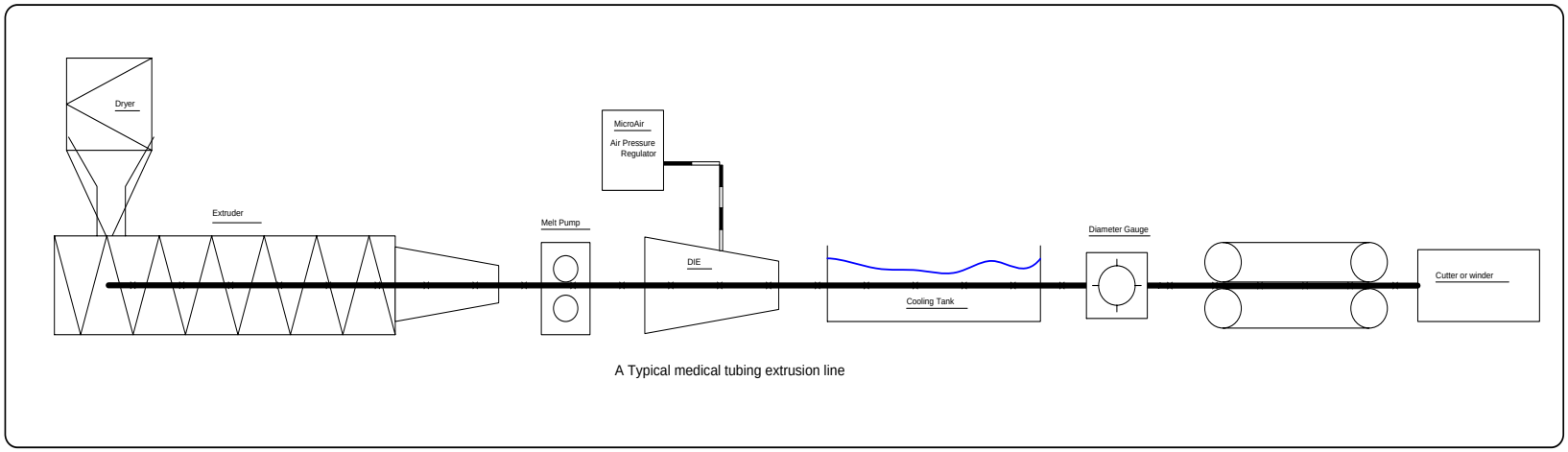
Extrusion Process and the need for Air Pressure Control

The Extrusion Process

During the extrusion process, air at a specific pressure is used to obtain the intended tubing shape. The goal is that by controlling the extrusion rate along with the internal air pressure of the tubing you can achieve the correct values for the outside diameter and wall thickness. Low air pressure is injected into the DIE which flows through the center of the pin that makes up the inner part of the extrusion die, and then directly into the semi-fluid tubing as it is coming out of the die. Sizeable diameter variations can be caused by the slightest pressure change during the extrusion of thin-walled products. If the air pressure is not constant, the extruded tube wall section will vary. A needle valve can control pressure only if the flow is constant. Since the flow varies (see below), a true pressure regulator is needed to maintain the required tubing dimensions.

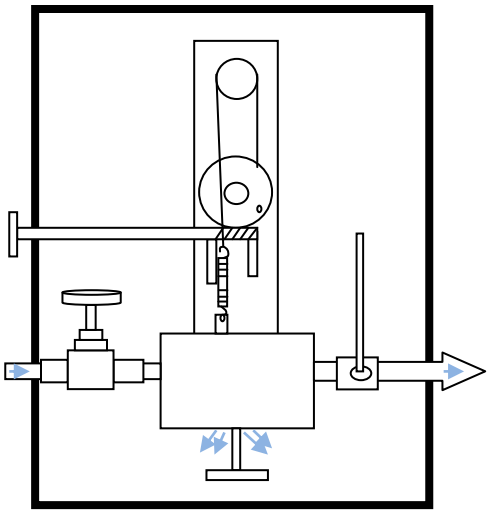
The main function of the MicroAir is to supply stable easily-regulated low air pressure air from your normal air source, which may have wide variations. Air-supply units for air-pressure size control of tubing must provide precise pressure regulation to ensure close tubing dimensional tolerances. Typically, the pressure regulation is +/- 0.01%. Air pressure control is most often the best variable to control because it directly affects O.D., and does not affect any part of the extrusion process that is sensitive to speed changes such as in line length-cutting, saws or wind-up.



A Typical medical tubing extrusion line

Spring – MicroAir

The simplest most effective technique for control air pressure is throwing away excess air through a force balance system consisting of a bleed off valve and a spring. This system may oscillate, so a damping means must be added consisting of a damping member and a small amount of silicone oil. The MicroAir is built this way and is widely used in the medical and catheter tubing field. The pressure is held constant independent from changes in flow from uneven puller belt pressure, cutter, spooling or line speed changes.



Our MicroAir units are designed for the precision pressure control of low air pressures on sensitive production processes. When connected directly to the standard factory air supply via the MicroAir's internal flow control valve, the regulator balances the output pressure against the tension of a low rate spring and expels surplus air to the atmosphere. The air in the MicroAir opens the blow off valve until a balance is reached between this air pressure and the spring tension. With the relief valve stem hung vertically on a balance spring, and literally floating on a cushion of air, friction is negligible and this produces a hysteresis-free output pressure as input pressure or output flow changes. An oil chamber mounted below the pressure relief valve adds viscostatic damping to movement of the relief valve, and ensures stability. The oil does not come in contact with the output air at any time.

Voice Coil – MicroAir IV – Bump or Taper Tubing

Bump, bubble or taper tubing is now made to allow the catheter maker to cut through this expanded portion and use it for easy entry of fiber optic bundles, wires, or other items into the various lumens. Making bump tubing can be done with our MicroAir IV unit which is capable of high-speed switch between two points.

Bubble tubing is produced by increasing and decreasing the puller speed to change the drawdown and thus create a different tube diameter at each speed. Air pressure can be applied inside the tube through the die to assist in setting the tube size and wall thickness. The air pressure

can be changed at the same time speed changes are made in order to affect wall thickness dimensions. To make bump or taper tubing the air pressure inside the tube is changed at the same time that puller-speed changes are taking place.

Air pressure supply units using an electrically controlled actuator such as our MicroAir IV can provide precise pressure regulation and the ability either to switching rapidly between two pressure set points or to respond to a 0-10 volt input signal to follow the transition between diameters. With its electronic setpoint control, bump and taper control is less than 0.1 second.

MultiLumen

Manufacturers have found that it is necessary to regulate separately the air into each one of the lumens of multilumen tubing. This allows for relatively independent control of the size of each of the lumens. To control the shape of each lumen while manufacturing multilumen tubing by having a separate air-pressure control for each lumen. Low Pressure regulators make it possible to accurately adjust and maintain pressure differentials at low pressures in each lumen. Care must be taken to ensure that the air supply used for pressure regulation is subject to the same influences as the ambient air surrounding the extrusion line.The MicroAir balances with ambient air as opposed an air pump regulator. Pressure and vacuum control are sometimes combined when making multilumen tubing. Even with vacuum control each lumen in multilumen tubing must have a separately regulated source of air pressure.

Each model of our MicroAir units comes in two or three channels in a box. The MicroAir IV model can be purchased in a 4-channel unit.

Ultra Low Ranges

The most common range of air pressure regulator is 0 – 30” of water column. The maximum range pressure is 0-5 psi. The minimum full-scale range of a MicroAir I is 0-.25 inches of water.

1 psi = 27.68” of water = 68.94 mbar
5 psi = 138.4” of water = 350 millibar = 34.47 kilopascal
It is recommended for your best resolution that the pressure your line requires be in the middle of the range (scale of meter). The range needed can depend upon the viscosity (soft/hard) of the tubing material.

Normal ranges or our MicroAirs are: 0 – 3” of water, 0 – 5” of water, 0-10” of water, 0-15” of water, 0-30” of water, 0-50” of water, 0-3 psi and 0-5 psi.
Other scales are available: mbar, kpa, and pa. And metric.
MicroAir I and MicroAir II models can be range changed for free within 60 days of purchase or with a range change kit.

Controlling your Pressure and forming a Closed-loop control extrusion line.

With the addition of an output option (0-10 volt or 4-20 ma) the MicroAir can connect to the PLC for 100% complete feedback control. Closed-loop control methods have led to major advances in the extrusion of precision tubes for medical and health-care applications.

A complete closed loop control system can automatically set the appropriate screw or gear pump speed, the puller speed, and internal air pressure.

Precision, Stability and Repeatability

Dwyer magnehelic differential Pressure gage (4") meters have a +/-2% accuracy. A 0-0.25" of water MicroAir I has been tested to hold 0.05" of water without any problems. Digital Displays can have two decimal places for units, 0- 10" of water or less. Our digital displays are more accurate than the magnehelic meter.

At less than 10% of full scale our units can lose some accuracy, which is why it is recommended that your range be in the middle of the meter. (Example 0-3 psi unit would loose some accuracy below 0.3 psi.)

The manual MicroAir I is controlled by a 10 turn knob. The MicroAir II can be controlled by an OD gauge, or ultrasonic wall gauges such as those built by Beta LaserMike, Zumbach, LaserLinc or Sikora. All our models can easily be ordered or installed on your Davis-Standard, Gimac (Italian), American Kuhne or RDN lines by their technicians when you set up a new line.

Stability of regulator:	<+- -/2% for 30 inches of water and below. <+/- 0.3% for psi
Accuracy:	Flow changes of 50% effect the pressure by less than +/- 0.2% of full scale for lower ranges and +/- 0.5% of full scale for higher psi units.
Regulator Pressure Repeatability:	+/- 0.2% of full scale for low ranges +/- 0.3 % for 3 and 5 psi
Pressure Display Resolution:	Dwyer magnehelic meter +/- 2% of full scale Digital Display (option): +/- 0.1% of full scale below 60" of water +/- 0.3% of full scale above 3 psi

About Us

On Line Controls has been the leading manufacturer of air pressure regulators and controllers for tubing extrusion lines for over 30 years. Many units 15 – 25 years old are still working in extrusion plants all over the world. In addition to our manual MicroAir I, controller MicroAir II and high-speed MicroAir IV units, OLC has added digital display, output options, and remote control for MicroAir II. As critical medical tubing has required tighter tolerances and smaller OD, ID and walls, we have led the way in increased stability, precision and accuracy of all our models.

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