

## 2.15 Suction Machines

### 2.15.1 Clinical Use and Principles of Operation

A suction pump can have hundreds of uses in the medical setting, all of which relate to removing fluids and substances from the body. Suction pumps can be used for removing ingested toxins (a stomach pump), unwanted fats (liposuction), mucosal secretions from the esophagus, blood from the surgical field, and many other applications.

Suction applies negative pressure, which is any pressure less than atmospheric pressure (760 mmHg, 100kPa or 14.7 psi), to allow for the movement of fluids or substances. The suction developed by the machine will be measured as a pressure. The common units of pressure are millimeters of mercury (mm Hg) or pascals (Pa or kPa), inches or centimeters of water (inH<sub>2</sub>O), or pounds per square inch (psi). To convert between pressures:

$$1 \text{ mmHg} = 0.133 \text{ kPa} = 1.36 \text{ cmH}_2\text{O} = 0.535 \text{ inH}_2\text{O} = 0.193 \text{ psi}$$

The essential elements of a suction machine are the source of suction, the tubing, the collection canister or bottle and if present, a manometer to measure the amount of suction. For the source of suction, there are two types of suction machines most commonly found in the developing world: electric pumps and foot-operated suction. The electrical suction is often called a "Gomco" after one of the more popular brands. A thermally driven suction machine is occasionally seen as well.

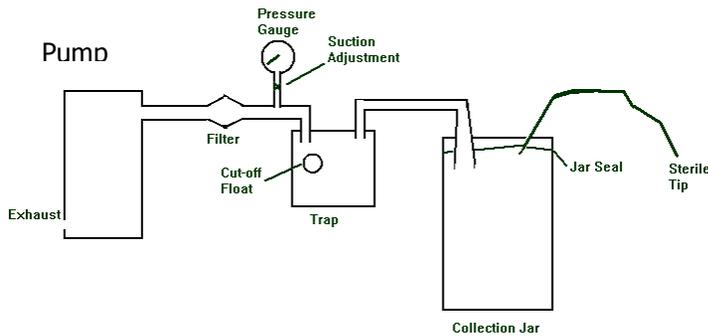


This is a typical simple suction machine. The collection jar and seal are missing. The float valve and trap are shown near the bottom left (arrow).

No matter what the source of suction, the vacuum is pulled through a collection bottle. A water trap may also be present, to prevent liquid from entering the vacuum source.

The most common suction machine will use electric motor to drive a single piston. As the piston descends, it produces a vacuum through one of two one-way valves, often reed valves, typically at the top of the piston. As the piston moves up air is forced out of the piston chamber through the second valve.

Each suction machine is a bit different, but the basic components are nearly the same. The exhaust is rarely filtered in the developing world, and the inlet filter's absence is often the cause of failure.



With a foot-operated suction, manual labor acts to drive the piston. The valve assembly is identical. On the return stroke of the piston, as the foot is removed from the top of the pedal, the piston will return to its original setting, via a spring, and suction is created with a series of valves directing the flow of fluid and air flow.

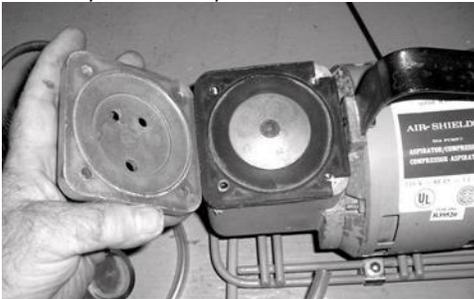
In all cases, the suction level can either be totally adjustable or has low, medium and high settings. The high settings are used for airway and gastric suctioning. The medium setting for chest tubes and the low setting for wound suction.

The thermally driven units are sometimes called thermionic units. They operate on the principle of air movement caused by heating and cooling. A coil in the unit heats up for approximately 45 seconds at which point the power to the coil is shut off and it cools rapidly. This cooling creates a suction airflow and pulls fluid from the wound site.

### 2.15.2 Common Problems

The most common problems with suction machines are clogs, leaks and the motor. Material from the collection bottle can migrate into the suction machine. This can be very damaging to the machine, possibly permanently damaging the suction machine. To avoid this, machines should be operated with some sort of filter or valve before the suction machine. However, the filter and valve present problems because they can get clogged.

If the device is operated without a filter, the suction pump can be damaged. Remove the head, as shown, to see if it can be cleaned and repaired.



A shutoff float is sometimes provided to shutoff the suction before the collection bottle overflows into the motor. The float volume must be on the pump side, not the patient side, of the collection bottle. If a multicannister setup is used, only the last canister before the connection to the suction source must have a float valve. The other canisters, closer to the patient will have the floats removed. Sometimes, someone on the operating room will remove the shutoff float from the last suction canister as well. If fluid does get into the suction machine, it will need to be completely disassembled, cleaned and reassembled.

On some Gomco machines, bacterial filters are used in input or output of the machine. These should be replaced after each patient, but in the developing world they are not. If the unit is used without the filter, it will eventually need to be rebuilt. However, this may be a short term solution. For a more long term solution, the filter may be replaced by any filter 3 micron size. The hose barb-hose barb PTFE filters can often be found for under US\$1 each. Hose barb adapters (to convert the NIPT connection on the Gomco to a hose barb) are available to allow the use of hose-barb/hose-barb filters.

Air leaks are probably the most common problem. A leak will cause the flow and pressure to cease or be reduced. The first place to look for air leaks is in the collection bottle lid, particularly with disposable canisters. The tubing can be replaced with any compatible tubing. If the leak is near one end, the tubing can be cut and used as shortened tubing. To find the leak, rub the top with soapy water while blowing through the cleaned-off tube (close off the distal end). Bubble will form where there is a leak.

The collection bottle often breaks. The collection bottle is not special. Any glass or rigid plastic bottle can be used as a substitute. The alternative must be air tight and have two connections of the proper size to fit the collection set. The seal between the collection bottle and its cap can be improved with a small amount of petroleum jelly, or replaced with rubber, or even leather, cut to the proper size and shape.

Noise is a frequent complaint from electrical pumps. Try placing a pad under the machine to reduce the vibration noise between the suction machine and the floor.

The pistons are generally driven with an induction motor. An induction motor is used as it is the easiest, most cost effective motor to drive a medical device. There are no gears or chains. Check the section on the centrifuge (later in this book) for more information on electrical motor repair and testing.

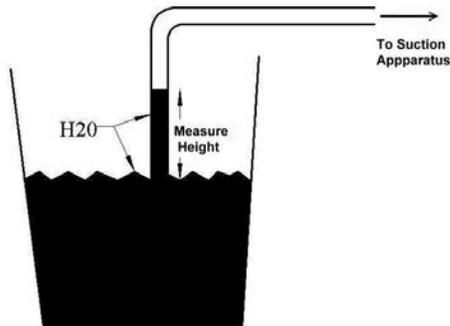
### **2.15.3 Suggested Minimal Testing**

The pump is connected to the piston through a bearing. To clean bearings without dismounting, hot light oil at 180-200° F may be flushed through the housing while the shaft is slowly rotated. Light transformer oils, spindle oils or automotive flushing oils are suitable for cleaning bearings, but oils heavier than light motor oils, such as SAE 10, are not as effective. To lubricate the pumps, first, thoroughly clean the grease fitting and outside of the bearing housing. Next remove the drain plug and inject clean, new grease to forcing out the old grease. Start and run the pump for a short time to eject any excess grease, which should later be wiped off surfaces, and then replace the drain plug.

Most suction apparatuses cannot be calibrated, per se. However, the accuracy of the pressure gauge can be checked as can the ability of the suction machine to pull a vacuum in the desired range. To check the pressure, place water in a bucket. Turn on the vacuum and draw the water as high as it will go, typically between three and five feet. Record the height in inches or millimeters and calculate the actual pressure in mmHg as the  $(\text{Height of Water (in inches)} * 25.4 \text{ (mm/in)}) / 13.6 \text{ (mmH}_2\text{O/mmHg)}$ . This can be compared to the pressure shown on the gage and compared with the physicians intended use.

## Equipment found in the OR, ICU and ER

To check the pressure, place water in a bucket. Turn on the vacuum and draw the water as high as it will go.



As collection sets (tubes and suction tips) are frequently reused in the developing world, they often become clogged and leaky. Before releasing a suction machine for use, if you suspect that a collection set will be reused, try to perform your equipment checks using the intended collection set.

The filters often become clogged, and are not often replaced because the correct filter requires a threaded NIPT male end for some models. However, with an NIPT to hose-barb adapter, you can use the very cheapest filters, which have hose barb on both ends.