Term Project Assignment

Introduction

Process engineers are often called upon to optimize plant performance by adjusting operating parameters or by using new equipment, reagents, or flowsheet configurations. These optimization studies can be of substantial value to companies as even small plant improvements, such as a 0.5% gain in recovery, can lead to millions of dollars of increased revenue each year. Process engineers who can identify and implement these changes are often quickly promoted and well-compensated.

Since full-scale plant trials are laborious and costly, most new technologies are first validated in the laboratory using proof-of-concept tests. While standard testing procedures and analytical methods are often applied, most testing campaigns must be carefully designed to evaluate variables of interest. Considerable care must be observed during the sampling, sample preparation, and analytical phases so that small changes in performance can be detected. Pending successful results, these tests may then be expanded to larger pilot programs or full-scale plant trials. In any case, the knowledge gained from the laboratory test is often used to guide and direct larger scale studies.

In this assignment, you will be provided two project scenarios. Working with your laboratory group, you will select one project to complete. Your deliverables for this project will include (1) an initial proposal and (2) a final project report. While you are encouraged to work with your group during the testing and data analysis phases, the deliverables must all be written/prepared/created and submitted individually.

Please note: these projects represent real problems that have been supplied by an industrial colleague. Some details have been omitted to protect confidentiality; however, your results may support future research and development in these areas.

Scope of Work

This project will be completed in three phases: (1) test planning/preparation; (2) laboratory test work and data collection; (3) data analysis and reporting. Each is described in further detail below.

Phase 1: Test Planning and Preparation

In the first stage, you will work with your lab group members to select the project that you find most interesting. You will carefully review the project requirements, identify and articulate concise project objectives, and develop an experimental plan to achieve those objectives. In this phase, you should perform all preliminary calculations needed to maximize your efficiency in the laboratory phase. To this end, you should consider dilution (i.e. percent solids) calculations, reagent dosing calculations, sampling and splitting protocols, and any assay requirements. You should also prepare a tentative schedule for completing all work elements so your time can be carefully managed during the project period.

As in any open-ended engineering problem, you may not be given sufficient information to answer every question you may have. For example, you may not know the true density of the solid material and thus may not be able to solve the slurry calculations. In these cases, you are encouraged to consult the instructor or make a well-reasoned assumption supported by external evidence (e.g. … the sample is mostly silica, so a material SG of 2.65 is suitable …).

After completing the test preparation work, you will prepare <u>a project proposal/bid</u> that carefully describes approach to completing the work to be submitted by each individual student. This project proposal will be graded for both technical accuracy as well as written quality. A detailed outline/report guide is provided in an accompanying document. In summary, the project proposal needs to address why the work is important, what steps are needed to complete the work, and what resources (i.e. time, supplies and equipment) are required. It should be written as if a contractor with laboratory, but not necessarily mineral processing, expertise is carrying out the tasks.

Deliverable: Project Experimental Proposal Report
Due: 3/29 (Mon), 3/30 (Tues), 3/31 (Wed)
Submission: Canvas website, one per individual

Phase 2: Data Analysis and Reporting

After submitting your proposal document, the course instructor will review these documents and provide feedback. After receiving the technical feedback (**anticipated no later than April 14, 2021**), you may begin data analysis. Feedback on the written quality will also be provided at this time and will include provisions for mandatory or voluntary writing conferences, depending on the performance. Both technical and written feedback should be incorporated into the final project report.

Using the data obtained from the contractor, you will summarize your findings in a final technical report to be submitted by each individual student. A detailed outline/report guide for the project proposal is provided in an accompanying document. In summary, this report will follow the typical outline of a laboratory report, which will include an executive summary, introduction, methods, results & discussion, and recommendations section. This report should be of sufficient quality and technical merit so that it could be presented to a supervisor or client. You should carefully consider your conclusions and the best way to present the data to lead the reader to those conclusions.

Some of the material for this report, particularly the introduction and the methods section may be repurposed from the proposal document that was submitted earlier in the semester. In any case, given the short turn around between obtaining the contractor's report and the final project submission, you are encouraged to start early on your report writing to ensure that your final product is sufficiently polished and refined.

Deliverable: Final Project Report
Due: May 7 2021
Submission: Canvas website, one per individual

Summarized Deadlines

Date	Item
2/29, 2/23, 2/24	Final project Assigned
TBA	Writing Workshop (in class)
3/29, 3/30, 3/31	Experimental Proposal Due
4/14/2021	Proposal Feedback Returned
4/5 - 4/28	Mandatory and Voluntary Writing Conferences
5/7/2019	Final Project Report Due

Grading Summary

Item	Fraction of Course Grade
Project Proposal	10%
Final Project Report	30%

Notes: *Both assignments will be weighted 70% technical grade, 30% writing grade.*

Detailed rubrics are provided with the respective writing guides.

Other Notes

1. The health and safety of all laboratory personnel must be held paramount at all times. Please observe all safety notices and protocols during testing.

2. The goal of this assignment is to synthesize many of the fundamental concepts you have learned throughout the term. With that intention, some of the project objectives may require some further reading and independent research. In any case, you are **STRONGLY ENCOURAGED** to work with the course instructors to develop your testing plan and experimental approach.

3. The industrial representative is open to further dialogue concerning the objectives and goals of these projects. Further communication between your group and this representative may be coordinated with the course instructor.

4. **Testable Hypothesis:** If you use the rubrics to write and contact Scott with your data analysis questions and Angelo with your writing questions; then you will get a good grade.

Project #1: Frother Comparison

Background

A copper concentrator has been told that a novel frother formulation, denoted Frother U, will improve flotation performance relative to their current reagent, Frother X. Froth U is believed to increase froth stability, which can improve the recovery of ore particles. They would like to validate this claim and quantify any performance gains with respect to copper recovery, copper grade, and separation efficiency. The final results should indicate if the frother has promise and if it should be recommended for full-scale trials.

Materials

You will be provided a dry sample of rougher flotation feed from the operating plant. You will not need to crush or grind the sample, but you will need to split the sample into representative lots suitable for testing. You will also be provided all reagents needed for testing, including Frother X, Frother U, collector, and pH modifiers.

Test Work

You may use the standard flotation test protocol described in Lab #5 to determine fixed operational parameters, such as conditioning time, flotation time, collector dosage, pH, etc. The two variable parameters that you will want to test in your experiments include frother type (Frother X vs. Frother U) and frother dosage (you should test each frother at three dosages). In total, you will need to run six flotation tests. After flotation, you will need to filter and dry the samples. Once dry, you can use the XRF to determine the copper assay.

Results and Analysis

You may use the procedures described in Lab #5 to determine grade, recovery, and separation efficiency for each test condition. From this data, you can determine the optimal dosage for each frother and determine which frother is superior. In addition to these quantitative results, you are encouraged to provide qualitative results from the observations made during the tests. Frother tests in particular rely very heavily on the visual observations of the flotation operator. Items such as froth color, froth texture, froth stability, and froth flowability are difficult to quantify but have considerable influence on the scalability of the results. You may want to include several pictures in your results section if they provide useful visuals.

Project #2: Kyanite Purity Improvements

Background

Kyanite (Al_2SiO_5) is an aluminum-rich silicate often used in specialized ceramic products and electrical insulators. Kyanite is separated from other host rock materials, such as silica, using flotation with fatty acid collectors. Unfortunately, these collectors also recover iron, which is a common nuisance contaminant in the kyanite product. One approach to reduce iron contamination and improve overall flotation performance is to perform attrition scrubbing and screening prior to flotation. The kyanite producer would like to determine the influence of attrition scrubbing on flotation performance (i.e. kyanite recovery and iron rejection) and also determine the optimal fatty acid collector dose.

Materials

You will be provided either a dry or a wet sample of rougher flotation feed from the operating plant. You will not need to crush or grind the sample, but for dry samples, you may need to split the sample into representative lots suitable for testing. If a wet sample is provided, the laboratory instructor will provide you a representative split along with the wet weight and percent solids data. You will be provided all reagents needed for testing, primarily including the fatty acid collector.

Test Work

Kyanite requires a unique flotation protocol unlike the one performed in Lab #5. Prior to the flotation, the material should be conditioned with fatty acid (dosed between 0.5 and 1.5 lb / ton) at a high percent solids (>50%). After conditioning for 4 minutes, the solution is diluted to the standard flotation conditions (~20%) and floated to exhaustion. No frother is needed, since fatty acid will form its own froth, and a natural pH is preferred. Only a single stage of flotation is required.

The two variable parameters that you will want to test in your experiments include the fatty acid dose and the addition of an attrition scrubbing stage in the process. Attrition scrubbing is performed by mixing the feed slurry at a high percent solids in a high-shear mixing device. The slurry is then wet screened at 325 mesh. The laboratory instructor will explain these tasks in greater detail during the exercise. The fine iron oxides that are released in the scrubbing stage will pass through the screen, while the screen overflow can be processed using the flotation procedure described above. The fatty acid collector should be evaluated with at least three dosages varying between 0.5 to 1.5 lb / ton, and the same dosages should be evaluated in both test series (i.e. with and without attrition scrubbing).

In total, you will need to run six flotation tests: three with attrition scrubbing and three without. After flotation, you will need to filter and dry all product samples, including the flotation concentrate, flotation tailings, and screen underflow. Once dry, you can use the XRF to determine the aluminum and iron assay.

Results and Analysis

You may use the procedures described in Lab #5 to determine grade, recovery, and rejection for each test condition. For these tests, you are particularly interested in Al (i.e. kyanite) recovery and Fe rejection. From this data, you can determine if the attrition scrubbing process is improving the product purity and the optimal reagent dose in both conditions. In addition to these quantitative results, you are encouraged to provide qualitative feedback that was observed during the tests.