

## Bubbles

Bubbles form when gasses are coming out of solution either because of an increase in temp (ie. gas is less soluble at higher temp) or because the partial pressure above the solution has decreased (as when a pressurized solution is move to atmospheric pressure). For example in a perfusion system the solution in the reservoirs (eg. syringe barrels etc.) might have been stored in the refrigerator overnight and then bubbles develop slowly as it warms or bubbles form as the solution warms as it flows through tubing leading to the tissue chamber. The bubbles are a particular problem when the solution is going through a perfusion device (eg. **MPRE8**) with small tubes since the bubble can block the solution flow. Even with a tissue chamber a bubble at the inlet can burst in the chamber and disrupt the solution surface enough to break a patch seal.

The general idea to avoid bubbles is to heat solution in the reservoir so that the amount of dissolved gas is reduced below the level at the final temperature of the solution. For example if the solution is going to be pre-heated going into the tissue chamber to 35C then you would heat the reservoirs to say a temperature above 40C for a sufficient time for the dissolved gas to be in equilibrium. One reason for heating to a higher temperature (than 35C in this example) is that some gas will pass back into the solution through the tubing walls. The table below gives the permeability for various tubing materials to oxygen. Commonly, silicone tubing (similar to gum rubber in permeability) is used for solutions but this

## Permeability of tubing materials

Resin	O <sub>2</sub> permeability
Silicon	7961
Pharmed	80
Polyethylene	60
Polypropylene	25
Viton	15
Tygon	12-30
Teflon	<1 (est.)
PVC	<1 (est.)

The following gas permeabilities (units of 10<sup>-10</sup> cm<sup>2</sup>/sec(cm Hg)) taken from Cole-Parmer Instrument Catalog

is not a good choice since it is highly gas permeable. Better choices are PVC tubing or Tygon tubing. Also increasing the thickness of the tubing walls decreases the gas permeability so the thicker walled Tygon tubing may be better than a thin walled PVC. Tube.

## cFlow and MPRE8

With the **cFlow** you can use the **SYRHT8K** syringe barrel heater kit to heat the solution in the syringe resevoirs. This kit has simple siliconized heaters that wrap around the syringe barrels, a rheostat to regulate the current to the heaters and a 12V power supply. Typically it isn't necessary to precisely control the temperature of solution in the reservoirs. The heat losses from the solution are also fairly constant but it will take time for the solutions to reach the desired temperature and if you add new solution you need to allow sufficient time for it to heat up. For the tubing that goes through the **cf8VS** valves you need to use a short length of silicon tubing but elsewhere you should use Tygon or another tubing with low gas permeability. For the Tygon microbore tubes going into the **MPRE8** you should keep these as short as possible and use thicker walled tubing elsewhere.