with Prof. Runstrom)

User and Task Analysis

FOR [PRODUCT NAME]

writer

date

document version

Contents

Intended Users 2

User Goals 2

Task Analysis for [User Goal 1] 3

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Procedure Topics 4

Concept Topics 4

Reference Topics 5

Troubleshooting Topics 5

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Appendix A: User Task Analysis Template (WR 3210 with Prof. Runstrom)

Intended Users

Who uses the product?

[User Type 1]

[Short description]

- Distinguishing factor A
- Distinguishing factor B

[User Type 2]

[Short description]

- Distinguishing factor C
- Distinguishing factor D

User Goals

Why do they use the product?

[User Goal 1]

[Short description of goal]

[User Goal 2]

[Short description of goal]

[User Goal 3]

[Short description of goal]

Appendix A: User Task Analysis Template (WR 3210 with Prof. Runstrom)

Task Analysis for [User Goal 1]

- What are the tasks the user needs to accomplish to achieve their goal?
- Capture tasks as a **workflow**.
- Capture what information is needed to accomplish each task.
- Workflow should not have branches or loops.

List **workflow steps** for achieving the goal. Then, for each step, list questions that you anticipate users might ask regarding that step:

1. [First step that produces a key incremental result.]
    - [User question about step]
    - [User question about step]
    - [User question about step]

2. [Second step.]
    - [User question about step]
    - [User question about step]
    - [User question about step]

3. [Third step.]
    - [User question about step]
    - [User question about step]
    - [User question about step]

4. [Fourth step.]
    - [User question about step]
    - [User question about step]
    - [User question about step]

5. [Fifth step.]
    - [User question about step]
    - [User question about step]
    - [User question about step]

Appendix A: User Task Analysis Template (WR 3210 with Prof. Runstrom)

Required Content

Procedure Topics

- Most of documentation should be Procedures ("How-To" topics)
- Base these on the tasks (steps) in your workflows, and group them by user goal

User Goal	Title	Short Description
[Goal 1]		
	[Procedure 1]	
	[Procedure 2]	
	[Procedure 3]	
	[Procedure 4]	
[Goal 2]		
	[Procedure 1]	
	[Procedure 2]	
	[Procedure 3]	

Concept Topics

- Each concept topic must support user decisions and procedures. "What is it?" "How does it work?"
- Concept topics either help the use choose a procedure, or directly help to perform a procedure.
- If conceptual information does not meet these criteria, leave it out of your documentation.

User Goal	Title	Purpose
[Goal 1]		
	[Concept 1]	
	[Concept 2]	
	[Concept 3]	
[Goal 2]		
	[Concept 1]	
	[Concept 2]	
	[Concept 3]	

Appendix A: User Task Analysis Template (WR 3210 with Prof. Runstrom)

Reference Topics

User Goal	Title	Purpose
[Goal 1]		
	[ref page 1]	
	[ref page 2]	
	[ref page 3]	
[Goal 2]		
	[ref page 1]	
	[ref page 2]	
	[ref page 3]	

Troubleshooting Topics

User Goal	Title	Purpose
[Goal 1]		
	[ref page 1]	
	[ref page 2]	
	[ref page 3]	
[Goal 2]		
	[ref page 1]	
	[ref page 2]	
	[ref page 3]	

Appendix A: User Task Analysis Template (WR 3210 with Prof. Runstrom)

Document Outline

Prototype the document Table of Contents, based on user goals and tasks.

Chapter1:

Section 1

- Topic 1
- Topic 2
- Topic 3

Section 2

- Topic 1
- Topic 2
- Topic 3

Chapter 2:

Section 1

- Topic 1
- Topic 2
- Topic 3

Section 2

- Topic 1
- Topic 2
- Topic 3

Chapter 3:

Section 1

- Topic 1
- Topic 2
- Topic 3

Section 2

- Topic 1
- Topic 2
- Topic 3

Chapter 4:

Section 1

Appendix A: User Task Analysis Template (WR 3210 with Prof. Runstrom)

Section 2

Appendix B: Semi-Structured Interview Questions

1. Can you tell me a little bit about what you were just doing? How often do you do this?
2. Can you describe the major steps to me?
3. Do you ever deviate from what you just did?
4. How did you learn to do this?
5. Can you tell me why you are wearing this specific set of PPE (personal protective equipment) during this task?
6. Do you feel there is a better or more efficient way of doing this task?
7. Do you make any common mistakes while doing this?
8. What do you call the different instruments and equipment you used in this task? In English & Portuguese?
9. How does this task relate to other ones you're doing to do today and over the course of this project?

Standard Operating Procedure for Using, Managing, and Analyzing Anaerobic Digestion Reactors

Katherine Vaz Gomes
Worcester Polytechnic Institute

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Document Overview

Purpose of This Guide	The Standard Operating Procedure for Using, Managing, and Analyzing Anaerobic Digestion Reactors provides reference information related to anaerobic digestion in the BIOTAR lab. This guide describes the process of building, maintaining, and studying anaerobic digestion.
Audience	This guide is designed for novice and experienced researchers.
Assumptions	This document assumes you are a current researcher in the BIOTAR lab. This guide also assumes that you have fundamental knowledge of anaerobic digestion.
Text Conventions	This guide uses the following conventions: • **<u>Bold and underlined</u>** indicates important safety information Always wear **<u>gloves</u>** when completing work in the laboratory. • *Italics* indicate new or important words *Always* wash dishes after completing lab work
Related Documentation	Please see the Analytical Methods and Lists of Solvents and Reagents in the Biological Treatment of Residues and Water Laboratory to assist you in your research.
How to Obtain Support	Reach out to Professor Tania Forester-Carneiro in the case of any question. If you need emergency assistance, please call 1-6000 for campus police.

Chapter 1: Preparation

This chapter reviews the initial set up of an anaerobic digestion reactor. This set up only needs to be completed once, at the very start of the experiment. This chapter includes the necessary steps to successfully install a reactor for anaerobic digestion.
This process includes:

1. Preparing the Digestate
2. Assembling the Reactor
3. Cleaning the Workspace

1.1 Preparing the Digestate

This section details how to prepare the contents of the reactor. The digestate is made of water, organic material, and inoculum. Inoculum houses the microorganisms which will undergo anaerobic digestion of the organic material. The inoculum in the lab is sourced from the AmBev Brewing company and is not parthenogenic. The digestate should be prepared **under the fume hood**, while wearing a **lab coat**, **breathing mask**, and **gloves**. Preform the following steps:

Prerequisite:

- 3 medium beakers
- 1 Large Plastic Beaker
- Inoculum Pot from the Incubator
- Organic Feed Material (Ex. Orange peels, barley bagasse)

1. Calculate the correct proportions for your reactor, which can be viewed on Page 5 in Figure 1
2. Consult Professor Tania to make sure your proportions are correct
3. Mix the water and inoculum together in the Large Plastic Beaker until they are well integrated
4. Split the organic material into three to five smaller batches
5. Mix each portion of the organic material into the inoculum and water mixture one at a time

NOTE: ALL THE ORGANIC MATERIAL MIGHT NOT INTEGRATE INTO THE MIXTURE, KEEP IT ASIDE AND WAIT UNTIL THE DIGESTATE BECOMES LIQUID TO COMBINE ALL PARTS

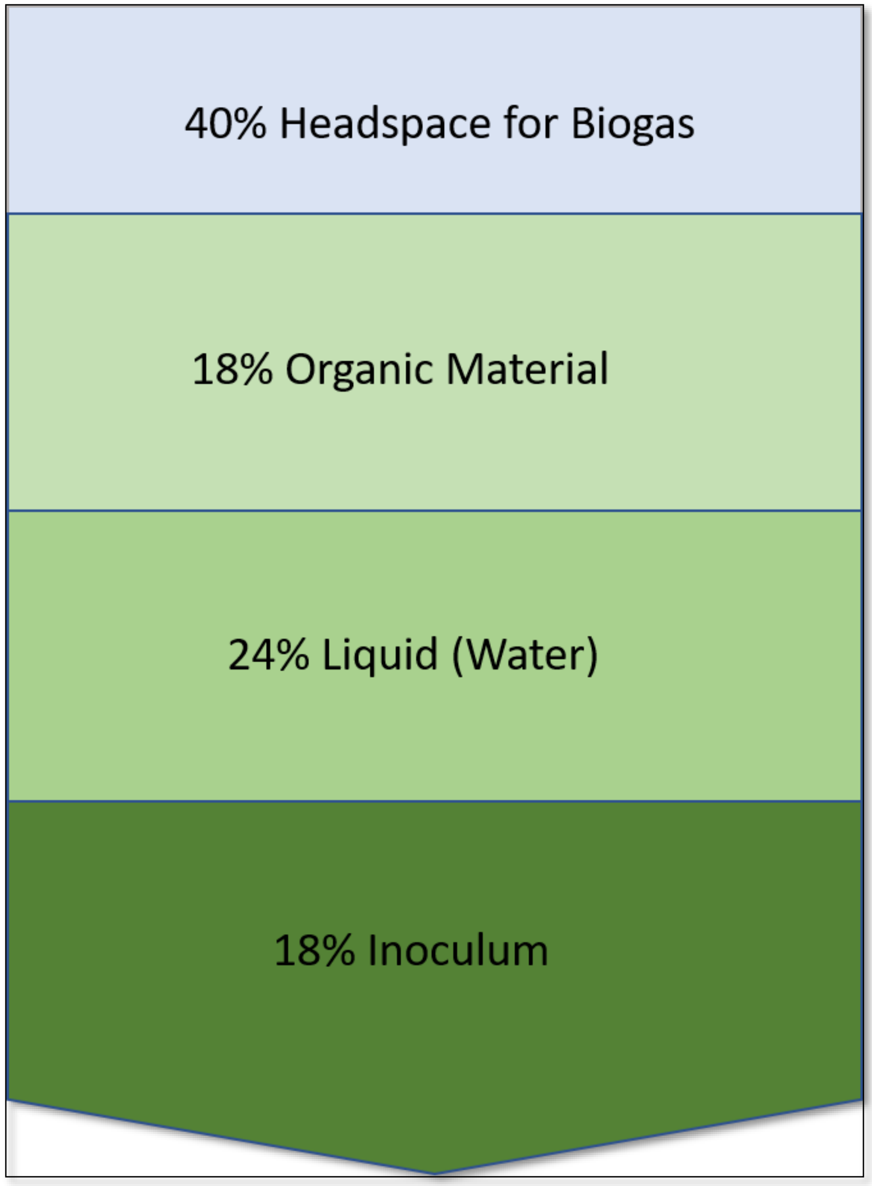

***Figure 1*: Typical Proportions of Materials in an Anaerobic Reactor**

1.2 Reactor Unit Assembly

This section details how to assemble the reactor unit. The reactor unit is comprised of the reactor, cooling system, and collection bag. The reactor unit must be assembled properly to successfully conduct anaerobic digestion. The reactor unit should be assembled while wearing a **lab coat** and **gloves**. Preform the following steps:

1. Measure the Reactor Volume
2. Construct the Reactor Unit

Procedure 1: Measure the Reactor Volume

This procedure describes how to measure the volume of the reactor if it is unknown. The reactor volume is essential for calculating the correct proportions for the components of the digestate.

Prerequisite:

- 1 medium beaker

1. Fill beaker with a known volume of water
2. Dispense water into reactor
3. Record volume of water dispenses into reactor
4. Repeat Steps 1-4 until reactor is full
5. Sum the recorded water volumes to obtain the total volume of the reactor
6. Empty the water out of the reactor
7. Use a paper towel or cloth to dry the reactor

Procedure 2: Constructing the Reactor Unit

This procedure describes how to construct the reactor unit.

1. Remove any dust or particulates from the inside and outside surfaces of the reactor with a cloth
2. Attach the inlet and exit cooling water tubes around the reactor
3. Tape a mylar collection bag onto the reactor apparatus
4. Attach a plastic tube to the opening of the collection bag
5. Mark the closing point of the knob by drawing a point on the bag with a marker
6. Connect a T-joint to the plastic tube on the end of the bag
7. Use plastic tubing to connect one end of the T-joint to the reactor
8. Place a septum on the open end of the T-joint

NOTE: THE SEPTUM SHOULD BE SECURE AND EASILY ACCESSIBLE

1.3 Cleaning the Workspace

This section describes how to properly clean instruments and beakers used in assembling and managing an anaerobic digestion reactor. Adequate sanitization of equipment is essential in making sure there is no cross contamination between experiments. Preform the following steps:

1. Wash Dishes
2. Decontaminate Instruments Used with Inoculum
3. Wash Writing from Beakers
4. Dispose of Hazardous Materials

> *BROKEN GLASSWARE SHOULD BE PUT IN THE LARGE WHITE BIN ON THE SHELF TO THE RIGHT OF THE SINK.*

Procedure 1: Washing Dishes

This procedure describes how to clean beakers, spoons, and implements in the laboratory. This procedure describes the basic steps you should take to clean the things you use.

1. Throw any solid material in the trash before washing
2. Place dishes in the sink
3. Rinse with water
4. Scrub with a sponge or brush to get rid of any residues
5. Place on one of the drying racks to the side of the sink

Procedure 2: Contaminated with Inoculum

This procedure describes how to properly clean beakers, spoons, and implements used with inoculum. Inoculum should be properly cleaned to avoid contamination and health hazards. You should complete the steps in Washing Dishes (General) before moving onto to this section.

1. Follow steps 1-4 from Washing Dishes (General)
2. Rinse with Alcohol from a squirt Bottle
3. Flush with water again to wash off any remaining residues
4. Place the beaker on one of the drying racks to the side of the sink
5. Rinse the sink, counter, and surrounding area with alcohol

Procedure 3: With Writing

This procedure describes how to wash dishes with writing on them. If you write on your beakers to label them as yours, please wash off the writing before putting them to dry.

1. Follow steps 1-4 from Washing Dishes (General)
2. Rinse the outside of the beaker with alcohol from a squirt bottle until the writing disappears
3. Place on one of the drying racks to the side of the sink

Procedure 4: Hazardous Material (COD Testing)

This procedure describes how to clean things used with hazardous materials, like the test tubes used in COD Testing. It is important to not wash hazardous materials in the sink.

Appendix C: English Standard Operating Procedure

Gather the following:

- COD Waste Container
- Vortex Mixer
- Squirt Bottle with Deionized Water

Note: You may need to use an adapter or an extension cord to plug in the vortex mixer

1. Open your test tube and pour the contents into the COD waste container
2. Squirt a few milliliters of deionized water into the test tube
3. Cap and place the test tube on the vortex
4. Hold the test tube on the vortex for approximately 15 seconds
5. Pour the contents of the test tube into the COD waste container
6. Repeat steps 4-7
7. Place the uncapped test tube on a test tube rack upside down
8. Place the test tube rack in the oven at 105℃

Chapter 2: Reactor Management

This chapter includes the necessary procedures for reactor management. The procedures in this chapter should be done every Monday, Wednesday, and Friday. This chapter includes instructions to properly manage your reactor. This process includes:

1. Continuously Feeding the Reactor
2. Collecting Samples from the Reactor

2.1 Continuously Feeding the Reactor

This section describes how to feed the reactor; the section only pertains to experiments where the reactor must be continuously feed. If the reactor requires a feed, the exact volume should be noted. The reactor should be fed after the measurement of biogas composition, biogas volume, and daily samples. This procedure should be completed while wearing **a mask, gloves, and a lab coat.** Preform the following steps:

1. Open the reactor by using the sample removal hatch, noted in Figure 2 on Page 10
2. Place and secure a funnel in the reactor opening

Note: Ask for help if another pair of hands is necessary

3. *Slowly* pour the feed into the funnel
4. Scrape the sides of the funnel with a spoon to help it enter the reactor
5. Continue pouring and scraping until of the feed has been used
6. Scrape the funnel with a spoon to get any excess feed into the reactor
7. Remove the funnel and set aside for cleaning
8. *Immediately* close the reactor to stop any air from entering

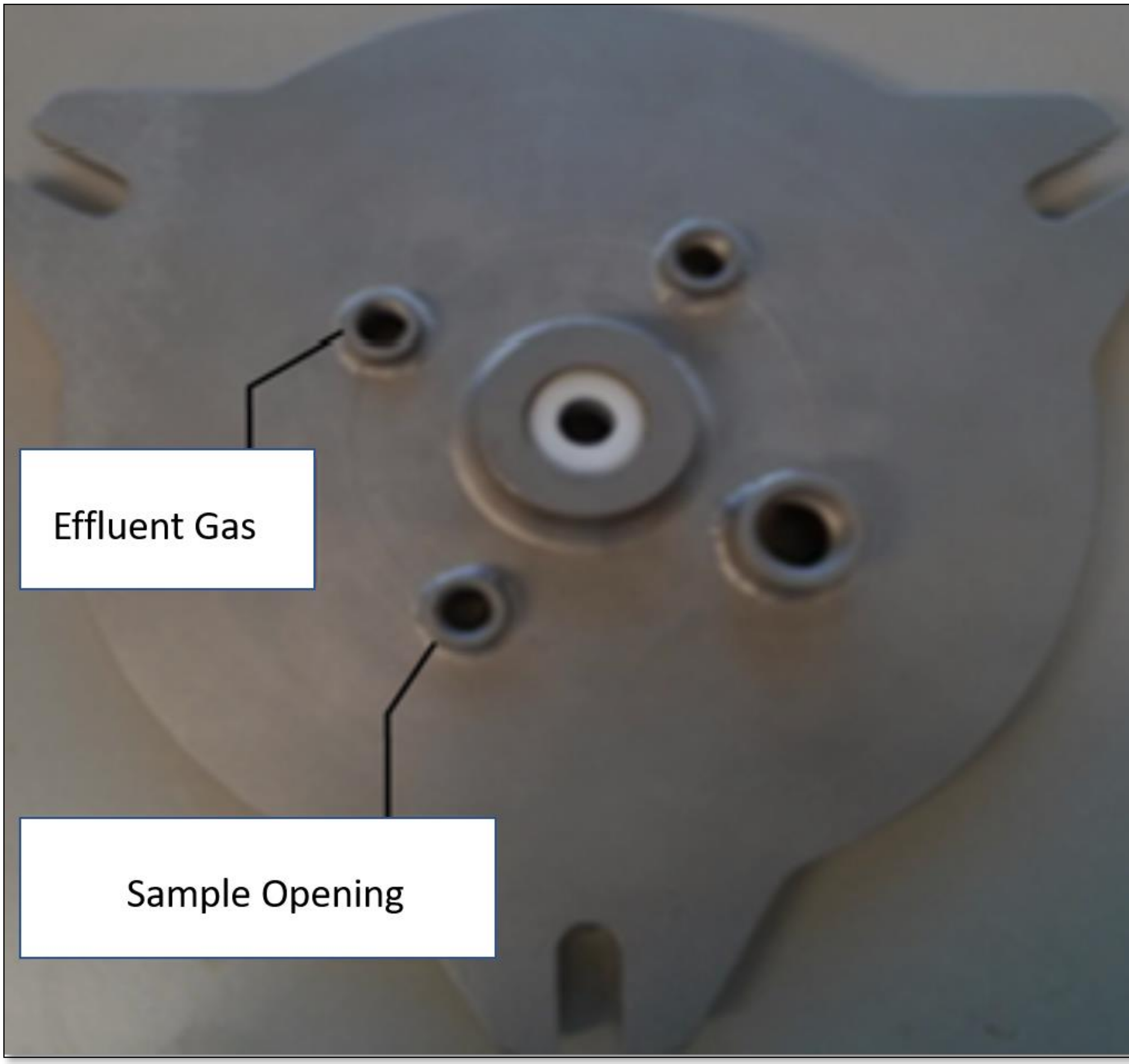

***Figure 2*: The Effluent Gas and Sample Opening holes on an Anaerobic Reactor**

2.2 Collecting Samples from the Reactor

This section describes how to collect samples from the reactor and test the pH of the reactor. These procedures should be followed every Monday, Wednesday, and Friday. These processes should be completed while wearing a **lab coat, gloves, and a mask**.

Preform the following steps:

1. Collecting Gas Phase Samples
2. Collecting Liquid and Solid Samples
3. Testing the pH

Procedure 1: Collecting Gas Phase Samples

This procedure describes how to properly collect gas phase samples. Gas phase samples should be collected to analyze the composition of biogas via gas chromatography. Exercise caution when collecting gas phase samples to not introduce oxygen into the reactor or damage the collection needle.

1. Collect the long thin needle located next to the gas chromatograph
2. Locate the septum on the reactor

Note: *Do Not* Poke the Bag or Tube with A Needle, It Will Cause A Leak

3. Slide the needle into the septum and gently pull the plunger to collect a gas phase sample
4. Transfer the gas sample into the gas chromatograph unit immediately
5. Wait for the results in the gas chromatograph unit to appear
6. Return the needle to the container next to the gas chromatograph

Procedure 2: Collecting Liquid and Solid Samples

This procedure describes how to collect liquid and solid samples from the reactor. Liquid and solid samples are necessary for testing the pH of the reactor, analyzing for moisture content, and preparing samples for analysis. Always wear a **lab coat, gloves, and mask** when collecting these samples.

1. Find a plastic beaker and use a marker to indicate the volume you intend to collect from the reactor
2. Open the reactor by unscrewing one of the cap on the top
3. Put the beaker into a bin and keep it close to the reactor
4. Use a long-nosed syringe to collect samples from the reactor and deposit them into the marked beaker
5. Shake the beaker regularly to make sure there are no air bubbles present in the sample
6. Put the sample under the fume hood once you have the desired quantity
7. Seal the reactor and begin to wipe down the area with a paper towel immediately
8. Wash the beaker, bin, long-nosed syringe, and any other tool you used to collect a sample

Procedure 3: Testing the pH

This procedure describes how to test the pH of an anaerobic digestion reactor. This task should be done after obtaining a liquid and solid sample from the reactor (refer to Procedure 2 in Section 2.2). The pH is an important test to make sure the environment in the reactor is optimal for producing methane. This procedure should be completed wearing **a lab coat, mask, and gloves.**

STORING SAMPLES

GAS SAMPLES SHOULD NOT BE STORED, THEY SHOULD IMMIEDIATELY BE RELEASED INTO THE GAS CHROMATOGRAPH OR THE ATMOSPHERE.

LIQUID AND SOLID SAMPLES SHOULD BE TRANSFERRED INTO A FALCON TUBE AND FROZEN UNTIL THEY ARE READY FOR ANALYSIS

Gather the following:

- 50 mL plastic beaker
- 50 mL glass beaker
- Pipette
- Squirt Bottle with Deionized Water
- pH meter

Note: The pH probe should *always* be submersed in liquid

1. Put the probe into the sample from the reactor and **r**ead the results

Only follow the remaining steps if the pH of the sample is higher or lower than the desired value

2. Transfer a known volume of the sample into the plastic beaker
3. Fill the glass beaker with NaOH solution (to raise the pH) or H2SO4 solution (to lower the pH)
4. Add and count drops of the solution into the sample
5. Gently mix the beaker to make sure the solution is incorporated
6. Put the probe into the adjusted sample and read the results
7. Rinse the probe with deionized water
8. Repeat steps 5-10 until you read the desired results
9. Calculate and add the proportion of solution needed to correct the entire reactor

Chapter 3: Analysis

This chapter reviews methods for keeping up with the analysis of an anaerobic digestion reactor. These procedures should be completed daily, throughout the lifetime of the reactor. This chapter includes the necessary steps to successfully record data associate with an anaerobic digestion reactor.
This process includes:

1. Keeping Records of Data
2. Displaying Data Graphically

3.1 Keeping Records of Data

This section details how to keep records of the data associated with an anaerobic reactor. Data associated with an anaerobic digestion reactor includes moisture content, biogas volume & composition, and the results of chemical oxygen demand (COD) ammonia, and alkalinity testing. A notebook and an excel sheet should be used to keep track of data. The notebook should be updated regularly and kept clean and dry. Preform the following steps:

1. On the first page of the notebook, draw a diagram of the reactor and include the total volume, percent of headspace for gas, and the weights of the components of the feed
2. On the second page of the notebook, record the daily pH of the reactor. Leave space for the data, sample identification, pH, and temperature.
3. On the third page, record the data associated with the solid analyzes of the reactor by saving space for the date, sample identification, P0, P1, P2, and P3.
4. On the fourth page, record the data from the COD testing by saving space for the date, sample label, absorption, and COD results.
5. On the fifth page, record the data from the ammonia testing by saving space for the date, sample identification, initial pH, number of drops, final pH, and volume of sulfuric acid.
6. On the sixth page, record the data from the volume of biogas by saving space for the data, description of the sample (reactor or collection bag), and volume collected.
7. On the seventh page, record the data associated with alkalinity testing by saving space for the date, sample identification, initial pH, volume used, and the final pH.
8. On the eighth page, reserve space for the biogas composition data by creating columns for the data, H_2, CH_4, CO_2, and O_2 data.

Appendix C: English Standard Operating Procedure

Each of the different types of analysis reveal important information about the anaerobic reactor.

Method	*Purpose*
Total Solids	Measure the moisture content in the reactor
Volatile Solids	Measure the amount of biodegradable organic matter in the reactor
Alkalinity	Measures the basicity and buffering capacity of the digestate
Chemical Oxygen Demand	Measures the potential of the microorganisms to convert organic material into methane
Ammoniacal Nitrogen	Measures the amount of ammoniacal nitrogen present in the reactor environment

Appendix D: Portuguese Standard Operating Procedure

Procedimento Operacional Padrão para Uso, Gerenciamento e Análise de Reatores Anaeróbicos de Digestão

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Sumário

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Visão Geral do Documento

Objetivo deste Guia	O procedimento operacional padrão para uso, gerenciamento e análise de reatores anaeróbicos de digestão fornece informações de referência relacionadas à digestão anaeróbica no laboratório BIOTAR. Este guia descreve o processo de construção, manutenção e estudo da digestão anaeróbica.
Audiência	Este guia foi desenvolvido para pesquisadores iniciantes e experientes.
Suposição	Este documento supõe que você é um pesquisador atual no laboratório BIOTAR. Este guia também pressupõe que você tenha um conhecimento fundamental da digestão anaeróbica.
Convenções do Texto	Este guia usa os convenções seguintes: • **Negrito e sublinhado** indica informações importantes sobre segurança Sempre use luvas ao trabalhar no laboratório. • *Italico* indica palavras novo ou importantes *Sempre* lava a louça depois de trabalhar no laboratório.
Documentação Relacionada	Consulte os Métodos analíticos e as listas de solventes e reagentes no laboratório de tratamento biológico de resíduos e água para ajudá-lo em sua pesquisa.
Obtendo Suporte	Entre em contato com a professora Tania Forester-Carneiro se tiver algumas perguntas. Quando voce precisa assistência emergência, por favor telefona 1-6000 por vigilância do campus.

Capítulo 1: Preparação

Este capítulo analisa a configuração inicial de um reator de digestão anaeróbico. Essa configuração precisa ser concluída apenas uma vez, no início do experimento. Este capítulo inclui as etapas necessárias para instalar com sucesso um reator para digestão anaeróbica.

Esse processo inclui:
1. Preparando o Digestado

2. Montagem do reator

3. Limpando a área de trabalho

1.1 Preparando o Digestado

Esta seção detalha como preparar o conteúdo do reator. O digerido é feito de água, material orgânico e inóculo. O inóculo abriga os microorganismos que sofrerão digestão anaeróbica do material orgânico. O inóculo no laboratório é proveniente da empresa AmBev Brewing e não é partenogênico.

O digerido deve ser preparado sob o **exaustor**, usando **jaleco, máscara respiratória e luvas**. Execute as seguintes etapas:

Pré-requisito:

- 3 copos médios
- 1 copo grande de plástico
- Pote de inóculo da incubadora
- Material de ração orgânica (por exemplo, cascas de laranja, bagaço de cevada)

1. Calcule as proporções corretas para o seu reator, que podem ser visualizadas na Página 5 na Figura 1

2. Consulte o professor Tania para garantir que suas proporções estejam corretas

3. Misture a água e o inóculo no copo plástico grande até que estejam bem integrados

4. Divida o material orgânico em três a cinco lotes menores

5. Misture cada porção do material orgânico no inóculo e mistura de água, uma de cada vez

NOTA: TODO O MATERIAL ORGÂNICO PODE NÃO INTEGRA-SE NA MISTURA, MANTENHA-O LONGE E ESPERE ATÉ O DIGESTATE SE TORNAR LÍQUIDO PARA COMBINAR TODAS AS PEÇAS

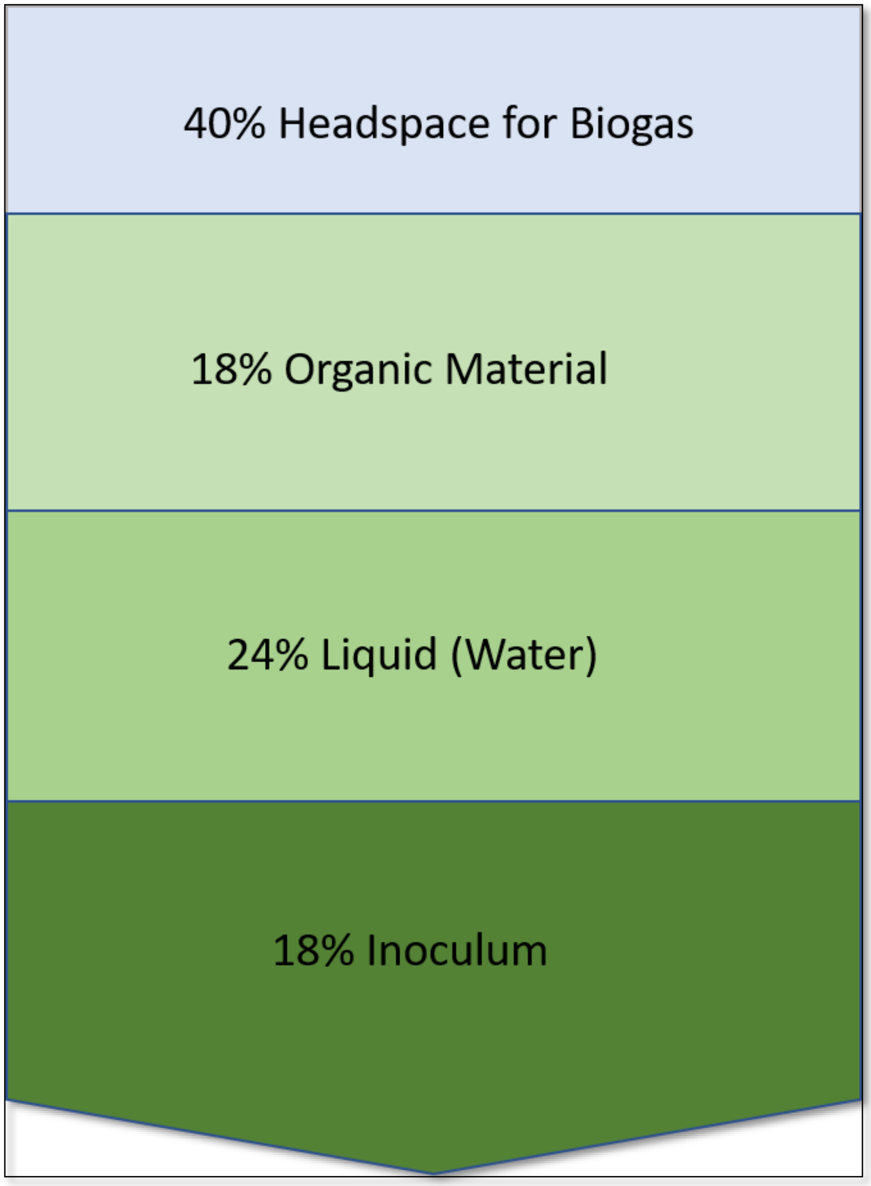

***Figure 1*: Typical Proportions of Materials in an Anaerobic Reactor**

1.2 Montagem do vaso do reator

Esta seção detalha como montar a unidade do reator. A unidade do reator é composta pelo reator, sistema de refrigeração e saco de coleta. A unidade do reator deve ser montada adequadamente para conduzir com êxito a digestão anaeróbica. A unidade do reator deve ser montada usando **um jaleco e luvas**. Execute as seguintes etapas:

1. Meca o volume do reator
2. Construa a unidade do reator

Procedimento 1: Medir o volume do reator

Este procedimento descreve como medir o volume do reator, se for desconhecido. O volume do reator é essencial para calcular as proporções corretas para os componentes do digerido.

Pré-requisito:

- 1 copo médio

1. Encha o copo com um volume conhecido de água
2. Dispensar água no reator
3. Registrar o volume de água dispensado no reator
4. Repita as etapas 1 a 4 até o reator estar cheio
5. Soma os volumes de água registrados para obter o volume total do reator
6. Esvazie a água do reator
7. Use uma toalha de papel ou pano para secar o reator

Procedimento 2: Construindo a unidade do reator

Este procedimento descreve como construir a unidade do reator.

1. Remova qualquer poeira ou partículas das superfícies interna e externa do reator com um pano
2. Conecte a entrada e saia dos tubos de água de resfriamento ao redor do reator
3. Cole um saco coletor de mylar no aparelho do reator
4. Prenda um tubo de plástico na abertura da bolsa coletora
5. Marque o ponto de fechamento do botão desenhando um ponto na bolsa com um marcador
6. Conecte uma junta em T ao tubo de plástico na extremidade da bolsa
7. Use tubos de plástico para conectar uma extremidade da junta T ao reator
8. Coloque um septo na extremidade aberta da articulação T

NOTA: O SEPTO DEVE SER SEGURO E FACILMENTE ACESSÍVEL

1.3 Limpando a área de Trabalho

Esta seção descreve como limpar adequadamente os instrumentos e provetas usados na montagem e gerenciamento de um reator de digestão anaeróbico. A higienização adequada do equipamento é essencial para garantir que não haja contaminação cruzada entre os experimentos. Execute as seguintes etapas:

1. Lavar Louça
2. Descontaminar instrumentos usados com inóculo
3. Lavar a escrita dos copos
4. Descarte de materiais perigosos

O VIDRO QUEBRADO DEVE SER COLOCADO NA GRANDE BANDEJA BRANCA DA PRATELEIRA, À DIREITA DA PIA.

Procedimento 1: lavar pratos

Este procedimento descreve como limpar copos, colheres e implementos em laboratório. Este procedimento descreve as etapas básicas que você deve executar para limpar o que você usa.

1. Jogue qualquer material sólido no lixo antes de lavar
2. Coloque a louça na pia
3. Enxágüe com água
4. Esfregue com uma esponja ou pincel para se livrar de qualquer resíduo
5. Coloque em um dos racks de secagem ao lado da pia

Procedimento 2: Contaminado com inóculo

Este procedimento descreve como limpar corretamente os copos, colheres e instrumentos usados com o inóculo. O inóculo deve ser limpo adequadamente para evitar contaminação e riscos à saúde. Você deve concluir as etapas em Lavar pratos (Geral) antes de passar para esta seção.

1. Siga as etapas de 1 a 4 em Lavar pratos (Geral)
2. Enxágüe com álcool de uma garrafa de esguicho
3. Lave com água novamente para remover os resíduos restantes
4. Coloque o copo em uma das prateleiras de secagem ao lado da pia
5. Enxágue a pia, o balcão e a área circundante com álcool

Procedimento 3: Com a escrita

Este procedimento descreve como lavar a louça com a inscrição neles. Se você escrever em seus copos para rotulá-los como seus, lave a escrita antes de colocá-los para secar.

1. Siga as etapas de 1 a 4 em Lavar pratos (Geral)
2. Lave a parte externa do copo com álcool de uma garrafa de esguicho até que a escrita desapareça
3. Coloque em um dos racks de secagem ao lado da pia

Appendix D: Portuguese Standard Operating Procedure

Procedimento 4: Material Perigoso (Teste DQO)

Este procedimento descreve como limpar itens usados com materiais perigosos, como os tubos de teste usados nos testes de DQO. É importante não lavar materiais perigosos na pia.

Pré-requisito:

- Recipiente de resíduos COD
- Misturador Vortex
- Squirt Bottle com Água Deionizada

Nota: Pode ser necessário usar um adaptador ou um cabo de extensão para conectar o mixer de vórtice

1. Abra o tubo de ensaio e despeje o conteúdo no recipiente de COD
2. Coloque alguns mililitros de água deionizada no tubo de ensaio
3. Tampe e coloque o tubo de teste no vórtice
4. Segure o tubo de teste no vórtice por aproximadamente 15 segundos
5. Despeje o conteúdo do tubo de ensaio no recipiente de resíduos de COD
6. Repita as etapas 4-7
7. Coloque o tubo de teste sem tampa em um rack de tubo de teste de cabeça para baixo
8. Coloque o suporte para tubos de ensaio no forno a 105 °C

Capítulo 2: Gestão do Reator

Este capítulo inclui os procedimentos necessários para o gerenciamento do reator. Os procedimentos deste capítulo devem ser concluídos toda segunda, quarta e sexta-feira. Este capítulo inclui instruções para gerenciar adequadamente seu reator. Esse processo inclui:

1. Alimentação Continuamente do Reator
2. Coletando Amostras do Reator

2.1 Alimentação Continuamente do Reator

Esta seção descreve como alimentar o reator; a seção refere-se apenas a experimentos em que o reator deve ser alimentado continuamente. Se o reator exigir uma alimentação, anote o volume exato.
O reator deve ser alimentado após a medição da composição do biogás, volume de biogás e amostras diárias. Este procedimento deve ser concluído enquanto estiver usando uma **máscara, luvas e um jaleco**. Execute as seguintes etapas:

1. Abra o reator
2. Coloque e prenda um funil na abertura do reator

Nota: Peça ajuda se necessário

3. Despeje *lentamente* o alimento no funil
4. Raspe as laterais do funil com uma colher para ajudá-lo a entrar no reator
5. Continue a derramar e raspar até que a alimentação esteja concluída
6. Raspe o funil com uma colher para obter excesso de alimentação no reator
7. Remova o funil e reserve para limpeza
8. Feche *imediatamente* o reator para impedir a entrada de ar

2.2 Coletando Amostras do Reator

Esta seção descreve como coletar amostras do reator e testar o pH do reator. Esses procedimentos devem ser seguidos toda segunda, quarta e sexta-feira. Esses processos devem ser concluídos com um **jaleco, luvas e uma máscara.**

Faça as seguintes etapas:

1. Coleta de Amostras de Fase Gasosa
2. Coleta de Amostras de Fases Sólidos e Líquidos
3. Teste do pH

Procedimento 1: Coleta de Amostras de Fase Gasosa

Este procedimento descreve como coletar adequadamente amostras de fase gasosa. Amostras de fase gasosa devem ser coletadas para analisar a composição do biogás via cromatografia gasosa. Tenha cuidado ao coletar amostras da fase gasosa para não introduzir oxigênio no reator ou danificar a agulha de coleta.

1. Colete a agulha fina e longa localizada ao lado do cromatógrafo a gás
2. Localize o septo no reator

Nota: *Não quebre* o saco ou o tubo com uma agulha, pois isso causará um vazamento

1. Deslize a agulha no septo e puxe com cuidado o êmbolo para coletar uma amostra da fase gasosa
2. Transfira imediatamente a amostra de gás para a unidade de cromatografia em fase gasosa

Procedimento 2: Coleta de Amostras de Fases Sólidos e Líquidos

Este procedimento descreve como coletar amostras líquidas e sólidas do reator. Amostras líquidas e sólidas são necessárias para testar o pH do reator, analisar o teor de umidade e preparar amostras para análise. Sempre **use jaleco, luvas e máscara** ao coletar essas amostras.

1. Encontre um copo de plástico e use um marcador para indicar o volume que você pretende coletar do reator
2. Abra o reator desaparafusando uma das tampas na parte superior
3. Coloque o copo em uma lixeira e mantenha-o próximo ao reator
4. Use uma seringa de nariz comprido para coletar amostras do reator e depositá-las no copo mercado
5. Agite o copo regularmente para garantir que não haja bolhas de ar na amostra
6. Coloque a amostra sob o exaustor assim que tiver a quantidade desejada
7. Sele o reator e comece a limpar a área com uma toalha de papel imediatamente
8. Lave o copo, a lixeira, a seringa de nariz comprido e qualquer outra ferramenta usada para coletar uma amostra

Procedure 3: Teste do pH

Este procedimento descreve como testar o pH de um reator de digestão anaeróbica. O pH é um teste importante para garantir que o ambiente no reator seja ideal para a produção de metano. Este procedimento deve ser concluído com **jaleco, máscara e luvas**.

GUARDANDO AMOSTRAS
AMOSTRAS DE GAS NAO DEVEM SER ARMEZANDAS, DEVEM SER IMEDIATAMENTO LIBERADO NO CHROMATÓGROFIA A GÁS OU NA ATMOSFERA.
AS AMOSTRAS SÓLIDIO OU LÍQUIDO DEVEM TRANSFERIR NO TUBO DE FALCÃO E CONGELADO ATÉ ESTAJAM PRONTOS PARA ANÁLISE.

1. Obtenha uma amostra líquida e sólida do reator, seguindo o procedimento 2 da seção 2.2
2. Reúna um copo pequeno de 50 ml de plástico, um copo de 50 ml de vidro, uma pipeta e uma garrafa de água deionizada.
3. Ligue o medidor de pH e verifique se ele está na configuração "Measure"

Nota: A sonda de pH deve sempre ser submersa em líquido

4. Coloque a sonda na amostra do reator e leia os resultados

Siga as etapas restantes apenas se o pH da amostra for maior ou menor que o valor desejado

5. Transfira um volume conhecido da amostra para o copo de plástico
6. Encha o copo de vidro com solução de NaOH (para aumentar o pH) ou solução de H_2SO_4 (para diminuir o pH)
7. Adicione e conte gotas da solução na amostra
8. Misture delicadamente o copo para garantir que a solução esteja incorporada
9. Coloque a sonda na amostra ajustada e leia os resultados
10. Lave a sonda com água deionizada
11. Repita as etapas 5 a 10 até ler os resultados desejados
12. Calcule e adicione a proporção de solução necessária para corrigir todo o reator

Capítulo 3: Análise

Este capítulo analisa métodos para acompanhar a análise de um reator de digestão anaeróbica. Esses procedimentos devem ser concluídos diariamente, durante toda a vida útil do reator. Este capítulo inclui as etapas necessárias para registrar com êxito os dados associados a um reator de digestão anaeróbico.

Esse processo inclui:

1. Mantendo registros de dados
2. Exibindo dados graficamente

3.1 Mantendo registros de dados

Esta seção detalha como manter registros dos dados associados a um reator anaeróbico. Os dados associados a um reator de digestão anaeróbia incluem o teor de umidade, o volume e a composição do biogás e os resultados da demanda de oxigênio químico (DQO), amônia e testes de alcalinidade. Um caderno e uma planilha do Excel devem ser usados para acompanhar os dados. O notebook deve ser atualizado regularmente e mantido limpo e seco. Execute as seguintes etapas:

1. Na primeira página do notebook, desenhe um diagrama do reator e inclua o volume total, a porcentagem de espaço livre no gás e os pesos dos componentes da alimentação.

2. Na segunda página do notebook, registre o pH diário do reator. Deixe espaço para os dados, identificação da amostra, pH e temperatura.

3. Na terceira página, registre os dados associados às análises sólidas do reator, economizando espaço para a data, identificação da amostra, P0, P1, P2 e P3.

4. Na quarta página, registre os dados do teste de COD economizando espaço para os resultados de data, rótulo da amostra, absorção e COD.

5. Na quinta página, registre os dados do teste de amônia economizando espaço para a data, identificação da amostra, pH inicial, número de gotas, pH final e volume de ácido sulfúrico.

6. Na sexta página, registre os dados do volume de biogás economizando espaço para os dados, descrição da amostra (reator ou bolsa coletora) e volume coletado.

7. Na sétima página, registre os dados associados ao teste de alcalinidade economizando espaço para a data, identificação da amostra, pH inicial, volume usado e pH final.

8. Na oitava página, reserve espaço para os dados de composição do biogás criando colunas para os dados, H_2, CH_4, CO_2 e O_2

Appendix D: Portuguese Standard Operating Procedure

Cada um dos diferentes tipos de análise revela informações importantes sobre o reator anaeróbico.

Método	*Objetivo*
Sólidos totais	Meça o teor de umidade no reator
Sólidos Voláteis	Meça a quantidade de matéria orgânica biodegradável no reator
Alcalinidade	Mede a basicidade e capacidade de tamponamento do digerido
Demanda de Oxigênio Químico	Mede o potencial dos microrganismos para converter material orgânico em metano
Nitrogênio Amoniacal	Mede a quantidade de nitrogênio amoniacal presente no ambiente do reator

Appendix E: Google Translate Sample

Capítulo 2: Gerenciamento de reatores Este capítulo inclui os procedimentos necessários para o gerenciamento do reator. Os procedimentos neste capítulo devem ser realizados toda segunda, quarta e sexta-feira. Este capítulo inclui instruções para gerenciar adequadamente seu reator. Esse processo inclui: 1. Alimentando continuamente o reator 2. Coleta de amostras do reator 2.1 Alimentação contínua do reator Esta seção descreve como alimentar o reator; a seção refere-se apenas a experimentos em que o reator deve ser alimentado continuamente. Se o reator precisar de alimentação, o volume exato deve ser observado. O reator deve ser alimentado após a medição da composição do biogás, volume de biogás e amostras diárias. Este procedimento deve ser concluído enquanto estiver usando uma máscara, luvas e um jaleco. Execute as seguintes etapas: 1. Abra o reator (veja a Figura 2 na página 10) 2. Coloque e prenda um funil na abertura do reator Nota: Peça ajuda se for necessário outro par de mãos 3. Despeje lentamente o feed no funil 4. Raspe as laterais do funil com uma colher para ajudá-lo a entrar no reator 5. Continue a derramar e raspar até que a alimentação seja usada 6. Raspe o funil com uma colher para obter excesso de alimentação no reator 7. Remova o funil e reserve para limpeza 8. Feche imediatamente o reator para impedir a entrada de ar   Figura 2: Os orifícios do gás efluente e da abertura da amostra em um reator anaeróbico2.2 Coletando amostras do reator

Esta seção descreve como coletar amostras do reator e testar o pH do reator. Esses procedimentos devem ser seguidos toda segunda, quarta e sexta-feira. Esses processos devem ser concluídos com um jaleco, luvas e uma máscara.

Execute as seguintes etapas:1. Coleta de amostras de fase gasosa2. Coleta de amostras líquidas e sólidas3. Testando o pHProcedimento 1: Coletando amostras da fase gasosa

Este procedimento descreve como coletar adequadamente amostras de fase gasosa. Amostras de fase gasosa devem ser coletadas para analisar a composição do biogás via cromatografia gasosa. Tenha cuidado ao coletar amostras da fase gasosa para não introduzir oxigênio no reator ou danificar a agulha de coleta.

1. Colete a agulha fina e longa localizada ao lado do cromatógrafo a gás2. Localize o septo no reator

Nota: Não puxe o saco ou o tubo com uma agulha, pois isso causará um vazamento

3. Deslize a agulha no septo e puxe com cuidado o êmbolo para coletar uma amostra da fase gasosa

4. Transfira imediatamente a amostra de gás para a unidade de cromatografia em fase gasosa5. Aguarde os resultados na unidade de cromatógrafo a gás aparecerem6. Coloque a agulha no recipiente próximo ao cromatógrafo a gás

Procedimento 2: Coletando amostras líquidas e sólidasEste procedimento descreve como coletar amostras líquidas e sólidas do reator. Amostras líquidas e sólidas são necessárias para testar o pH do reator, analisar o teor de umidade e preparar amostras para análise. Sempre use jaleco, luvas e máscara ao coletar essas amostras.

Appendix E: Google Translate Sample

1. Encontre um copo de plástico e use um marcador para indicar o volume que você pretende coletar do reator2. Abra o reator desaparafusando uma das tampas na parte superior

3. Coloque o copo em uma lixeira e mantenha-o próximo ao reator

4. Use uma seringa de nariz comprido para coletar amostras do reator e depositá-las no copo marcado

5. Agite o copo regularmente para garantir que não haja bolhas de ar na amostra

6. Coloque a amostra sob o exaustor assim que tiver a quantidade desejada

7. Sele o reator e comece a limpar a área com uma toalha de papel imediatamente

8. Lave o copo, a lixeira, a seringa de nariz comprido e qualquer outra ferramenta usada para coletar uma amostraProcedimento 3: Testando o pHEste procedimento descreve como testar o pH de um reator de digestão anaeróbica. Esta tarefa deve ser realizada após a obtenção de uma amostra líquida e sólida do reator (consulte o Procedimento 2 na Seção 2.2). O pH é um teste importante para garantir que o ambiente no reator seja ideal para a produção de metano. Este procedimento deve ser concluído com jaleco, máscara e luvas.Reúna o seguinte:o copo de 50 mL de plásticoo copo de vidro de 50 mLo Pipetao Squirt Bottle com Água Deionizadao medidor de pHNota: A sonda de pH deve sempre ser submersa em líquido

1. Coloque a sonda na amostra do reator e leia os resultadosSiga as etapas restantes apenas se o pH da amostra for maior ou menor que o valor desejado2. Transfira um volume conhecido da amostra para o copo de plástico3. Encha o copo de vidro com solução de NaOH (para aumentar o pH) ou solução de H2SO4 (para diminuir o pH)

4. Adicione e conte gotas da solução na amostra

5. Misture delicadamente o copo para garantir que a solução esteja incorporada

6. Coloque a sonda na amostra ajustada e leia os resultados7. Lave a sonda com água deionizada

8. Repita as etapas 5 a 10 até ler os resultados desejados9. Calcule e adicione a proporção de solução necessária para corrigir todo o reator