CEE 311: Environmental Engineering I Laboratory

SUBMISSION OF LABORATORY REPORTS

The experimental results of a laboratory study should be compiled as soon as possible after the laboratory work is completed, possibly for reproduction and subsequent distribution to all members of the group. Final laboratory reports are due one week following the completion of the experiment. The report should not be unnecessarily long but should contain the following elements.

Letter of Transmittal: This should be addressed to the instructor and briefly state what was measured, how and what the results indicate.

Abstract: Most technical journals require abstracts, which summarize the content of a paper in one or two paragraphs. (No more than 300-500 words. Abstract should indicate what was done, how was it done and what did you find.

Introduction: The introduction should provide the reader with the theoretical and rational basis for performing the experiment. Often, the introduction should include reference to background work done by outstanding researchers. It would be appropriate to follow the form frequently used in the ASCE journals for the introduction and the succeeding sections. Indicate equations and theories if relevant.

Objectives: State your objectives for the laboratory.

Experimental Methods and Procedures: Normally, in technical journals, references are made to "Standard Methods" unless the analytical techniques employed differ from these methods. You might say, for example, that chlorides were determined by the Mohr Method wherein chloride ion is titrated by silver nitrate in the presence of chromate. Silver chloride precipitates from solution until the chloride is consumed. Thereafter, the excess silver nitrate precipitates the silver chromate, which is red in color and indicates the end point.

The discussion of the procedure may include a sketch of any unusual apparatus. Normally, no detailed drawings of standard apparatus are required.

Experimental Results: Results should be summarized, tabulated, or plotted neatly. Particular attention should be paid to the units employed. Sample calculations should be shown.

This section of the report should be prepared carefully. ***Sloppiness here will hurt your grade***.

Discussion of Results: This section of the report gives the greatest insight into the integrity of the writers. It is very easy to overinterpret data. Caution should be observed in interpreting data, and alternatives should be considered.

Conclusions: Every statement in the conclusion should be capable of undergoing careful scrutiny.

References: List references

LABORATORY RULES AND SAFETY

The following rules are made to protect the students and the equipment and to expedite the laboratory work. The rules are intended to be helpful rather than restrictive. Much of the laboratory equipment is sophisticated and costly. If you obey these rules and use the equipment with care, it will last a long time. Used carelessly, you endanger both yourself and the equipment.

Read the Directions. There may not be time enough to demonstrate each instrument to all students, so there is no alternative to learning by your own efforts. Failure to follow directions can have expensive consequences.

Think. On unfamiliar tasks, take enough time to think. Make sure you know what to do and how to do it, and then proceed.

Always Be Careful. Glassware is delicate, easily broken, and often expensive. It can produce severe cuts. You need no special training or instruction to avoid breakage. Just use care.

Label All Containers. Unlabeled containers can cause confusion especially when several students are using the laboratory. Use lead pencil or ink on marking tape or grease pencil to label and date all containers. This rule applies to containers for temporary as well as permanent use.

No Smoking, Eating, Drinking or Playing. Many chemicals are flammable. Some people are careless and burn furniture. Tobacco smoke is especially hard on some kinds of instruments. The laboratory is full of poisonous chemicals and some are deadly, reason enough to bar foods. **The ban on horseplay needs no explanation**.

Prepare for Each Laboratory Experiment. Study your laboratory manual in advance of each experiment. If you are well prepared, the experiment can be done within the allotted time and you will not be forced into hasty and unsafe procedures.

Care of Chemicals. If it is necessary to take chemicals from the reagent bottles, pour out slightly into a clean beaker more than the amount of chemical needed. Measure the amount of chemical required, and flush the rest down the sink with plenty of water. **NEVER POUR A CHEMICAL BACK INTO A REAGENT BOTTLE, AND ALWAYS USE A CLEAN SPOON OR SPATULA**. Chemicals are often explosive if used improperly. For example, you must dilute strong acid by **POURING ACID INTO WATER**. Water poured into strong acid will cause an explosion. The same is true for strong bases. Such dangerous jobs should be performed behind the safety glass of the hood. **ALWAYS WEAR SAFETY GOGGLES AND AN APRON OR SMOCK WHEN DEALING WITH POTENTIALLY EXPLOSIVE MIXTURES.**
If you notice that a reagent bottle is nearly empty, inform the laboratory instructor.

Cleanup. At the conclusion of each work period, all used glassware must be cleaned and set to drain. Make provisions to place glassware on a shelf after it has dried. No experiment is complete until the laboratory has been policed.

Gas Cylinders and Gas Regulators. Compressed gases are extremely dangerous. The greatest danger is that the gas cylinder will be dropped in such a manner as to knock off the valve at the top. The cylinder is instantly converted to a rocket with power enough to go through brick walls and do incredible damage. **STUDENTS MUST NOT, UNDER ANY CIRCUMSTANCES,**

MOVE A GAS CYLINDER OR UNCHAIN A GAS CYLINDER except under the direct supervision of the laboratory instructor.

Another source of danger is the activity of highly compressed gases under special circumstances. OIL OR GREASE EXPLODES erratically when exposed to oxygen, usually with fatal results to those nearby. A regulator valve which has been used to regulate an oil-pumped gas (compressed air, for example) will often explode when used with oxygen. **NEVER USE ANY OIL OR GREASE ON ANY HOSE, FITTING, OR DEVICE CARRYING COMPRESSED GAS. NEVER USE A GAS REGULATOR** marked "use no oil" to regulate any gas except those KNOWN to be water-pumped.

Pressure regulating valves are closed when the handle is screwed counterclockwise until it appears to be free. NEVER SCREW A GAS REGULATOR VALVE CLOCKWISE AS FAR AS IT WILL GO lest it puncture the diaphragm. In general, leave the gas regulator valve set in its operating position at all times even when the gas is not in use. When finished with the gas, close the main valve by screwing the round handle clockwise to refusal.

Acetylene gas and copper form copper acetylide (Cu_2C_2) which is a powerful, erratic explosive. NEVER EXPOSE COPPER TO ACETYLENE GAS.

Spills. Some instruments contain mercury, a volatile liquid which vaporizes slowly at room temperature. The vapor is extremely poisonous. In operating any device that contains mercury which might be blown out of the device by excessive pressure, MAKE CERTAIN THAT THE PRESSURE WILL BE INSUFFICIENT TO EXPEL THE MERCURY FROM THE INSTRUMENT. IN THE EVENT OF AN ACCIDENT, IMMEDIATELY CALL THE INSTRUCTOR AND THEN BEGIN CLEAN-UP OPERATIONS. The only practical way to decontaminate a lab from an accidental mercury spill is physical -- all of the tiny globules must be found and picked up. Flowers of sulfur (finally-divided elemental sulfur) react slowly with fresh clean mercury and with mercury vapor. Some safety regulations proscribe sprinkling sulfur liberally around an area in which a mercury spill has occurred, but the surface of mercury quickly becomes oxidized so that sulfur is ineffective.

Acid Spills. IMMEDIATELY wipe up a spill of concentrated acid with paper towels, and sprinkle the area with baking soda. Wash the area clean, and then dry it. If the acid is dilute (less than 1N), was it off with water and, after sufficient cleansing, mop the area dry with paper towels.

Base Spills. IMMEDIATELY sprinkle the area with baking soda or was with dilute acetic acid. After neutralization, was the area thoroughly with water then dry it with paper towels. Strong base reacts rapidly with skin. Wash skin thoroughly, and use a dilute weak acid to get rid of the "soapy" feeling.

Contaminated Water. Sewage may contain pathogenic bacteria. Wash the entire area with a strong disinfectant. Chlorox diluted 10:1 will do. Allow it to soak about 5 minutes, and wash it off with water. Dry the area with paper towels. ALWAYS wash the entire surface of the benches at the close of a laboratory period in which raw sewage has been used.

Cleanup. If contaminated glassware is allowed to dry, it becomes more difficult to clean. Run a sink full of water. Add a couple of squirts of a phosphate-free detergent (such as Liqui-Nox) so that there are plenty of suds; and scrub the insides of all volumetric flasks, cylinders, beakers, and erlenmeyer flasks thoroughly with a bristle brush. Scrub every part of the inside of the

glassware. Rinse with tap water at least five times because detergent tends to cling to glass. Five equivalent rinsings can be more quickly accomplished by holding the vessel upside down and squirting water from a pressure hose up into the vessel. Rinse twice with distilled water. Hold the glass upside down, and allow it to drain for about ten seconds while watching the film of water become uniformly thinner as it drains. If the film tends to pull away from the glass leaving an unwetted surface, the glass is not clean and must be scrubbed again. Stubborn contamination should be removed by acid washing.

Allow all glassware to drain until dry before returning it to the shelves.

Acid Washing. Many chemical analyses and some laboratory experiments require laboratory glassware to be scrupulously clean. Traces of foreign material will frequently invalidate hours of otherwise careful work. The best way to ensure clean glassware is to wash it in acid. Chromic acid cleansing solution consists primarily of 36N technical grade sulfuric acid to which 35 ml of saturated sodium dichromate solution per liter of acid has been SLOWLY and carefully added. (Use 100 ml sodium dichromate solution per a standard 9 lb bottle of acid.) All containers of cleansing acid should be conspicuously marked. Use concentrated hydrochloric acid (under a hood) for cleansing solution when washing polyethylene laboratory equipment because chromic acid solution oxidizes polyethylene. ALL OF THESE ACIDS ARE DANGEROUS - to you, your clothes, and others working in the laboratory. The best way to eliminate acid damage is to prevent the acid from contacting any unintended surfaces.
Rubber gloves, aprons, and safety goggles MUST be worn. Also wear old clothes, and especially old shoes, when working with cleaning acid. Occasional spills will occur. Be prepared to follow clean-up procedures. Know the location of eye washes and safety showers. Skin burns from acids can be very dangerous, so act promptly. Always wash with acid in or near a sink with copious quantities of running water to protect the plumbing. Some chemicals react violently with acid cleaning solution, so prerinse dirty glassware with tap water before immersing it in concentrated acid solution. Chemicals encrusted in graduated cylinders, test tubes, volumetric flasks, etc., should be removed with special brushes.

Carefully pour the acid into a plastic dishpan. Clean any acid drips on the bottle and replace the cap. Gently place dirty glassware in the acid bath, and rotate each piece until all surfaces have been fully covered with acid. Remove the piece, and drain most of the acid back into the dishpan. Place the glassware (now coated with acid) into another dishpan or plastic bucket to drain. After draining for twenty minutes, the glassware should be rinsed in at least 10 changes of tap water. Chromic acid clings to glassware and, if not completely removed, will invalidate biological experiments. Follow tap water rinses with at least three rinses of distilled water. Note: squirting water in a swift-flowing, thin film over the surfaces with a pressure hose for 10 seconds is equivalent to 10 rinsings. Air dry the glassware in a position so that dust cannot accumulate on the inside surfaces, and put it away as soon as it is dry to prevent the accumulation of dust.

When finished with the cleaning acid, return it to the storage bottle through a large plastic funnel. Again, be sure the acid bottle is clean before putting it away. Gloves should be thoroughly cleaned and turned inside out to dry before you leave the laboratory.

For any kind of microbiological work (such as BOD determinations), glassware cleaned with chromic acid solution should especially be thoroughly rinsed. Nochromix (Godax Lab, 6 Varick St., New York, New York 10013) is superior to chromic acid solution for acid cleaning of glassware to be used in bacteriology experiments.