Tubing Flow Measurement Applications

Flow measurement through tubing has the flexibility to be available to many applications in life sciences that perivascular flow measurement, due to required surgical training and the highly regulated use of animals, is not. Tubing flow measurement can be applied at all levels of expertise: from the bioengineering student learning interrelationships of hemodynamics, to R & D engineers at medical device manufacture companies testing new devices, as well as by medical doctors and perfusionists involved in translational research to improve patient care. Knowledge of flow dynamics plays a huge role in all these environments and is applicable to all these uses. Transonic "research" flowmeters are utilized in any of these applications where the equipment is not directly used on a human subject (please contact Transonic for information about clinical tubing flowsensor options). The following list is not exhaustive. New applications arise frequently as innovative therapies and new devices are developed and need to be tested. The flexibility, quality and accuracy of Transonic Tubing Flowsensors makes them the technology of choice for flow measurement from the early stages of scientific innovation to final device development.

Mock Circulation Loops

Bench models of the circulatory system are comprised of tubing flow channels, compliance chambers, a pump or method to circulate reservoir liquid in a manner that mimics the arterial and/or venous circulatory system for the purpose of understanding the underlying mechanisms of blood flow, pressure and impedance. If well developed, circulatory models can be created for any arterial configuration to study cause and effect of blood flow & pressure/resistance changes in a physical system that can be monitored with flow and pressure sensors to characterize normal hemodynamics for basic science studies as well as compromised circulatory conditions such as heart failure, congenital heart flow defects, sheer stresses on vascular walls, vascular stenosis, etc. The real time monitoring of flow in the loop gives hands on feedback to manipulations of the cardiovascular system if well designed without the need to sacrifice animal subjects.

MEnPXL Clamp-on Flowsensor and
TS410 Tubing Flow Module

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Pulse Duplicators & Heart Valve Testing

Some flow loop models are configured to specifically duplicate a pulse with the same characteristics of a human heartbeat. These pump devices produce a flow wave pattern to test performance of replacement aortic and mitral heart valves under the hydrodynamic flow conditions found in the heart, but reproduced on the bench. The FDA has stringent test requirements for heart valves including regurgitant fraction (low leakage values), effective orifice area and mean transvalvular pressure gradient. With the increase in valve replacement therapy, there are several new valve options. The valves undergo testing in specialized labs at the major medical device suppliers. High resolution instantaneous flow measurement is required to characterize valve function in the pulse duplicator. Transonic tubing Flowsensors are well designed for this purpose and are now integrated into some of the commercially available pulse duplicator test devices on the market. It was previously thought that Transonic's specifications (zero offset spec) were inadequate to measure valve leakage. However, with the modern pulse duplicators utilizing wave form analysis software, the system has been reproducible and is now widely accepted.

VAD (Ventricular Assist Device) & Pump Testing

The purpose of a VAD or bypass pump is to augment, relieve or replace the human heart pumping action for short or extended periods to deliver oxygenated blood flow to the systemic circulation. Any such device, from its design conception, must be tested and measured to ensure that the pump is delivering the required flow. Transonic plays a well-established role in this market with tubing Flowsensors used at all phases of the device development. Our Flowsensors are used in design, validation, and in LCT (Life Cycle Testing) where our Flowsensors independently measure pump output 24/7 to monitor pump performance. Performance data is supplied to the medical device regulatory agencies annually. Clamp-on sensors preserve sterility of system which is ideal when the solutions must be contained and perhaps treated to suppress bacterial growth during extended in-use periods.

Flow Phantoms (Fluid Dynamics/Physics Labs)

These are specialized circulatory models used to test and validate ultrasound imaging systems that monitor flow profile and velocity to study shear stresses on the vessel walls and stenosis. They are typically set up to use liquids that can model the acoustic properties as well as the physical properties of blood such as viscosity. While Doppler imaging systems give information on flow profile and velocity; Transonic tubing Flowsensors provide validation for the volume flow component. Microspheres or nanoparticles may be added to the solution to provide refractive index to the solution to monitor flow profile by laser light or Doppler ultrasound. Viscosity is often achieved by mixing specified concentrations of glycerin (typically 35 – 55%) to water. Some solutions also include concentrations of salt. All these additives have an effect on the timing of our ultrasound signal and sensor calibration must be performed with the actual fluid to ensure the most accurate calibration.

Bioreactors, Cell Culture & Regenerative Medicine

Bioreactors are environmental soup-pots used to mix cell media and nutrients at optimal doses to grow biologic material: virus vaccines, biologic pharmaceuticals, tissue engineered vascular grafts (TEVG) and other cell therapies. Conditions are optimized for cell growth and survival, so any dosing or flow transport is done at specific flow rates to guard against shear damage.

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Isolated Perfused Organ Research (Animal Research)

This is a staple application of the cardiovascular laboratory. One of the best methods to study organ perfusion or cardiac function is to isolate the organ and maintain the living tissue in a chamber where it can be studied without the complications of hormonal changes or maintenance of the rest of the body. Pressure and Flow are monitored via catheterization of the heart chambers. Langendorff and working heart preps allow study of myocardial circulation in mice and rats that cannot be measured directly with Perivascular Flowprobes.

Organ Perfusion Devices

R&D development of organ perfusion chambers for transplant (heart, kidney, liver) also use Transonic tubing Flowsensors. These devices require circulation of nutrient perfusates at cold temperatures to preserve tissues after harvest and during transport before transplant. Device development typically uses Transonic research Flowmeters and Flowsensors as a precursor to OEM development.