Mechanical Advantage Lab

Instructor's Module

Overview:
College professors and academic textbook authors do a good job of relating generic physics lessons to their appropriate laboratory exercises. However, due to the nature of a terminal degree seeker, such as a Process Technology student, adherence to the philosophy of "real world" job related lab examples should be a primary importance. This is not to say that a straightforward generic lab exercise is of no value. In fact, they can reinforce fundamental concepts to a high level of student understanding. But again, most our students are at best marginally interested in (as well as afraid of) Physics, Chemistry and Math. We should see these classes as a " last chance" opportunity to capture the interest of a large group of intelligent productive people who might otherwise leave school with a feeling of relief instead of a yearning for more knowledge.

At first view this lab exercise may seem too simple or for that matter, far too general to enhance a more complete understanding of a physics lesson. Nevertheless, it can help a skeptical student who doesn't understand the need for a physics class, to possibly warm-up to the idea. They will see how the concepts described in physics actually impact an operator on a daily basis.

The main idea of this lab is to help students understand the concept of mechanical advantage. As we all know, mechanical advantage is a product of simple machines. Simple machines are in turn, intuitively understood by most people when a little background knowledge provided. By taking the students into the process lab and having them physically measure control valve actuators and/or handwheels on a block valve, they are forced into seeing physics in the process.

Taking this laboratory exercise out of the physics lab and adapting it to the process lab is of paramount importance. Keep in mind that the process lab is the "real world" for these students and it should be viewed in such a manner. Examples of mechanical advantage are found throughout the processing industry just as they are found throughout our own homes. If we can help them develop an eye for physics, then maybe we can help them better understand why they need to know it.

Objective:

Relate mechanical advantage to the process technician's world. We will do this by measuring and calculating the mechanical advantage of several simple machines.

Class Preparation Checklist:

1. The class should have completed the chapter on mechanical advantage.
2. The class should also have a good understanding of simple machines.
3. The class should know what a control valve actuator is as well as a valve handwheel.

Materials:

1. 2" inch *or larger* rising stem gate valve (industrial type)
2. Valve Wrench (minimum length: the diameter of the valve's hand wheel)
3. Spring type weigh scale (0-5 lb. minimum for good working 2 inch process valve)
4. Measuring Tape or ruler.
5. various pneumatic actuators

Safety Requirements:

If the students are instructed to go into a processing plant or laboratory, they will need to use the personal protection equipment normally needed in that area.

Prerequisite Skills:

1. Ability to read a ruler.
2. Ability to calculate the area of a circle and Mechanical Advantage.
3. Proper use of a valve wrench.
4. Proper use of a micrometer.

Additional Information:

1. You may choose to have the class do one or all of the activities as well as the homework.
2. In activity 2, you may need to use a micrometer to measure the valve stem if you can't read it off the tag.
3. In the diaphragm actuator example, I intentionally show the cutaway of the actuator so that a discussion about "real world" can be pursued. In this example, the "built-in" oppositional force (the large spring) is necessary to return the actuator and ultimately, the valve, to its fail-safe position.
4. Homework:

- The homework assignment is optional.
- Obviously not every student can get to a playground before the next class. This does not preclude them from participating in the discussion with the others. Everybody has played on a seesaw at some point in their lives and should have no trouble visualizing the concepts.
- The weight of the board behind the heavier person must be taken into account.

* Lab Report Draft form is attached to this document

Lab Report Draft

NAME: DATE:

Objective: (What are you trying to accomplish in this lab)
Equipment: (List all equipment used and how you use it)
Lab Task: (Steps employed to accomplish the Lab objectives)
Observations: (What did you learn by doing this lab)